Ngapuna Air Quality Monitoring Report 2008

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Environment Bay of Plenty
Environmental Publication 2009/02
January 2009

5 Quay Street
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ISSN: 1175 9372

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Executive Summary

Air quality monitoring data recorded during the last two summer periods (2007/08 and 2008/09) at the monitoring caravan located in the Ngapuna Industrial Area has shown exceedances of the NES-AQ for PM_{10}. Designation of the Air Quality Management Area for Rotorua was primarily based on the wintertime exceedances recorded within several residential areas of the city. The latest exceedances are a summer time phenomenon and council requires a better understanding of the contributing emissions and frequency.

This report summarises PM_{10} data collected within the Ngapuna Industrial Area, Rotorua and investigates the cause of the recorded PM_{10} exceedances at the Ngapuna air quality monitoring site.

Historical monitoring data (1999-2002) shows the Ngapuna Industrial Area to be a “dustier” environment when compared to values recorded for the same period at the Pererika Street residential/traffic air quality monitoring site located in central Rotorua.

The full PM_{10} dataset is unlike the three other monitoring locations within Rotorua City, no winter peak, bell shaped annual distribution is evident. This more even annual pattern highlights the fact that domestic emission influences are not dominant at this particular location, rather the pattern is for sporadic elevated levels to typically occur during the spring and summer months.

The high resolution dataset (10 minute values) shows an increase in base levels of PM_{10} in the quadrant from 220° to 280°. Peak values are also prevalent within this quadrant. This direction represents an air mass that has moved through the Ngapuna Industrial Area. Interestingly elevated levels also occur outside this quadrant and occur during the winter periods and therefore could originate not only from traffic on Te Ngae Road (SH30) but from the domestic sources in the Lynmore residential subdivision area to the east and the southwestern ends of the Owhata subdivisions.

Several temporal patterns exist within the PM_{10} dataset. Noticeably the highest daily results occur during the working week with concentrations diminishing in the weekends. This pattern would be associated with the typical Monday to Friday trading hours of a business operation. It should be noted that the boilers associated with the wood processing industries within the Ngapuna Industrial Area are normally 24 hour a day, 7 day a week operations.

The performance of the two main industries (currently operating) in regard to particulate emission control has been chequered. Stack test results show that both sites have had issues with compliance for particulate emissions.

Investigation of video surveillance footage for the October 2008 exceedances showed the emissions from the Tachikawa boiler stack to be ‘normal’. There was however evidence in the footage of plumes/clouds of dust passing through the field of view of the camera. Because of the limited view of the camera it was not possible to determine the source but it is suggested that the primary source of particulate during these elevated periods of data was not the nearby boiler stack.

The elemental composition of particles identified on the collected samples indicates a general urban dust profile with contributions from soil and road sources. No dominant potassium signature was evident on any of the investigated particles, which would indicate wood material that has been exposed to a combustion process.

This report shows that there is no one single contributor to the exceedances recorded to date, more so a combination of a number of sources. Table 6 attempts to list emissions in order of level of contribution to the summer time NES-AQ exceedances impacting on the Ngapuna Industrial Area, and this will hopefully give direction to action plan strategies for obtaining compliance with the NES-AQ.

Chapter 1: Introduction

Environment Bay of Plenty is required to undertake monitoring activities as part of its statutory responsibilities under the Resource Management Act 1991 and the Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004.

The current air Natural Environmental Regional Monitoring Network (NERMN) is based around a regional network of monitoring sites designed for regional state-of-the environment monitoring, documentation and reporting. Natural environment monitoring determines the overall regional impact of activities on environment quality.

A new Regulation for ambient air quality in New Zealand was promulgated in September 2004, as a National Environmental Standard (NES-AQ) under s43 of the Resource Management Act 1991. In response to the Ministry for the Environment's request to nominate Air Quality Management Areas, Environment Bay of Plenty has currently designated only one Air Quality Management Area for the Bay of Plenty region, this is the Rotorua Air Quality Management Area (New Zealand Gazette, 2005).

Air quality monitoring data recorded during the last two summer periods (2007/08 and 2008/09) at the monitoring caravan located in the Ngapuna Industrial Area has shown exceedances of the NES-AQ for PM_{10}[1]. Designation of the Air Quality Management Area for Rotorua was primarily based on the wintertime exceedances recorded within several residential areas of the city. The latest exceedances are a summer time phenomenon and council requires a better understanding of the contributing emissions and frequency.

[1] Particulate matter less than 10 microns in diameter.

Chapter 2: Report Scope

This report –

- summarises PM_{10} data collected within the Ngapuna Industrial Area, Rotorua (Figure 1).

- investigates the cause of the recorded PM_{10} exceedances at the Ngapuna air quality monitoring site.

Chapter 3: Physical Description of Ngapuna Industrial Area

The Ngapuna Industrial Area is a mixture of industrial and residential land use covering approximately 1 km^2. The area is bounded to the east by SH30 which has an average daily traffic volume of ~18,000 vehicles, of which ~5% is classed as heavy. To the south and west the area is bounded by the Puarenga Stream and Sulphur Bay of Lake Rotorua. To the immediate north is farmland which is covered in pasture and during summer, maize crops. 400m further north is the southern boundary of the Owhata West residential subdivision.

Topography is generally flat throughout the Ngapuna Industrial Area, with a slight fall of 8m over 800m from SH30 (290m ASL) to the western margin (282m ASL). Soil type is varied, with the area south of Allen Mills Road being the well drained Tikitere Sand (parent material - hydrothermal altered tephras). North of Allen Mills Road and east of Vaughan Road is the well drained Whakarewarewa sandy loam, and to the west of Vaughan Road is the imperfectly drained Waiowhiro Sand (parent material – pumice derived from lake sediments and colluvium).

Annual rainfall is 1450mm, compared to 1300mm for Tauranga and 1250mm for Whakatane.

Landuse is predominately light to medium industry, but is punctuated by a centrally located 0.1km^2 area occupied by the Ngapuna residential subdivision centred around Hona Road and Hurunga Avenue. The Census 2006 usually resident population count for this subdivision was 270, with a calculated deprivation index of 10 (most deprived).

Industry is mixed, but has a focus on the primary and secondary timber industries. Timber processing plants are the largest operators and current air discharge consents are held by Tachikawa Forest Products (NZ) Ltd (hereafter referred to as Tachikawa) and McAlpines (Rotorua) Ltd (hereafter referred to as McAlpines) and the ex-Panahome site currently owned by Claymark Industries Ltd (but at the time of this report the boilers are not being used).

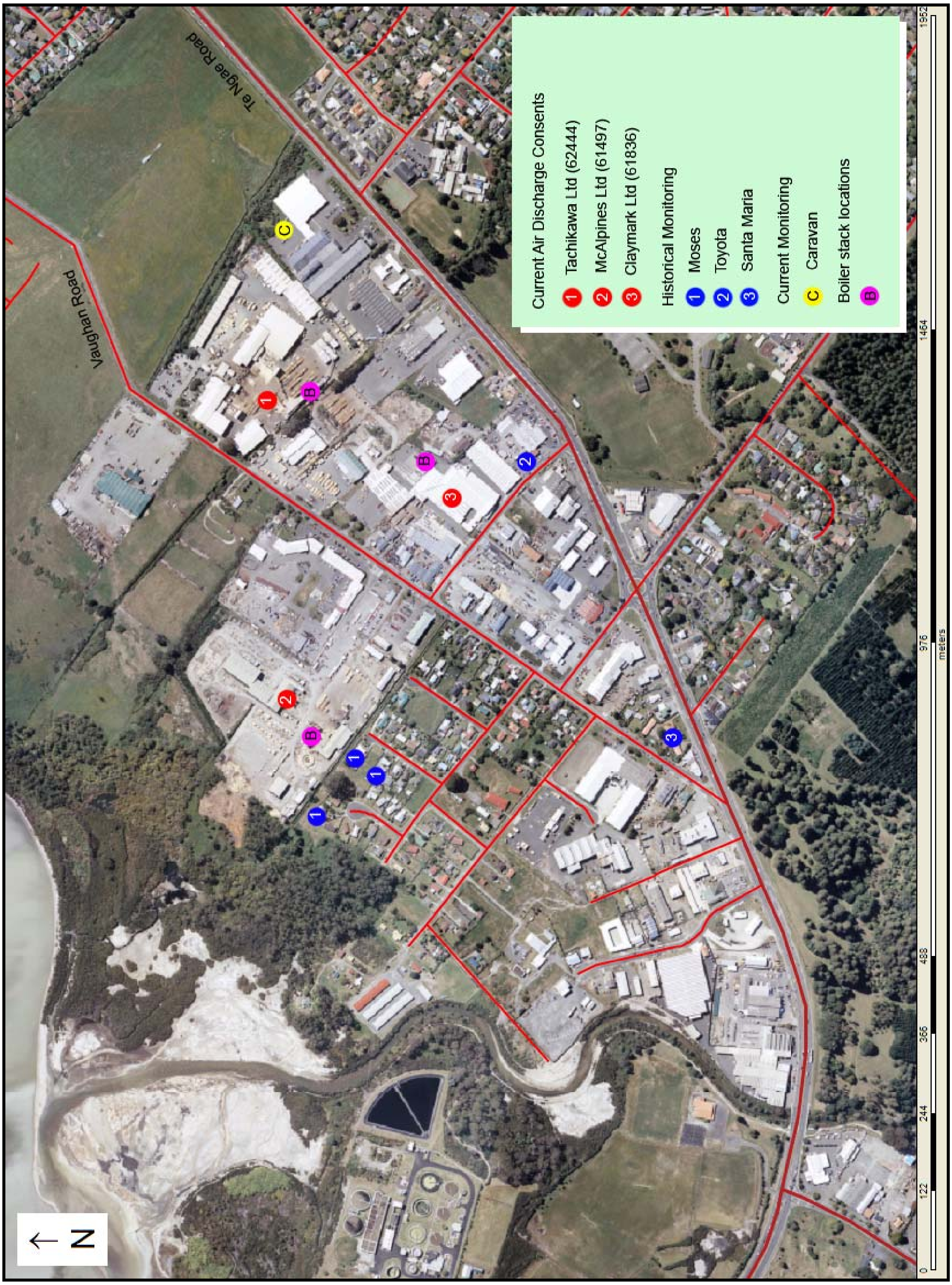


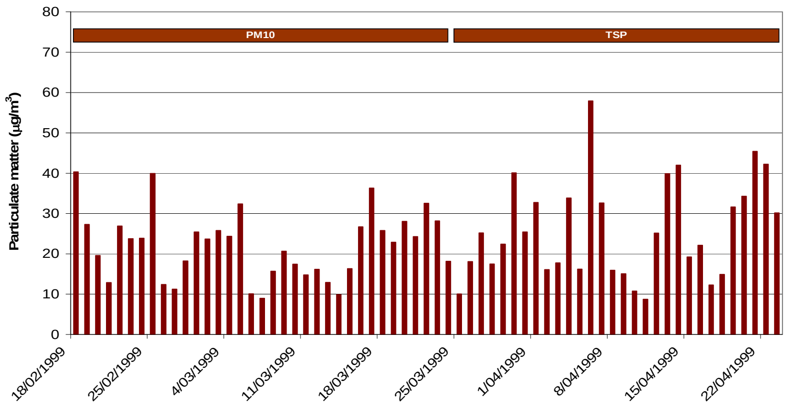
Figure 1 Ngapuna Industrial Area.

Chapter 4: Historical Monitoring Information

The following section contains a brief graphical summary (Figure 2) of historical particulate monitoring (1999-2002) that has been undertaken in the Ngapuna area by Environment Bay of Plenty. This monitoring was undertaken as part of the compliance/complaint monitoring programme and site locations were determined as a result of nuisance dust complaints. At the time of monitoring and reporting, the PM_{10} guideline was 120µg/m^3 and the total suspended particulate (TSP) guidance value (from the Environment Bay of Plenty Air Plan) was 150µg/m^3 (both as 24 hour averages).

The results show a "dustier" environment when compared to values recorded for the same periods at the Pererika Street residential/traffic air quality monitoring site located in central Rotorua. For the period of the Santa Maria data record the mean value at Pererika Street was 13µg/m^3. Mean values of 15 and 12µg/m^3 where recorded at Pererika Street during the Rotorua Toyota and Moses Road monitoring respectively. These limited sets of monitoring results show, as a rule of thumb, the Ngapuna Industrial Area is generally twice as dusty as the NERMN monitoring site in central Rotorua.

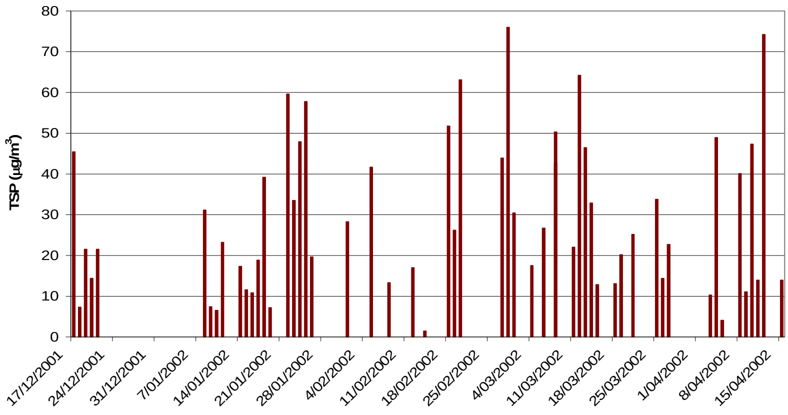
Santa Maria



PM_{10}	
Mean	22
Median	23
Minimum	9
Maximum	40
Count	37

TSP	
Mean	27
Median	25
Minimum	9
Maximum	58
Count	28

Moses Road



TSP	
Mean	29
Median	23
Minimum	1
Maximum	76
Count	55

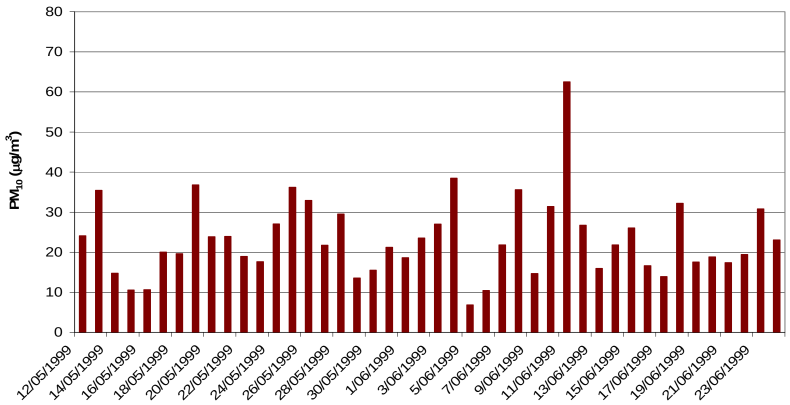
Rotorua Toyota		**PM$_{10}$** Mean 23 Median 22 Minimum 7 Maximum 63 Count 44

Figure 2 Historical particulate datasets collected within the Ngapuna Industrial Area.

Chapter 5: Methodology

The following section outlines the current datasets that are used within this report.

Air quality and meteorological data is collected from the Environment Bay of Plenty monitoring caravan situated on the Cryovac Ltd premises located at the northeastern boundary of the Ngapuna Industrial Area.

Video surveillance data is collected from a camera mounted to the east of the Ngapuna Industrial Area. Currently the field of view of this camera is centred on the Tachikawa boiler stack.

Scanning electron microscope imagery and associated elemental data has been collated from analysis of particles collected on the Sequential Partisol 47mm quartz fibre filters (24 hour exposure) at the monitoring caravan.

Aerial photography collected in 2006 and the Rotorua District Council (RDC) waste control spatial dataset has been used for identifying possible air emission sources.

Rainfall data collected at Whakarewarewa has been used for investigating the relationship with wet deposition and dust suppression.

Dispersion modelling of the consented industries has been undertaken to determine ground level concentrations and spatial distribution of PM_{10}.

Other episodic events such as agricultural activities (e.g. lime application) have been briefly investigated.

Chapter 6: Data Analysis

6.1 Meteorology and particulate matter datasets

Windspeed and direction are important parameters to access when investigating air quality. Moderate to high windspeeds can often be responsible for the grounding of stack emission plumes and resuspension of dust material. Depending on the settling velocity of a particle, moderate windspeeds can be capable of transporting particles (<100μm) several hundreds of meters. Coupled with knowledge of the wind direction, this information can often make identification of a particulate source a simple mapping exercise.

For the Ngapuna Industrial Area the annual prevailing wind is a southwesterly (Figure 3). Seasonal variations do occur and a general 180° shift is recorded in the dominant wind direction between winter and summer for the Rotorua area. The direction of the annual prevailing wind means the air monitoring caravan is well positioned to measure the maximum affect of the Ngapuna Industrial Area activities on air quality.

Hourly wind data from the long term Rotorua Airport site shows an annual prevailing pattern dominated by winds from the west to southwest quadrant. This is emphasised in the wintertime dataset. During summer there is a significant period of time when there are winds from the northern quadrant generated by sea breeze circulation. However for this investigation finer temporal resolution data is required in order to determine smaller scale influences of the contributing sources on air quality.

Within the Ngapuna Industrial Area 10 minute resolution PM_{10} and meteorological data has been collected at the air monitoring caravan for the period 22 June 2007 to present.

Two sets of analysis have been performed (i) on the entire overlapping datasets for meteorological and PM_{10} data, and (ii) on a selection of periods associated with exceedances of the PM_{10} standard.

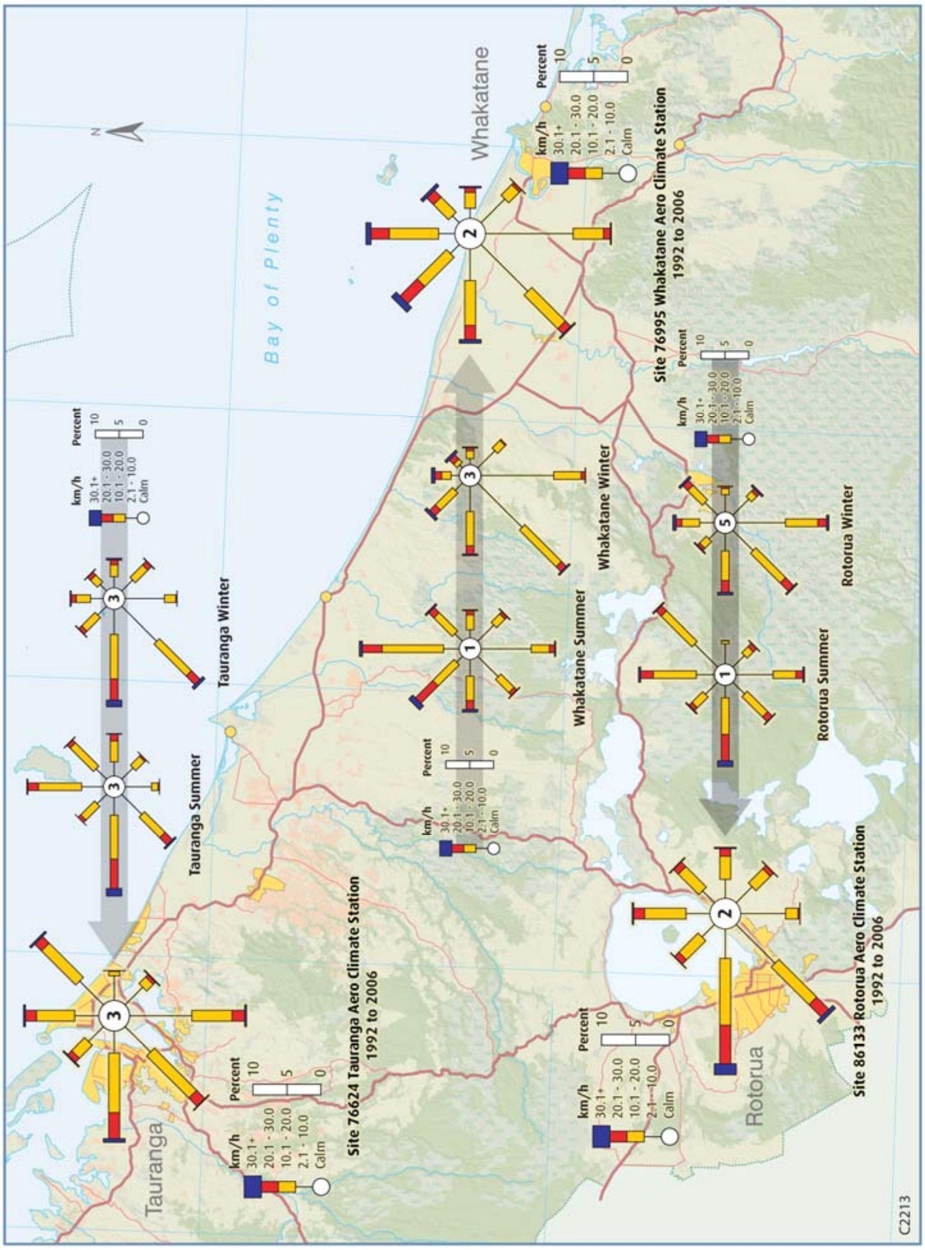


Figure 3 Annual and seasonal wind patterns for the Bay of Plenty.

The full PM_{10} dataset is shown in Figure 4. Unlike the three other monitoring locations within Rotorua City, no winter peak, bell shaped annual distribution is evident. This more even pattern highlights the fact that domestic emission influences are not dominant at this particular location, rather the pattern is for sporadic elevated levels to typically occur during the spring and summer months.

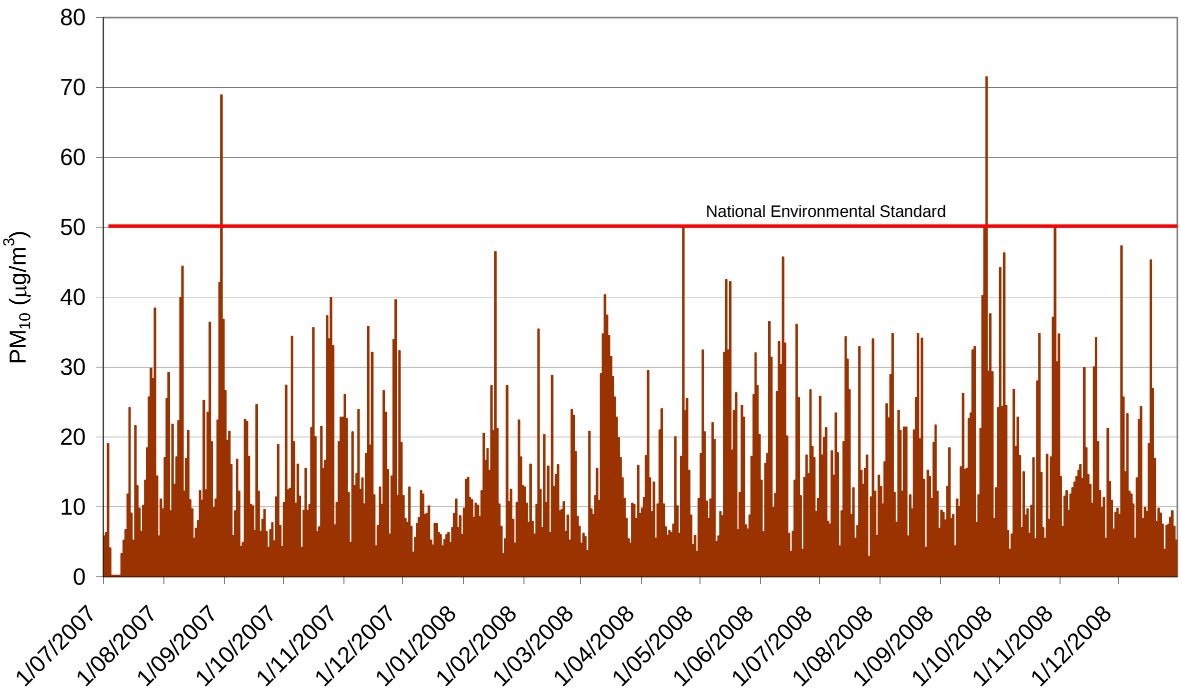


Figure 4 PM_{10} time series for the Ngapuna air quality monitoring caravan.

Figure 4 shows a number of exceedances of the NES-AQ and these are tabulated in Table 1. Concentrations presented in Table 1 often only just exceed the NES-AQ for PM_{10} ($50\mu g/m^3$) and are typically well below the levels recorded at the peak neighbourhood site in Edmund Road on the western side of Rotorua City (90%ile = $50\mu g/m^3$, max. = $162\mu g/m^3$).

Table 1 Recorded exceedances at the Ngapuna monitoring caravan.

2007		2008	
Date	**PM_{10} ($\mu g/m^3$)**	**Date**	**PM_{10} ($\mu g/m^3$)**
23 June	59	24 September	72
30 August	69	29 October	50

Pollution roses for a selection of the recorded exceedances are presented below (Figure 5) these show the directional dominance of the source material leading to these exceedances.

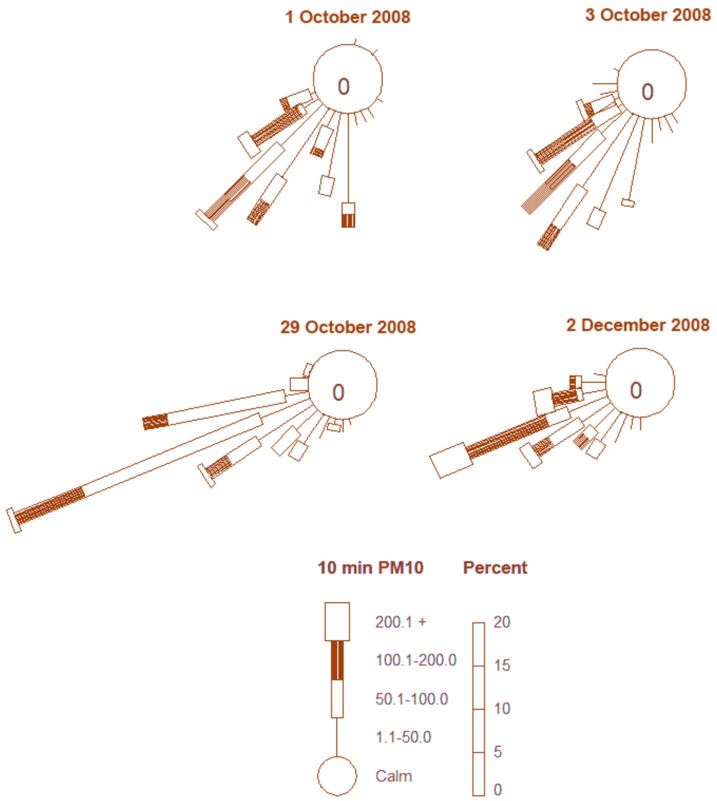


Figure 5 Pollution roses for a selection of recent NES exceedance recorded within the Ngapuna Industrial Area.

As stated earlier in this section, the combination of both wind information and air quality data provides a useful tool in determining possible particulate source(s). The annotated scatterplot below (Figure 6) incorporates both of these datasets to attempt to identify contributing sources. The plot information is 10 minute average data which provides suitable temporal resolution for undertaking such a task.

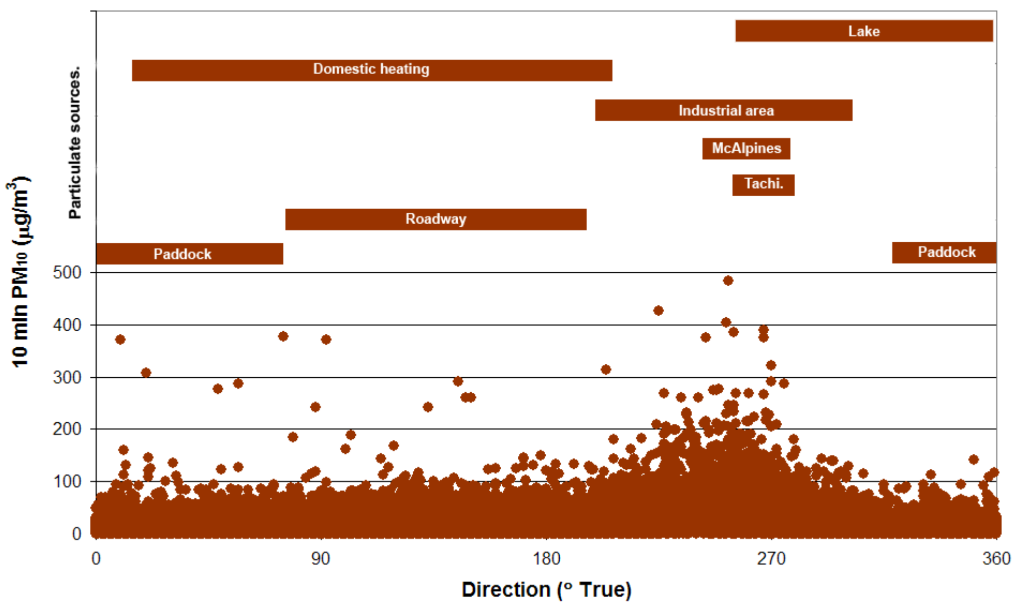


Figure 6 Wind direction/ PM_{10} relationship for August 2007 to November 2008

Figure 6 shows an increase in base levels of PM_{10} in the quadrant from 220° to 280°. Peak values are also prevalent within this quadrant. As annotated, this represents an air mass that has moved through the Ngapuna Industrial Area. Interestingly elevated levels also occur outside this quadrant and when the dates were checked they occur during the winter periods and therefore could originate not only from traffic on the busy Te Ngae Road (SH30) but from the domestic sources in the Lynmore residential subdivision area to the east and the southwestern ends of the Owhata subdivisions. On a less frequent basis, short lived elevated PM_{10} levels can also be attributed to agricultural activities in the adjacent paddocks to the northeast of the monitoring caravan. This was the case recently where lime was being applied to the paddock prior to the planting of maize (Figure 7).

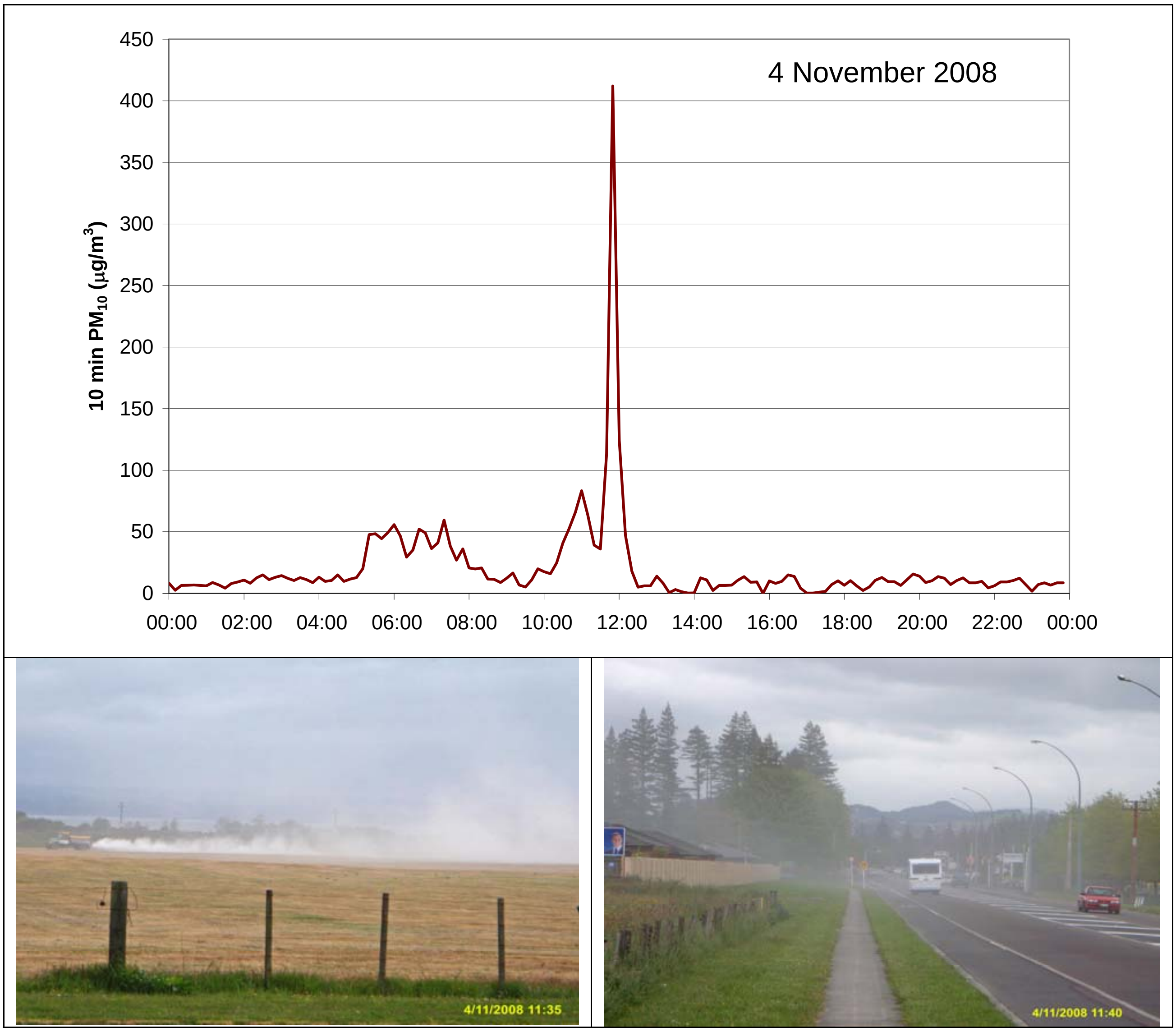


Figure 7 *Lime applications in the paddocks to the NE of the monitoring caravan and resulting drift of finer material across Te Ngae Road on 4 November 2008 with associated spike in the PM_{10} record.*

Further investigation of PM_{10} values when the wind is from the 210 to 280° quadrant is shown in Figure 8. Windspeed data is included and a positive correlation with windspeed and PM_{10} is demonstrated. This relationship would support resuspension of fine material from throughout the Ngapuna Industrial Area, but also the confinement and grounding of any plumes from stack emissions, both possible sources of PM_{10} within the Ngapuna Industrial Area. Temporal analysis is the next step in identifying if further indicative patterns exist within the PM_{10} dataset.

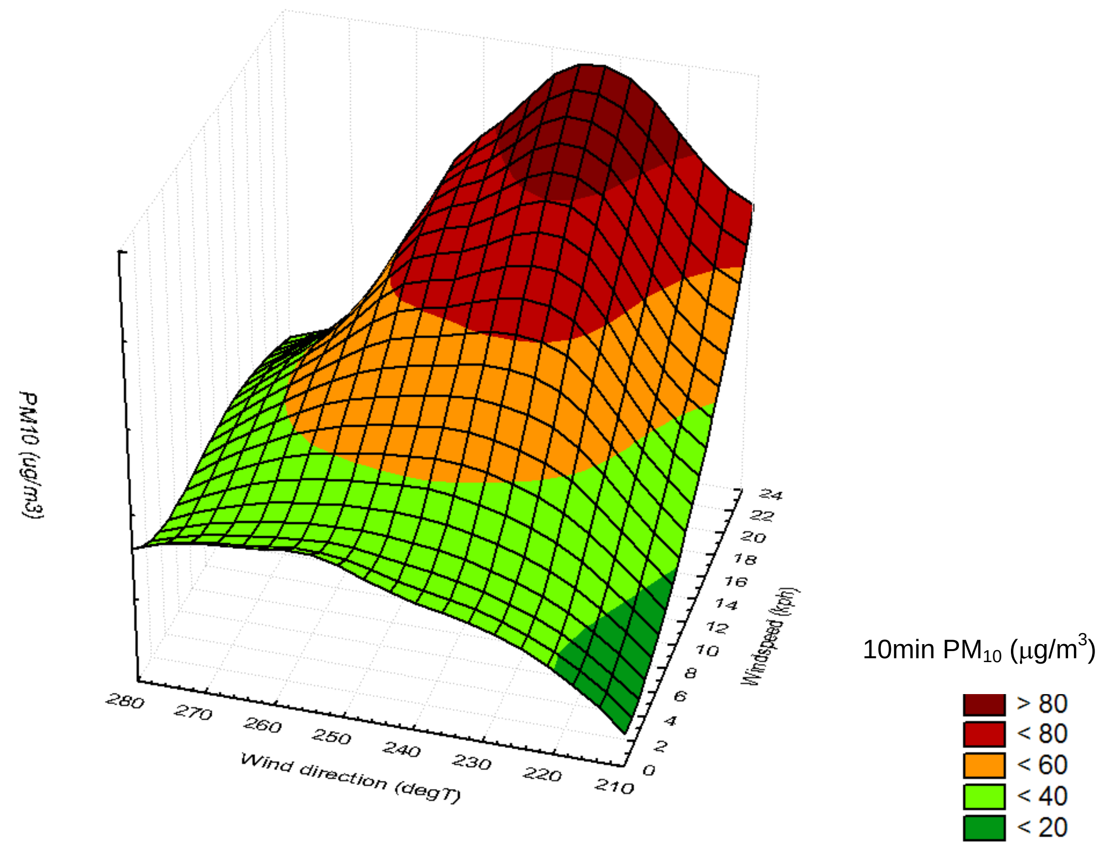


Figure 8 PM_{10} for wind directions through the Ngapuna industrial area.

Several temporal patterns exist within the PM_{10} time series. Noticeably the highest daily results occur during the working week (Figure 9) with concentrations diminishing in the weekends. This pattern would be associated with the typical Monday to Friday trading hours of a business operation. It should be noted that the boilers associated with the wood processing industries within the Ngapuna Industrial Area are normally 24 hour a day, 7 day a week operations. There may also be a relationship with heavy transport volumes on Te Ngae Road (and also intermediate roads within the Ngapuna Industrial Area) which would be typically less in the weekends. In total 63 weeks of data were analysed.

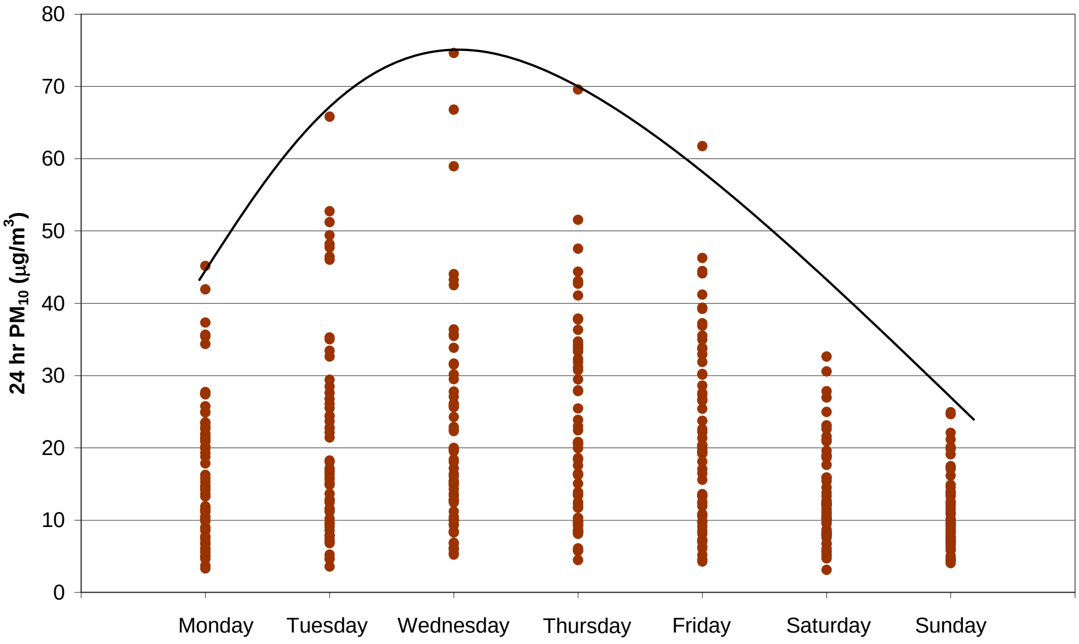


Figure 9 Weekly pattern in PM_{10} at monitoring caravan.

Diurnal patterns (Figure 10) are also evident at this monitoring site with an increase in PM_{10} concentration being recorded beginning at approximately 08:00 and more pronounced at 10:00, a decrease is evident between 16:00 and 18:00. Several elevated outliers are seen in the 04:00 to 06:00 window. This pattern is closely mimicked in the averaged windspeed dataset (Figure 11).

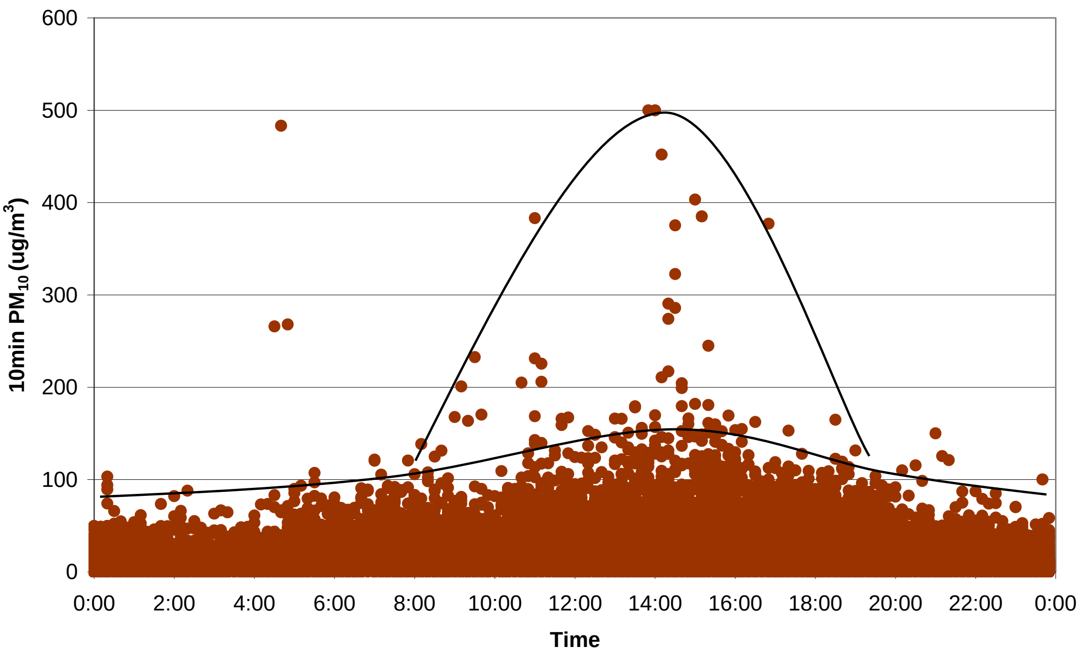


Figure 10 Diurnal patterns in PM_{10} at monitoring caravan.

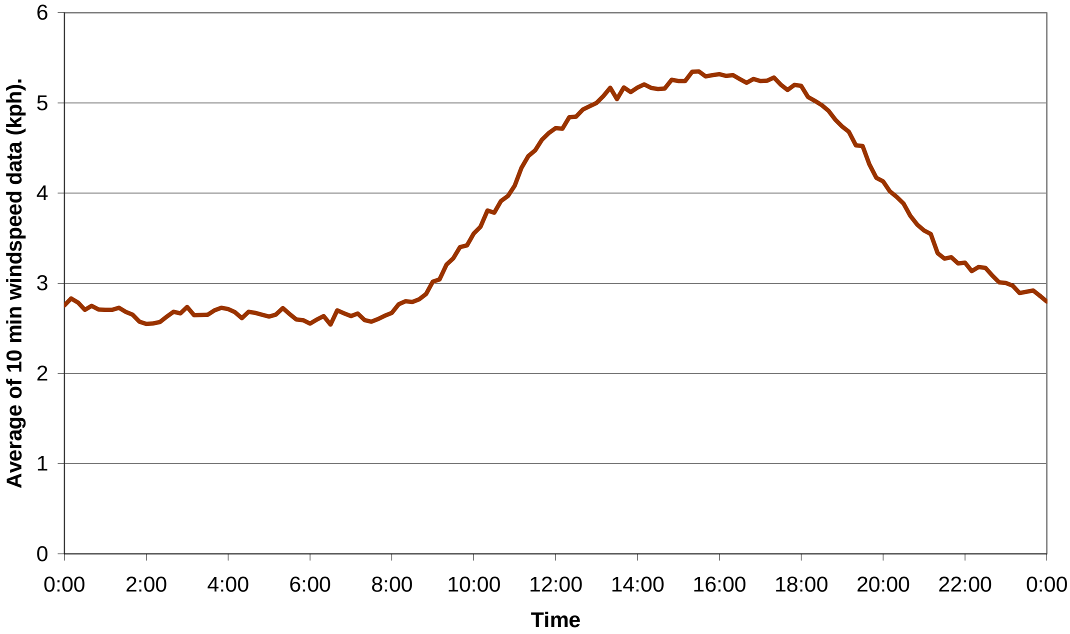


Figure 11 Diurnal pattern in windspeed at monitoring caravan.

The process of resuspension of particulate matter as a result of windspeed is well documented within the literature and should be further investigated within the Ngapuna Industrial Area by way of a detailed fugitive source survey; this will build on information available from high resolution aerial photography analysis (Figure 12) and provide a means of validation.

Uncovered stockpiles

Poorly managed dumping areas

Yard best practice procedures

Figure 12 Areas highlighted for further investigation within the Ngapuna Industrial Area.

Unsealed regularly accessed yards

Wash down area residues

Figure 12 (cont'd) Areas highlighted for further investigation within the Ngapuna Industrial Area

Particle resuspension is driven by particle availability, windspeed (and associated turbulence), and surface moisture levels and is obviously suppressed by the amount of recent precipitation experienced on the surface of interest. This effect along with the process of particle scavenging by wet deposition is looked at briefly below.

To exhibit the effect of particle suppression (such as but not limited to wet deposition) caused by precipitation events, correlation analysis between the Whakarewarewa raingauge (2.6km to the southwest) record and PM_{10} was performed. 24 hour datasets were used for this comparison (Figure 13).

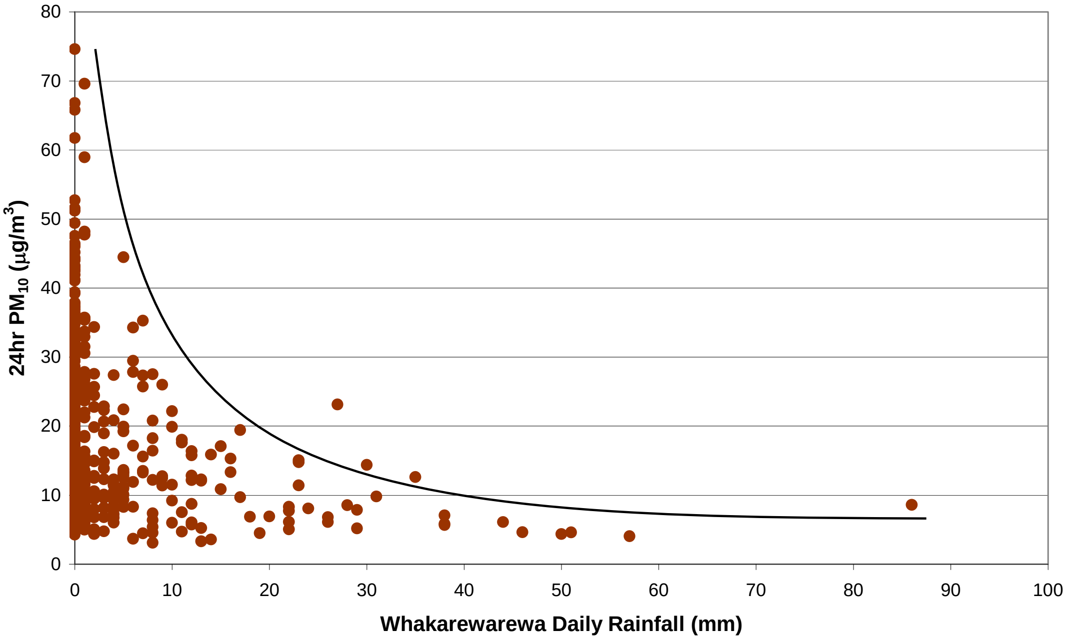


Figure 13 Rainfall / PM_{10} relationship, August 2007 to November 2008, (note rainfall measured on previous day).

A clear inverse relationship exists between particle concentration and the amount of precipitation. Rainfall would, (i) remove material from the air mass, (ii) temporarily dampen surfaces which may under dry conditions be sources of windblown material, and (iii) also wash surfaces thus resulting in lower levels of potentially suspended material being available. Rainfall may also dissolve certain particles, although this may not be particularly common in the Ngapuna Industrial Area due to particle chemical composition.

6.2 Industrial activity datasets

The waste control spatial dataset[2] from Rotorua District Council shows a wide range of light to medium industrial activities being undertaken in this area. Analysis of the general emissions (and resulting ground level concentrations) from these activities was undertaken in the recent Rotorua LAMA emission inventory (Figure 14) and modelling investigations. A follow up specific modelling investigation of consented industries in the Ngapuna area has also been undertaken (see Appendix 1). The emission inventory showed the total particulate releases from the main sources (based on consent limits) and estimated releases for small scale activities (Figure 14), and the percentage contributions from all main source types (Figure 15).

The specific modelling investigation showed that during periods with a significant domestic contribution, the NES-AQ for PM_{10} could be exceeded. However the exceedances that have been recorded at this site to date are outside the traditional domestic heating season of May to September.

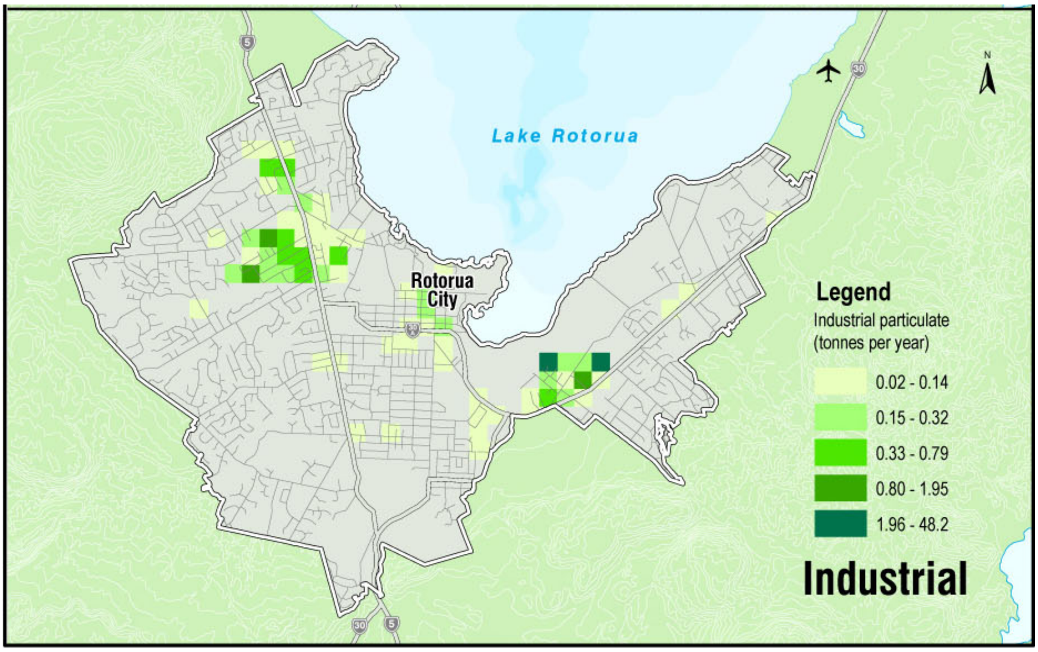


Figure 14 Particulate emission estimations for the Rotorua Air Quality Management Area.

[2] The waste control dataset supplied by RDC, lists business activity by type with a unique spatial identifier associated with each record.

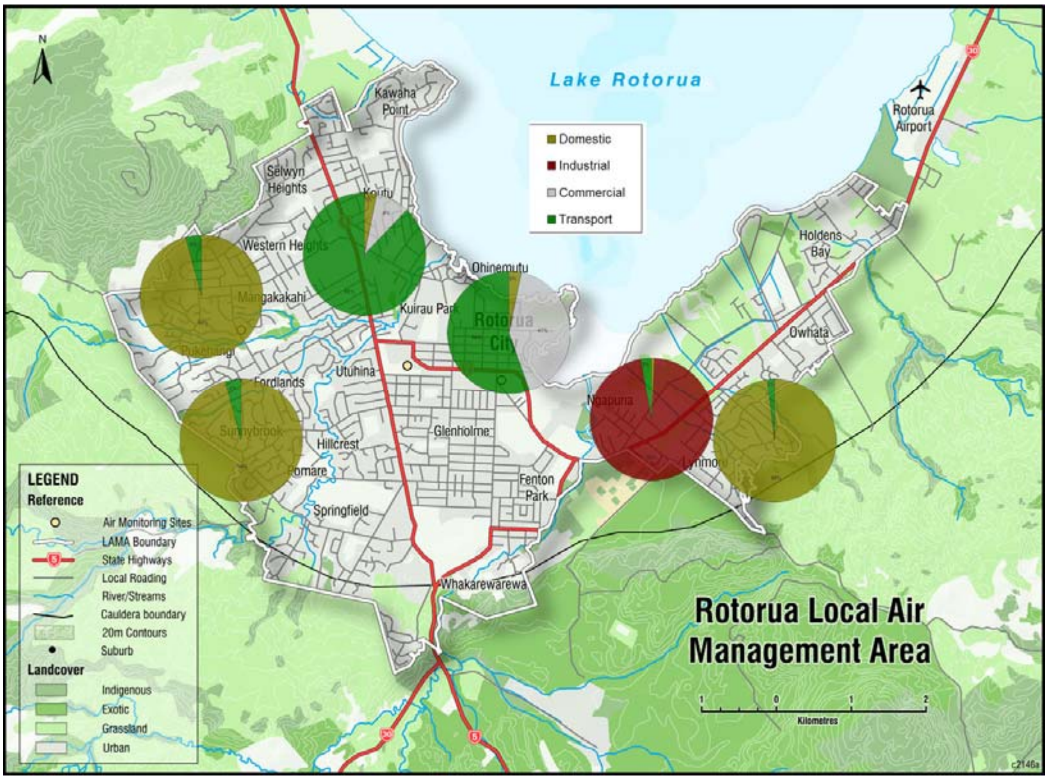


Figure 15 *Percentage contribution of emissions represented spatially for the Rotorua Air Quality Management Area.*

To determine the contribution from nearby industry a 3 week period of PM_{10} data was investigated. For approximately 3 weeks from 22 December 2007 a maintenance shutdown was undertaken at Tachikawa. On several occasions during this shutdown, short periods of elevated levels of PM_{10} where recorded (Figure 16). Investigation of the wind data at these times shows that the wind is moving through the middle of the industrial area and towards the sampling inlet of the monitor. At other times during these days of interest when the wind direction is particularly from the north or west only “background levels” are recorded.

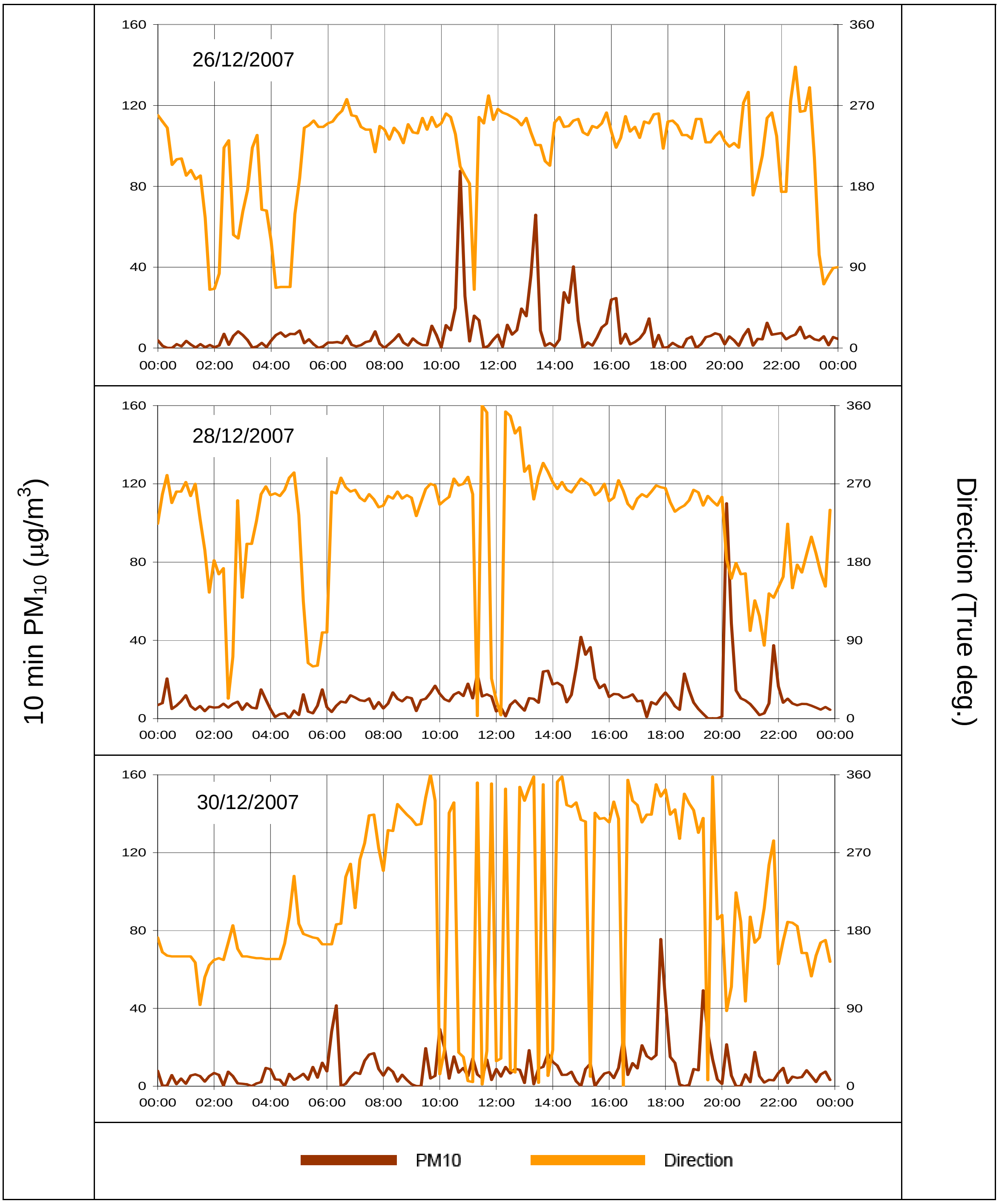


Figure 16 *Time series with PM_{10} spikes during the Tachikawa maintenance shut.*

The occurrence of elevated levels during the shutdown period would highlight the presence of other sources contributing to the PM_{10} profile at the monitoring site.

6.3 Stack testing results

The performance of the two main industries (currently operating) in regard to particulate emission control has been chequered. Stack test results show that both sites have had issues with compliance for particulate emissions. For the Tachikawa site (Table 2) this appears to have been remedied recently with expert boiler engineers reviewing and adjusting operational procedures. McAlpines (Table 3) has traditionally been within their consent limit, but continues to have dust complaints lodged by adjacent property owners.

Table 2 Tachikawa recent stack test results.

Test date	Concentration (mg/m^3) (Consent Limit – 250 mg/m^3)	Emission rate (kg/hr) (Limit – 6kg/hr)
28 September 2006	1314	24.2
6 December 2006	1264	21.7
21 February 2007	914	14.5
22 August 2007	365	5.2
7 November 2007	233	3.9
22 February 2008	242	4.5
25 September 2008	198	3.1

Table 3 McAlpines recent stack test results.

Test date	Concentration (mg/m^3) (Consent Limit – 400 mg/m^3)	Emission rate (kg/hr) (Limit – 3kg/hr)
27 October 2006	369	2.1
16 August 2007	679	3.3
26 November 2007	357	1.6

6.4 Video analysis

Video surveillance has been undertaken in the Ngapuna area since 2007. The equipment has been setup to primarily focus on the Tachikawa wood boiler stack as complaints and poor stack test results where associated with this site. Footage from 2007 shows occasions where dark smoke was evident from the boiler stack. Comparison with the particulate data did not always show a positive relationship with these events as wind direction was critical in ensuring the plume intersected the instrument sampling inlet. Investigation of the footage for the October 2008 exceedances listed in Table 1 showed the emissions from the stack to be ‘normal’, in most cases there was sufficient windspeed to draw the plume in a direction towards the ground in a coning fashion. There was however evidence in the footage of plumes/clouds of dust passing through the field of view of the camera. Because of the limited view of the camera it was not possible to determine the source but it is suggested that the primary source of particulate during these elevated periods of data was not the nearby boiler stack.

Figure 17 Footage from an event on 9 September 2007. Boiler stack located at the bottom centre of the image.

For more benefit to be gained from the video surveillance equipment a new more elevated site should be found in order to gain greater coverage of the wider industrial area (Figure 17).

6.5 Photomicrography and SEM analysis

Two sets of filters have been reviewed for this part of the investigation. The first set consists of 3 filters which were collected on the 1^{st} (SA260), 3^{rd} (SA262) and 29^{th} October 2008 (SA284) (Figure 18) these were collected during exceedances of the NES-AQ. These filters showed marked discolouration. Visible particles ranged in colour from light brown through to black. Particle shape was typically angular.

The second investigation looked at the predominant wind direction during the collection of material on the filters. Table 4 lists these samples and the area of potential source material that they could represent.

SA260

SA262

SA284

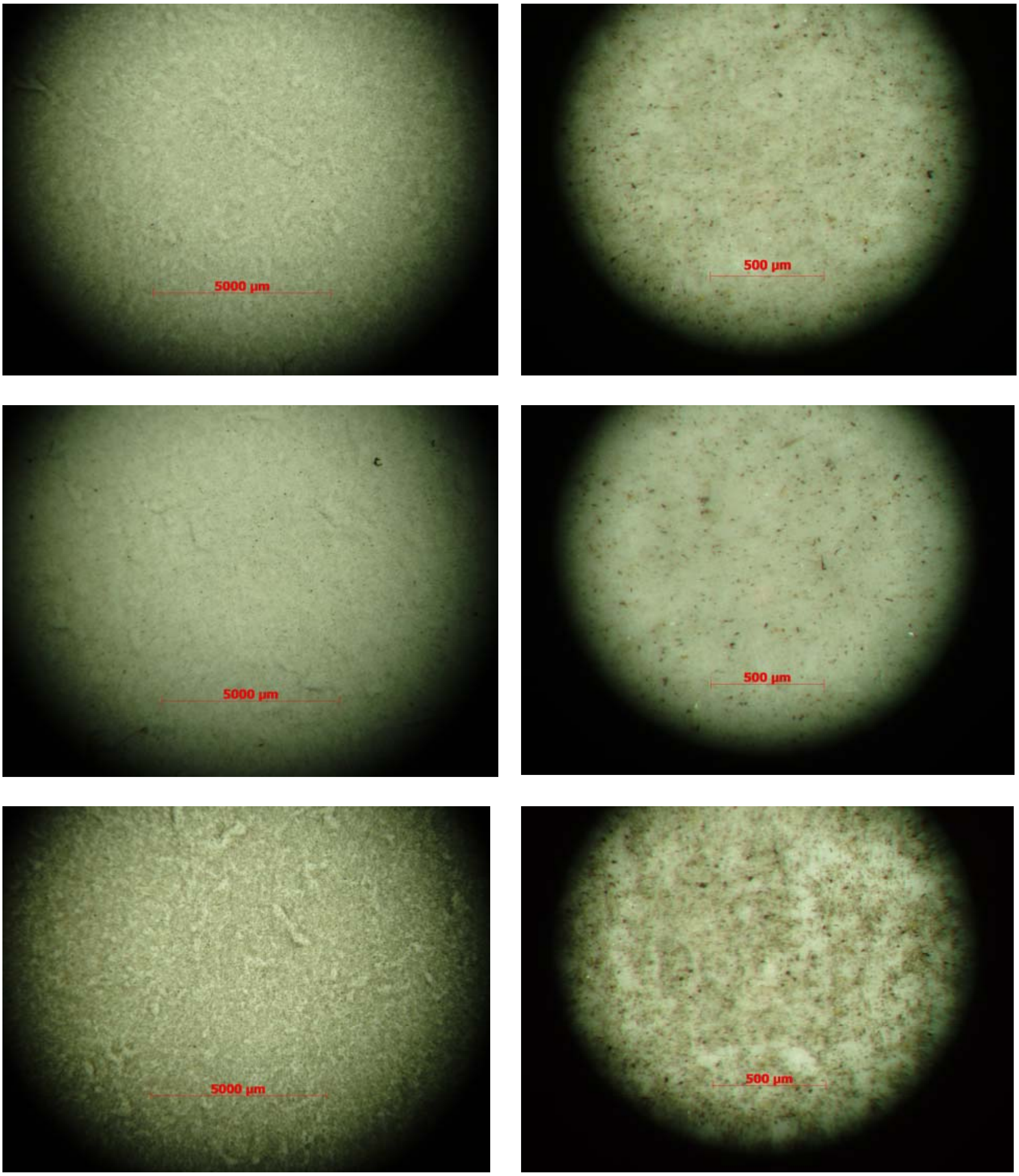


Figure 18 Photomicrographs of the filters collected during 3 NES exceedances.

Table 4 Direction selected filters for further SEM analysis.

Source area	**Filter number**
Recorded NES-AQ Exceedances	SA260, SA262 and SA284.
Narrow industry sector	SA58
Wider industry sector	SA32
Roadway	SA40
Paddocks	SA139
During Tachikawa shut (26/12/07)	SA110

Energy Dispersive X-ray analysis[3] was undertaken on both sets of filters using the Waikato University scanning electron microscope. This technique was chosen as the output provides high definition images and elemental signatures for selected particles.

The dominant elements that were identified by SEM for the collected samples are listed in Figures 19-21. Further identification of potential sources based on the elemental signature from representative particles for each sample can be partially achieved by using results from source apportionment investigations. For sea salt or marine sources Na, Cl, Ca, Mg, K and S can be dominant elements. Si, Al, Cl and Ca can be dominant elements for road/general dust sources. C, S and Al can be dominant elements for motor vehicle sources. The presence of K is normally the key indicator for wood material that has been exposed to a combustion process (See Table 5).

Table 5 Composition of wood ash (from Shelton, 1983[4].)

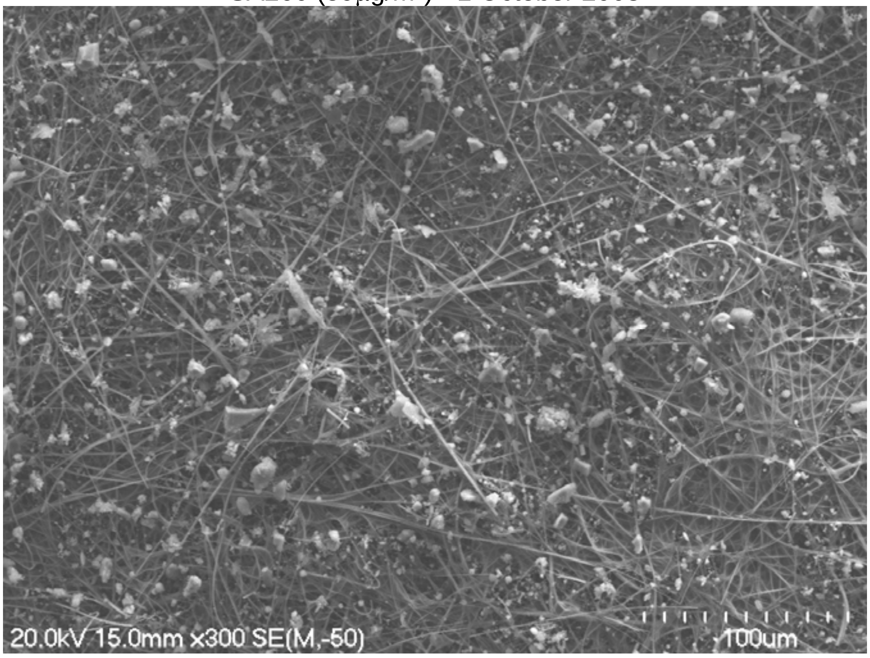
Element	**Assumed Form**	**Typical Quantity (percent of total ash)**
Calcium	CaO	30-60
Potassium	K_2O	10-30
Sodium	Na_2O	2-15
Magnesium	MgO	5-10
Iron	Fe_2O_3	1-2
Silicon	SiO_2	2-7
Phosphorus	P_2O_5	5-15
Sulfur	SO_3	1-5

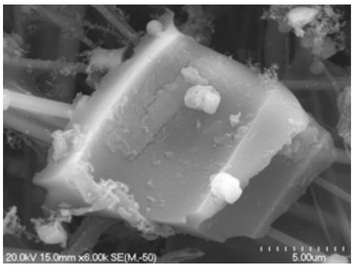
[3] Energy Dispersive X-ray analysis. is a technique used for identifying the elemental composition of the specimen, or an area of interest thereof. The EDX analysis system works as an integrated feature of a scanning electron microscope (SEM), and can not operate on its own without the latter.

[4] Shelton, J., Jay Shelton's Solid Fuels Encyclopedia, ISBN 0-88266-307-0

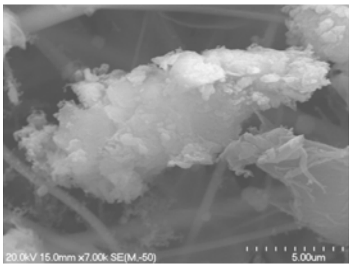
The elemental composition of particles identified on the collected samples indicates a general urban dust profile with contributions from soil and road sources. No dominant K signature was evident on any of the investigated particles. Fibrous particles (for example see SA262, 2nd row, centre) where evident in all samples, and were assumed to be from motor vehicle combustion based on results presented in Davy (2007)[5].

SA260 (59μg/m^3) - 1 October 2008

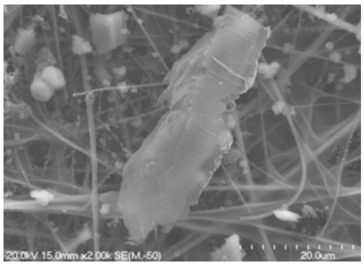




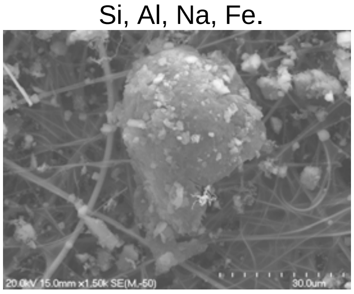
Si, Al, Na, Fe.



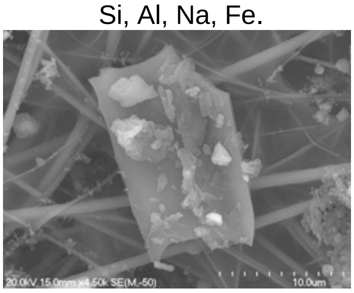
Si, Al, Na, Fe.



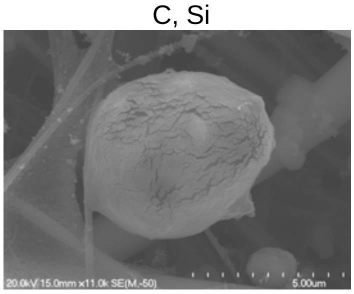
C, Si



Si, Na



Si, Al, Na.

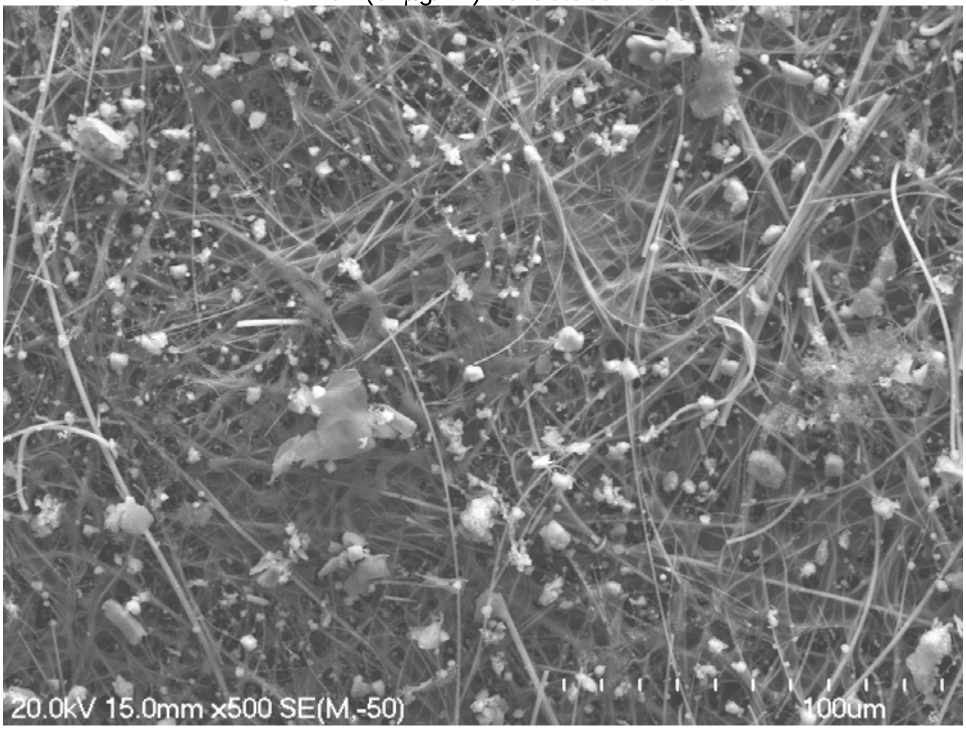


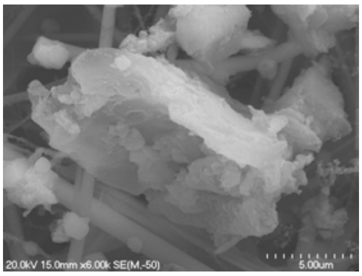
C, Si, Na.

Figure 19 *SEM imagery for sample SA260 with dominant elements for each particle (Note: the long thin fibres in the background are part of the filter material).*

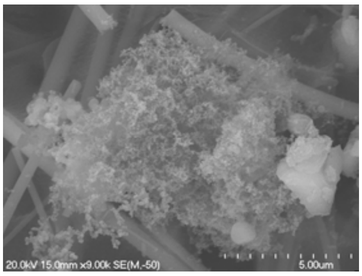
[5]Davy, P., 2006, Composition and Sources of aerosol in the Wellington Region, Doctor of Philosophy in Chemistry thesis, Victoria University of Wellington (Section 6.5.8.1).

SA262 (62μg/m[3]) - 3 October 2008

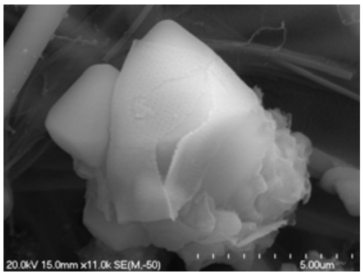




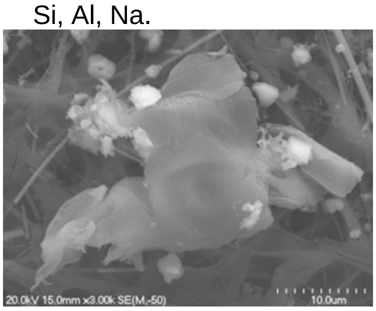
Si, Al, Na.



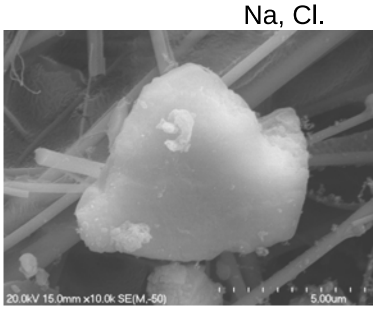
Si, Na, Ti.



Na, Cl.



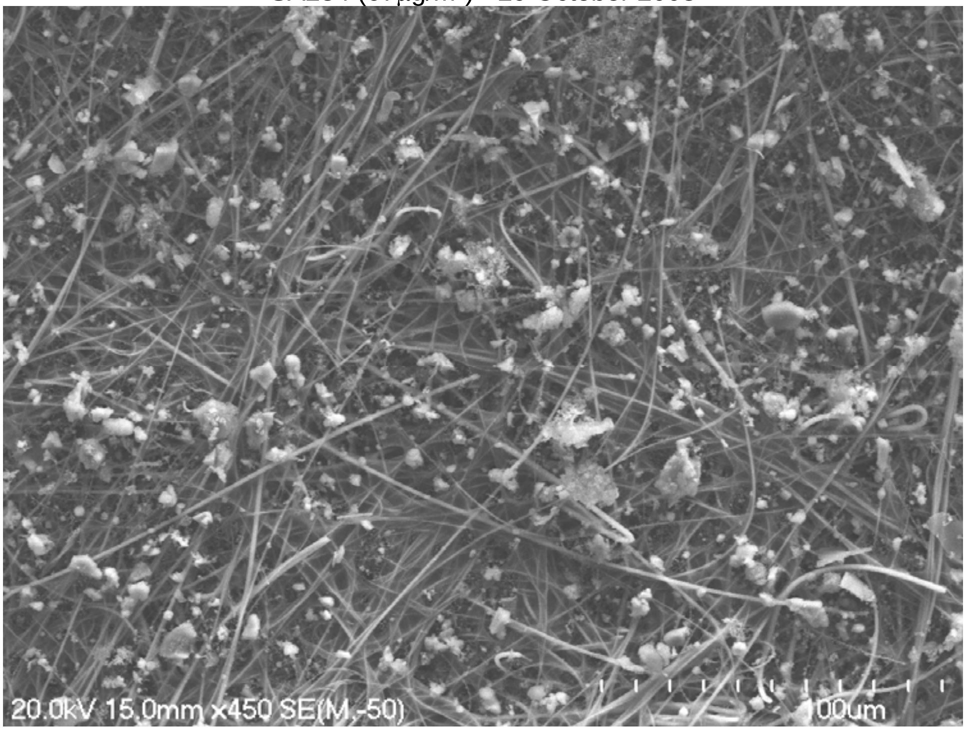
Si, Al, Na.

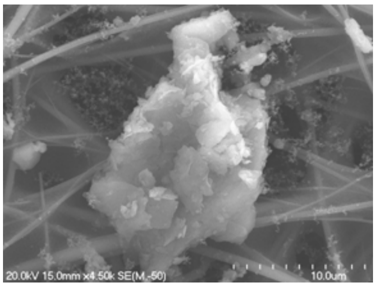


Si, Al, Ca.

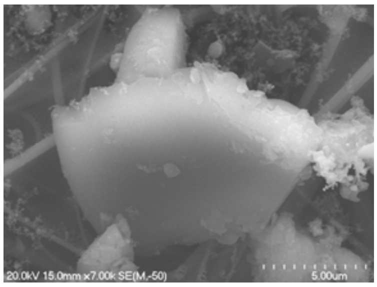
Figure 20 SEM imagery for sample SA262 with dominant elements for each particle.

SA284 (67$\mu g/m^3$) - 29 October 2008





Si, Al, Fe, Mg.



Si, Al, Na, K.

Figure 21 *SEM imagery for sample SA284 with dominant elements for each particle, potassium identified in the second particle but not shown to be dominant.*

Chapter 7: Conclusion

Historical data (albeit short and complaint focussed) highlights that the Ngapuna industrial area is often exposed to elevated levels of TSP and PM_{10}. These datasets where collected at locations in the southern area of the Ngapuna Industrial Area and possibly not representative of the full contribution of sources when favourable conditions exist for impacts at the current monitoring site at the north-eastern boundary of the Ngapuna industrial area.

The analysis of the more recent monitoring data suggests a number of sources are contributing to the PM_{10} exceedances recorded at the Ngapuna monitoring caravan. The traditional main sources - domestic heating, traffic and consented industries have been quantified and modelled with results showing exceedances under worst case conditions. However these were determined for a wintertime period and the contributing source mixture will be different during the summer which is when these latest exceedances have been recorded.

The 2005 emission inventory attempted to identify the level of contribution from the non consented business activities (storage yards, heavy machinery workshops etc) and these were deemed to be low contributors at the time. Natural and general background levels where also only estimated in the earlier airshed modelling exercise. Additional point source modelling has been undertaken (see Appendix 1) for the consented industries within the Ngapuna Industrial Area and a summation of modelled and estimated PM_{10} values highlighted that exceedances would be experienced within the Ngapuna Industrial Area.

This report shows that there is no one single contributor to the exceedances recorded, more so a combination of a number of sources. Table 6 attempts to list emissions in order of level of contribution to the summer time NES-AQ exceedances impacting on the Ngapuna Industrial Area, and this will hopefully give direction to action plan strategies for obtaining compliance with the NES-AQ.

Table 6 Emissions contributing to elevated PM_{10} in the Ngapuna Industrial Area.

	Source	Comment
← LOW Level of contribution to summertime PM_{10} exceedances HIGH →	Resuspended yard/process dust	Difficult to quantify. Appears to be the significant contributor to recorded summertime exceedances to date. Requires a field mapping exercise to more accurately validate information available from high resolution photography to determine the extent of areas and activities within these areas. Possibly the IP^3 programme could be undertaken in this small well confined industrial subdivision to improve knowledge and assess activity levels and non best practice activities.
	Traffic emissions (including road dust)	This source can be broken into two groups: i) traffic activity on SH30, the SEM analysis showed evidence of combustion particles. A less common E/SE wind would be required for material to be carried through the Ngapuna Industrial Area from this source; ii) traffic activity within the Ngapuna Industrial Area, this could be a significant contributor of both combustion particles and dust particles from tyre and road wear and also material coming from loads. Anecdotal evidence suggests that there is much heavy traffic activity servicing and receiving services from business within the Ngapuna Industrial Area. This activity needs to be more accurately quantified.
	Consented industrial emissions	Annual stack test results provide limited understanding of overall performance of such operations. Their contribution to the exceedances is not definitive, but theoretically they could be contributing at least 30%.
	Natural sources	These had been estimated (5-7$\mu g/m^3$) based on data collected from the long term Pongakawa monitoring site. This value may be higher due to nature of the soils in the area and the large exposed areas of sediments (pumiceous sands, reworked tephras, hydrothermally altered mud and lake sediments exposed in the Puarenga Stream delta, Sulphur Bay (1km to the west of the monitor).
	Domestic heating	Predominantly wintertime emissions although domestic heating survey shows some households heat all year round. Contribution is well understood and timing of these emissions is not aligned with peak concentrations during recorded summertime exceedances. Already part of action plan strategies.

Chapter 8: Appendices

Appendix 1 – Industrial Emissions in the Rotorua LAMA.

Appendix 1

MEMORANDUM

To: Karen Parcell

From: Shane Iremonger and Bruce Graham **Date:** 26 February 2008

File Ref: 0240 01 I01

Copy To:

Subject: **Industrial Emissions in the Rotorua LAMA.**

Karen

1. As agreed late last year, we have carried out a preliminary assessment of the industrial sources of PM-10 in Rotorua to assist in deciding whether any actions are required to lower the emissions from any of these sources to ensure future compliance with the NES.

2. There are currently 19 consents for discharges to air within the Rotorua LAMA; 4 timber mills, 4 abrasive blasting/spray painting workshops, 10 paint and panel-beating workshops, and 1 compost plant. Information on the timber mills and selected examples of the abrasive blasting and paint/panel workshops is given in the attached table. The information given in the table was taken from the consent file for each source.

3. The compost plant was not assessed because it is not expected to be a significant source of PM-10. The consent is mainly directed at odour and dust nuisance.

4. Similarly, the paint and panel-beating workshops have not been assessed because any discharges of PM-10 should be limited to minor fugitive releases through doors and windows. Some particulate will be generated inside these facilities from sanding but this can be minimised through the use of wet or vacuum sanding, in combination with regular cleaning of the workshop. The paint booths are another potential source of particulate – as paint droplets – but most of these would be much larger than 10 microns.

5. Dispersion modelling (using Ausplume) has been carried out for the 4 timber mills and one of the abrasive blasters. The modelling was done with the emissions set at the consent limits and with other discharge parameters (stack dimensions, temperature, velocity) taken from the available test reports on each of the sources. The activities were assumed to operate for 24 hours a day. Allowance was also made for building downwash effects, with the dimensions of nearby buildings being estimated from aerial photographs of the sites.

6. Only a limited amount of source information was available for the abrasive blasting booth so the modelling was based on some worst-case assumptions, including an emission rate of 0.05 kg/hr, a zero (vertical) discharge velocity, and stack gases at ambient temperature.

7. The modelling was done using a 2006 meteorological data file specific to Rotorua, and the predictions for maximum 24 hour average PM-10 levels are shown in the following figures.

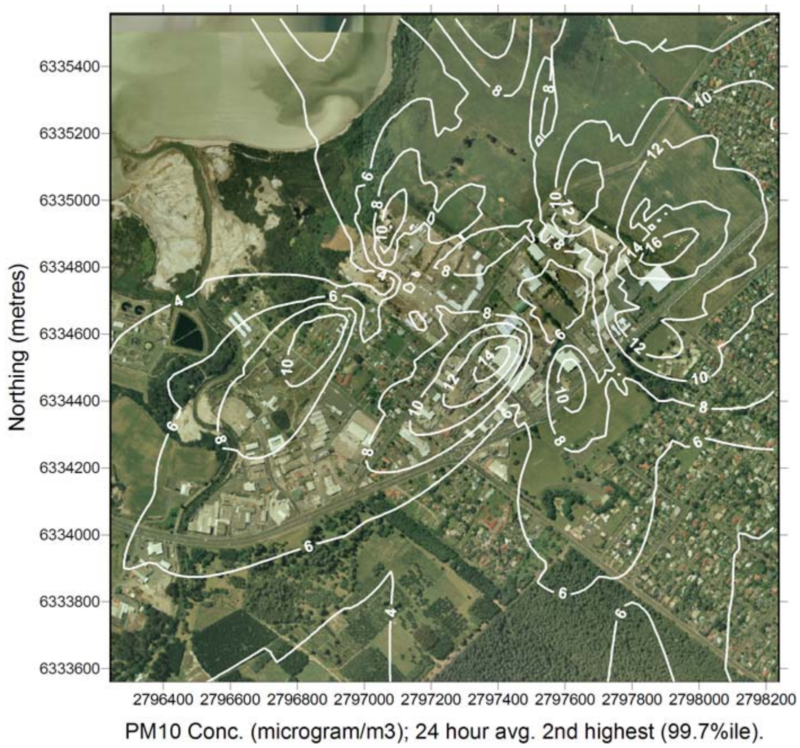


Figure 1 Modelling for Tachikawa and McAlpines Combined.

8. The Tachikawa and McAlpines mills have been combined in this model output because the two sources are close enough to each other for their plumes to overlap. Separate model runs are available for each of the sources if required.

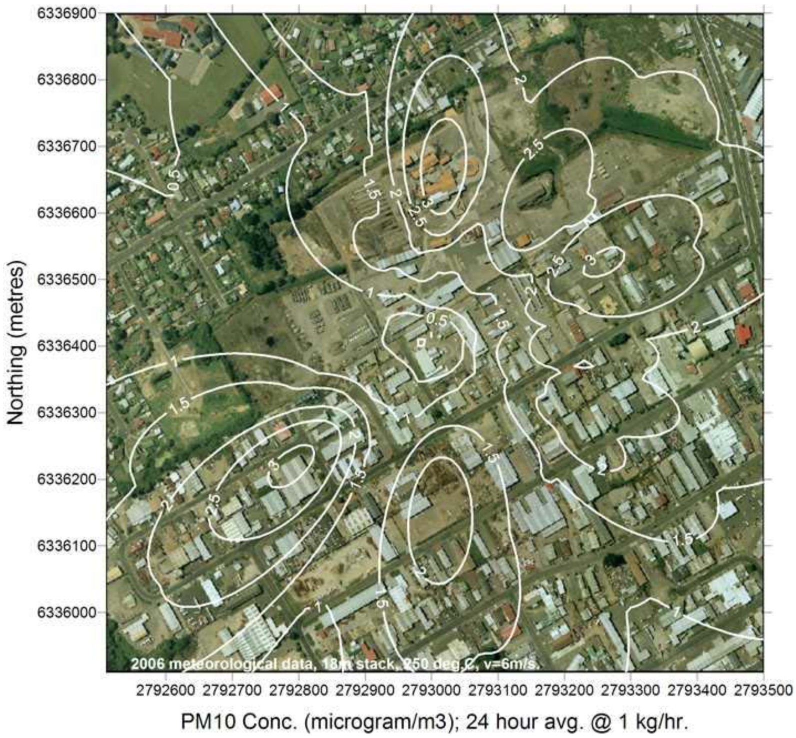


Figure 2 Modelling for Stewart Logging.

9. This is a much smaller boiler than the others and with much lower emissions. As a result, the modelled concentrations are much lower.

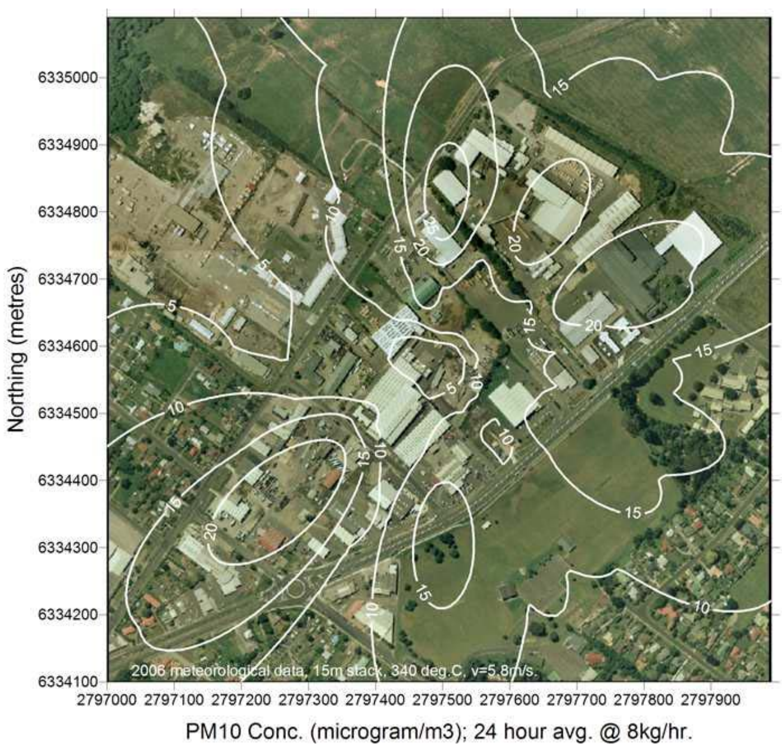


Figure 3 Modelling for Claymark Industries.

10. This source is very close to Tachikawa and McAlpines, but has been modelled separately because it is currently not in use. However, if it was being operated, the combined impacts from all three sources would be significant (eg. up to about 30 µg/m^3 along parts of Te Ngae Rd/SH30).

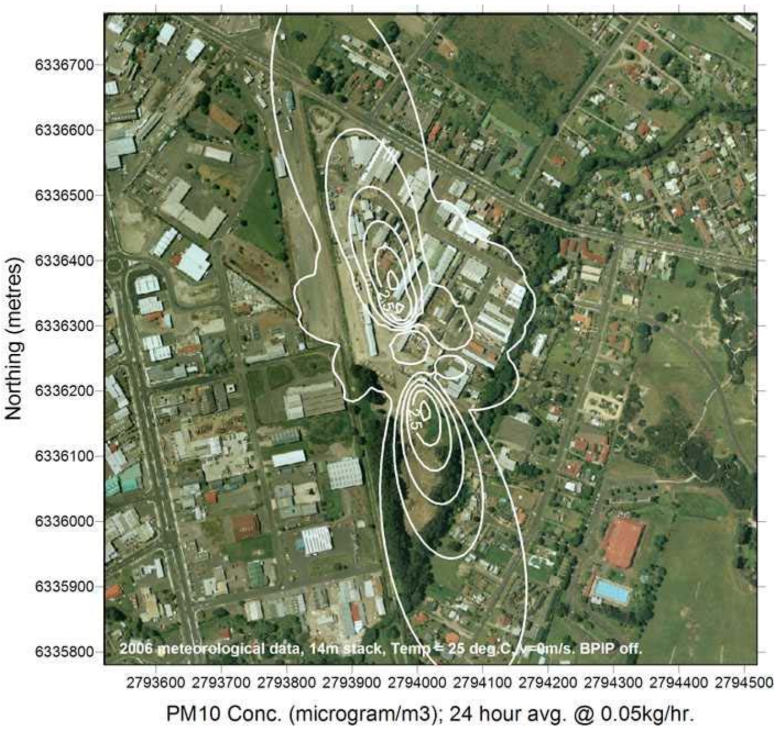


Figure 4 Modelling for Roadmaster Trailers Ltd.

11. As expected, the potential ground level impacts from this source are insignificant.

Discussion – Claymark Industries

12. The modelling for Claymark Industries was done at the consent limit of 8 kg/hr, which is very high for a 4 MW wood boiler. The consent appears to be in error, because, according to the Officer's Report, the application indicated a maximum emission rate of 3.5 kg/hr. A model output is also available for this lower emission rate, and indicates ground level concentrations slightly less than half those shown in Figure 3.

13. Regardless of any other actions arising from the overall assessment (all sources), there is an obvious need for this consent to be reviewed. This would be to either confirm that the plant is no longer expected to operate (consent cancelled) or to specify the correct emission limit (nb. The stack height may also be incorrect).

Discussion – All Sources

14. The results from the Rotorua Airshed Modelling Investigation (Endpoint, 2007) showed that the industrial source contributions were only significant in the area around Ngapuna. This is illustrated in the extracts from the report shown in Figure 5 below.

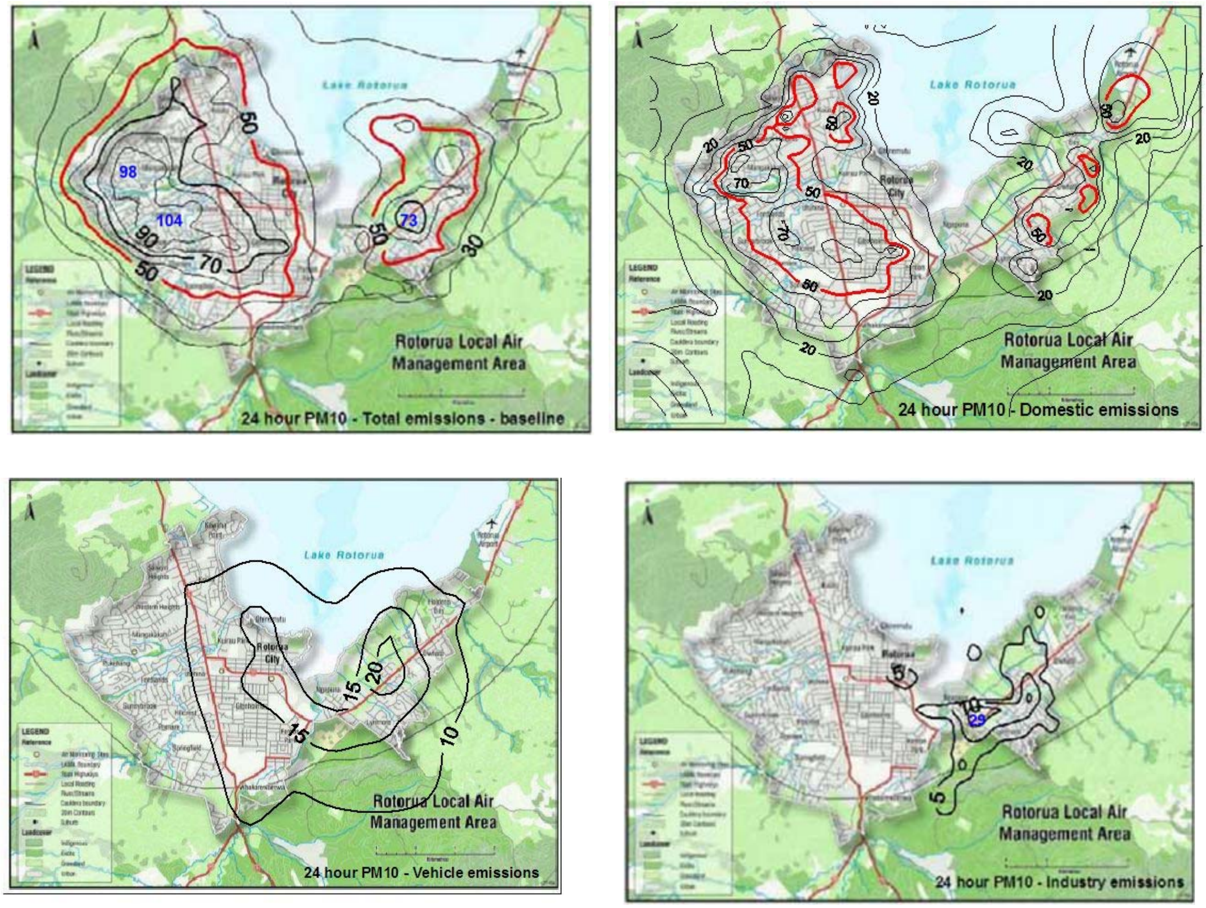


Figure 5 Modelling Results[6].

15. The industrial plot in Figure 5 also indicates a very reasonable level of agreement between the modelling predictions from the broad-scale (250m grid) air shed modelling and the source-specific estimates using Ausplume (10m grid). The air shed predictions are essentially a 'smoothed' version of the Ausplume outputs.

16. The maximum combined impact from all sources occurs within about two hundred metres either side of Te Ngae Road (SH30), and the relative source contributions are (very approximately) as follows:

   - domestic heating, up to 40 µg/m^3
   - motor vehicles, up to 20 µg/m^3
   - industry, up to 12 µg/m^3 (based on the second highest (99.7%) result for Tachikawa plus McAlpines)
   - background contribution, 5 µg/m^3 (not shown)
   - Total impact, 77 µg/m^3.

[6] Fisher et. al., 2007, Rotorua Airshed Modelling Investigation Final Report, September 2007, prepared for Environment Bay of Plenty, Endpoint Limited, Auckland, New Zealand.

17. The expected changes in these emissions over the next 5 years are as follows

    - Domestic heating, reduced by 60%, down to 16 µg/m^3

    - Motor vehicles, 15% reduction (down to 17 µg/m^3) due to better engine technologies and vehicle emission controls, although some of this may be offset locally by increases in traffic volumes

    - Industry and background, no change

    - Total impact, 50 µg/m^3.

18. It must be stressed that the above numbers are very crude estimates. However, when taken at face value they indicate that we have a fairly border-line situation for future compliance with the NES for PM-10. If the expected reductions in domestic heating and vehicle emissions are not achieved then the emissions from the Tachikawa and McAlpines sites have the potential to push the overall PM-10 levels above the NES.

19. This also assumes there will be no future contributions from the Claymark Boiler, and that both Tachikawa and McAlpines will continue to comply with their consent limits. We know from past experience that this may not always be the case.

Options for Action

20. The assessment given above is not sufficient to justify an immediate move on reviewing the Tachikawa and McAlpines consents. That would simply open up a Pandora’s Box of technical debates over the accuracy of the modelling, the use of consent limits versus actual emission rates, whether or not the timing of peak industrial impacts coincides with those from domestic heating, and so on.

21. The best way to address these uncertainties is through monitoring. The Ngapuna monitoring site was set up in mid-2007 with exactly this role in mind, and it is recommended that this monitoring be continued for at least the next 2 years. Several exceedances of the NES have been recorded, including during the summer months, and we are starting to develop an understanding of the most likely contributors to these exceedances.

22. It would also be appropriate to initiate discussions with the two consent holders regarding possible reductions in their stack emissions, on the basis that voluntary actions now would be preferable, and potentially less costly, than compulsory actions in a few years time. (It should be noted here that some related discussions have already taken place with Steve Pickles’ team in relation to the past non-compliance problems at Tachikawa)

23. The options for emission reductions would range from better management of fuel composition and quality (especially moisture content), improved combustion monitoring and control (eg. installation of CO, O_2 and opacity monitors, if not already there, directly linked to the combustion control system), replacement or upgrading of the multicyclones to achieve higher collection rates, and add-on high-efficiency particulate control equipment, such as

electrostatic precipitators. Bag filters are another possible option but have a very high fire risk with wood-fired boilers.

24. The first two of these options could be expected to achieve overall emission reductions of, say, 5 to 15% at a cost of up to about $50,000. These are the ones most likely to be undertaken voluntarily because they can also lead to reduced fuel costs through improvements in combustion efficiency.

25. The option of upgrading the multicyclones would lead to emission reductions of a further 20% or more, but at a cost of, say, $100,000 to $200,000. The electrostatic precipitators would take out 95% or more of the emissions but at a cost typically in excess of $1million. Both of these options are only likely if forced by a consent change.

Shane Iremonger
Environmental Scientist

Dr Bruce Graham
Consultant

Rotorua Industrial Sources of PM10

No.	Consent Holder	Process/Source	Consent Conditions	Emission Data/Info	Other Info
62444	Tachikawa Forest Products Ltd	Sawmill, with 8MW Easteel wood waste boiler (24-hr operation?)	17.5m stack, 250 mg/m^3, 6 kg/hr	22/8/07: 365 mg/m^3, 5.2 kg/hr, 15.0 m/s, 230 C 21/2/07: 681 mg/m^3, 14.5 kg/hr, 15.5 m/s, 196 C	
61836	Claymark Industries Ltd (prev Panahomes)	Sawmill, 4 MW wood waste boiler and 3.4MW auxiliary gas boiler (op hours?)	11m, 250 mg/m^3, 8 kg/hr (NB. Off. report says 15m stack, and 3.5 kg/hr)	AEE estimate 3.5 kg/hr, modelled 98% PM-10 of 10 µg/m^3 (24-hr)	Boiler currently not in use.
60842	Stewart Logging Ltd	Sawmill, 1MW wood waste high pressure hot water plant (op hours?)	10m stack, 350 mg/m^3, 1 kg/hr (NB. Appln was for 18m stack)	Application info: 1.2 m^3/s, 6 m/s, 250 C, <300 mg/m^3	boiler building 5m, adjacent building 7m
61497	McAlpines (Rotorua)	Sawmill, wood waste boiler and auxiliary coal fired unit, both for high pressure hot water	5.7MW (total?), single stack, 10m, 400 mg/m^3, 3 kg/hr	27/10/06: 289-369 mg/m^3, 1.8-2.1 kg/hr, 212 C, 8.3 m/s (report suggests this may be wood only)	
30123	Claymark Industries (another site)	Sawmill			consent expired
63494	Roadmaster Trailers Ltd	Truck building, abrasive blasting + spray painting (8-hr day operation)	no specific limits	spray booth, 14m stack, 10m building, but a/b booth is separate	a/b booth fitted with wet scrubber, then stack – no details given (but see site plan on file) Assume 0.05 kg/hr
62211	Lakeland Steel Products Ltd	timber + engineering fabrication, abrasive blast + paint booth, abrasive blasting ~1hr/day	no specific limits	spray booth, 3.7m stack, 2.5m bldg, but a/b both is separate (may not discharge outside)	a/b fitted with water scrubber
61242	P G Lock (Te Ngae Panelbeaters & Colourtone Car Painters)	panel/paint: internal preparation area, with self-contained spray booth (2 hrs/day spraying)	spray stack 8.6m	5.45m bldg	dust from car prep is internalised by use of dustless (vacuum) sanders
61044	J R Autospray & Panel Ltd	panel/paint: internal preparation area, with self-contained spray booth (2 hrs/day spraying)	spray stack 7.6m	6.5m bldg	dust from car prep is internalised by use of wet sanding plus vacuum cleaners
61203	Bob Archer Spray Painters Ltd	panel/paint: internal prep area, with self-contained spray booth	spray stack 8.05m	5.1m bldg	wet and dry sanding plus vacuum cleaners