Inhalable particulate (PM10) Regional Monitoring Programme Report 2010

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Executive summary

Section 35 of the resource Management Act requires local authorities to undertake monitoring of the region's environment, including land, air, and fresh and marine water quality. The inhalable particulate component of the State of Environment Monitoring (SEM) programme for air quality in Taranaki was initiated by the Taranaki Regional Council in the 1999-2000 monitoring year covering three monitoring sites representing rural, urban and pristine regions (Stratford, New Plymouth, and Mount Egmont respectively). Subsequently inhalable particulate monitoring was conducted in the coastal area near the Maui production station, and then two surveys were undertaken in central New Plymouth.

Particles found in the air we breathe vary greatly in size. The greatest health hazard from particles comes from the smallest ones – less than 10 microns (10 µm or 10 micrometres) across – because we easily inhale these small particles into our lungs. These particles are referred to as PM10 (referring to their size) or as inhalable particulate (referring to their potential effect). PM10 come from sources such as burning coal, oil, wood, and petrol and diesel in domestic fires, transportation and industrial processes. Natural sources of particles include sea salt, dust, pollens and volcanic activity. In terms of comparative size, a human hair is approximately 50 microns across, while the finest beach sand is approximately 100 microns across.

This report describes the fourth monitoring programme in the Taranaki region and the third monitoring run in New Plymouth, implemented by the Council to assess the quality of the ambient air in the New Plymouth CBD during the period under review, and the results of that work. The work entailed the sampling of air on a continuous basis using Beta Attenuated Monitor (BAM) equipped with PM10 size selective inlet. Continuous sampling was conducted for five months over the period January-May 2010.

The highest daily mean result for the entire dataset was 46.5µg/m^3 (microgrammes of particulate, or millionths of a gramme of particulate, per cubic metre of air), and the mean of all results was 16.2µg/m^3. The monitoring showed that 55% of the daily average results fell into the Ministry's 'excellent' or 'good' categories and 41% of the results met the 'acceptable' category. Six daily results from the total 138 of days monitored fell into the 'alert' category. It is noted that all of those six results happened during moderate to heavy rainfall events, and in the majority of cases, during fresh onshore winds. These findings confirm those of the previous inhalable particulate surveys that found sea salt spray to be a major PM10 source.

No results ever entered the 'action' category, i.e., no results ever exceeded the National Environmental Standard of 50µg/m^3.

These results, and all regional monitoring to date, has shown that Taranaki has very clean air, and on a regional basis there are no significant pressures upon the quality of the air resource.

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1. Introduction

This report describes the monitoring of PM10 undertaken by the Taranaki Regional Council during the summer-autumn 2010 as part of the Council's State of the Environment Monitoring programme. A total of 138 days were monitored covering a five-month period starting from January 2010. In combination with a previous six-month study, in 2003, the Taranaki Regional Council has now gathered PM10 data in New Plymouth's CBD which cover all four seasons.

1.1 Project background

1.1.1 National Environmental Standard for fine particulates

In September 2004 the Ministry for the Environment promulgated the National Environmental Standards (NES) relating to certain air pollutants. The (NES) for PM10 is 50µg/m^3 (24-hour average).

Particulates can be derived from many sources, including motor vehicles (particularly diesels but also petrol-fuelled vehicles), solid and oil-burning processes for industry and power generation, incineration, the burning of greenwastes and rubbish, photochemical smog processes, and natural sources such as pollen, abrasion, and sea spray.

Particles found in the air we breathe vary greatly in size. The greatest health hazard from particles comes from the smallest ones – less than 10 microns (10 µm or 10 micrometres) across – because we easily inhale these small particles into our lungs. These particles are referred to as PM10 (referring to their size) or as inhalable particulate (referring to their potential effect). In terms of comparative size, a human hair is approximately 50 microns across, while the finest beach sand is approximately 100 microns across.

PM10 particles are linked to adverse health effects that arise primarily from the ability of particles of this size to penetrate the defences of the human body and enter deep into the lungs significantly reducing the exchange of gases across the lung walls. Health effects from inhaling PM10 include increased mortality and the aggravation of existing respiratory and cardiovascular conditions such as asthma and chronic pulmonary diseases.

1.1.2 Location

New Plymouth is a coastal city lying due north of Mt Taranaki (2815 m) and on the northern coastline of the Taranaki region. The region is on the west coast of the North Island of New Zealand (Figure 1). The topography of the region consists of a ring plain surrounding the conical mountain (a dormant volcano), with hill country running along the eastern side of the region, 20 kilometres from New Plymouth at its nearest point. The hill country is sparsely populated. New Plymouth, with a population of 68,000, is the region's only major city. The region has an area of 723,610 square kilometres and a population of 106,000 (2006 Census).

By comparison with other regions, Taranaki has a relatively low population density, an exposed landscape, minimal vehicle congestion, and no significant industrial zones with air pollution problems. The predominant fuel is natural gas, used in petrochemical industries and for thermal electricity generation. Coal or heavy oil usage in the region is unknown other than heavy oils for ships at the port. As a rural region there is some supply and domestic use of fire wood.

The retail and commercial part of New Plymouth lies towards the foreshore. The residential areas on the inland side of the city are located on rising ground.

The eastern balcony of the TSB Bank building was chosen for the setup of the monitoring site. This location of the monitoring site would represent the general ambient air quality in the central New Plymouth area. It is also located on the "crossroad" of the prevailing wind directions from north-west and south-east in the path of air flows either about to impinge on or having already passed over the residential areas of the southern part of the city.

The site was selected to represent what was expected to be the 'worst case scenario' for air quality as it is in the middle of the CBD, between two main roads and many busy shops and car-parks including The Warehouse, New World supermarket, KFC fast foods outlet, and several others (see Appendix I). This location was also in close proximity to previous two PM10 sampling sites, to allow comparison with data from previous studies. Figure 2 shows the location of the monitoring site in relation to the residential areas to the south.

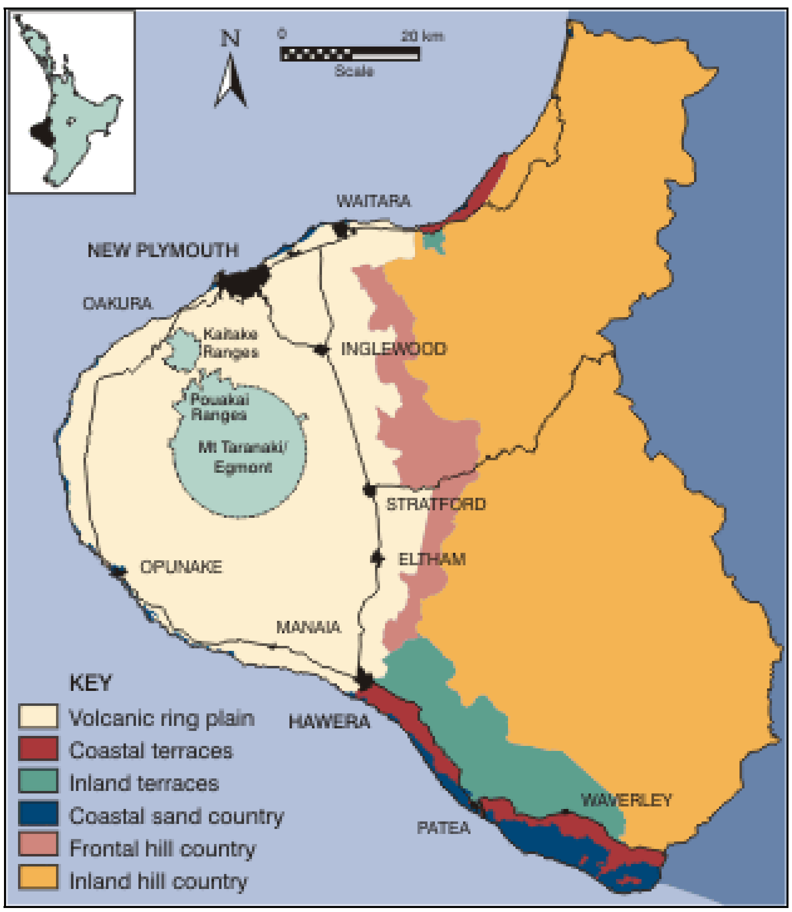

Figure 1 Taranaki region and landforms

Figure 2 Location of PM10 monitoring site in New Plymouth

1.1.3 Meteorology

Taranaki's climate is determined by its westerly position, its mid latitude location, and its topography. The region lies in the path of weather systems moving west over the Tasman Sea. The region is generally sunny and windy, with moderate temperatures and regular rainfall throughout the year. Westerly winds predominate in spring and summer, often bringing unsettled and showery weather. About 40% of New Plymouth's rain comes with winds from the north or north-east, usually falling as steady rain for several hours or longer. South easterlies tend to be dry. The annual rainfall for New Plymouth averages around 1500 mm. Rainfall across the region varies from around 1000 mm on the southern coast, to 2000 mm at the highest points of the ringplain around Stratford, and higher rainfall in the hill country and on Mt Taranaki.

Wind roses for the region are shown in Figure 3.

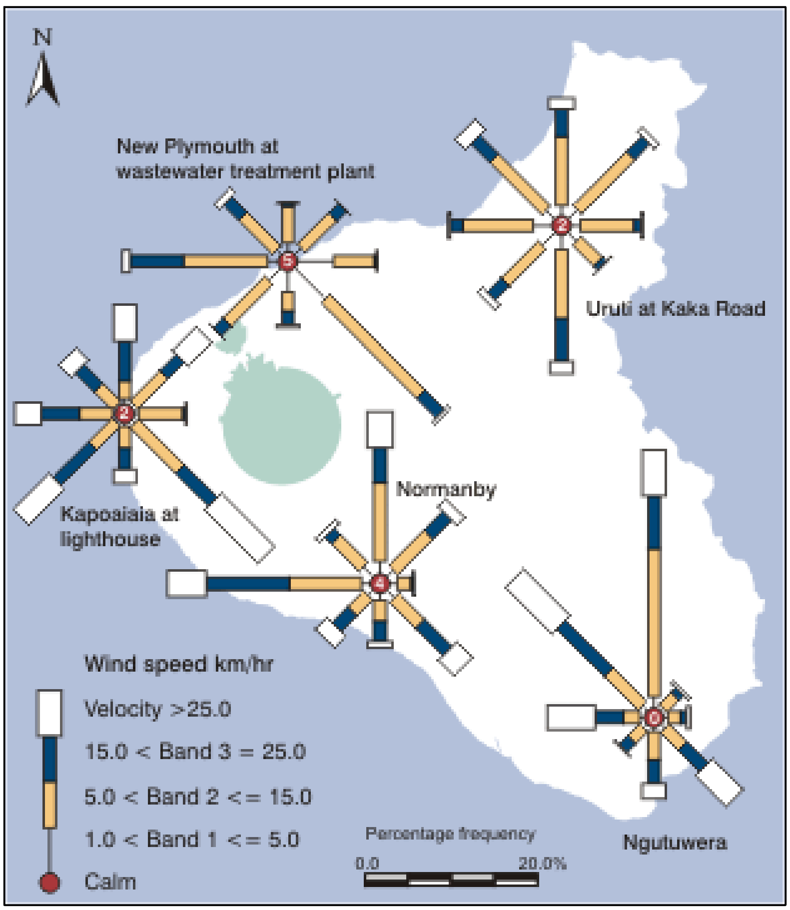

Figure 3 Wind roses for Taranaki

Figure 4 shows the orientation of the coastline in relation to wind directions. A eight-point wind rose was used for analysis of results. Wind directions from 247.5^o to 360^o to 67.4^o (or from WSW to N to ENE) were deemed to be on-shore winds, while wind directions from 67.5^o to 247.4^o (or from ENE to WSW) were deemed to be off-shore winds.

Figure 4 Coastal orientation of New Plymouth

1.1.4 Traffic counts

An estimated 400 premature deaths occur each year in New Zealand due to motor vehicle emissions. In addition to premature deaths, acute and chronic health effects including asthma, chronic obstructive pulmonary disease (COPD), heart disease and bronchitis, as well as increased hospitalisations and restricted activity days (sick days) are also associated with vehicle emissions. Epidemiological studies have shown that respiratory diseases such as asthma can be exacerbated by increases in the concentration of PM10 from motor vehicle emissions. Significant positive associations have been found between proximity to heavily travelled roads and increased childhood respiratory disease symptoms including hospitalisations for childhood asthma[1].

A recent study in Auckland has shown that on main streets the PM10-concentration is up to 40% higher than the urban background. Half of this additional pollution is due to motor vehicle exhaust emission and tyre abrasion and the other half is due to re-suspended dust particles.

A report has determined New Plymouth to be the urban area with the lowest mortality from adverse air quality, of 67 urban centres in New Zealand. [2]

To establish if a relationship exists between vehicle densities and the measured PM10 levels, traffic counts recording vehicle densities throughout continuous 24 hour sampling periods at two locations were undertaken. This work was carried out by New Plymouth District Council (NPDC). The two locations selected were the intersection of Courtney and Gover streets, at one corner of the block within which the sampler was located, and on Devon Street in close proximity to the PM10

[1] See bibliography and references

[2] *Health and Air Pollution in New Zealand,* Ministry for the Environment and Ministry of Transport 2007

sampling site. These locations are the immediately adjacent streets to the north and south of the PM10 sampler (see Appendix I). The findings of this study are discussed in section 3.4.1 of this report.

1.1.5 Public access to on-line air quality monitoring data

The results of air quality monitoring were made available to the public in real time on the TRC web site in a simple and easy-to-understand format.

PM10 data generated by the Thermo BAM analyzer were captured by 'Ebase Lite' (Real-time monitoring software). Ebase then processed the raw data and formatted in graphical form ready for publication. A second process involved a wireless internet connection to deliver the graphs to the TRC web site via the website's host server. The graph for each day was continually updated hour by hour so website users could see the latest air monitoring results, and a simple icon indicating how these results ranked against National Environmental Standard (Figure 5).

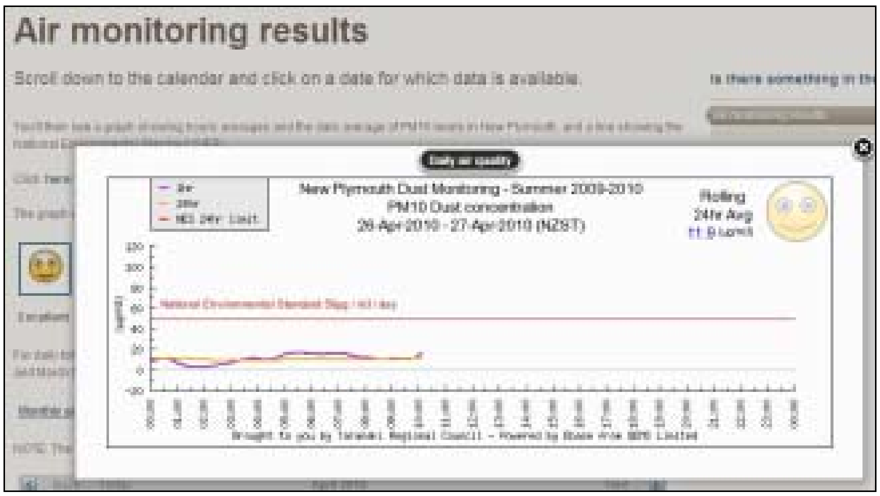

Figure 5 Screenshot of the life PM10 monitoring data on TRC's website.

1.2 Monitoring programme

1.2.1 Introduction

Section 35 of the Resource Management Act sets out an obligation for the Taranaki Regional Council to gather information, monitor, and conduct research on 'the state of the whole or any part of the environment of its region….'

The Taranaki Regional Council may therefore make and record measurements of physical and chemical parameters, take samples for analysis, carry out surveys and inspections, conduct investigations, and seek information.

Whilst the Taranaki region has a well established record of good air quality, and monitoring of industry and various other parameters enables the Council to determine whether changes to air quality might be anticipated, to demonstrate the province meets the National Environmental Standard for inhalable particulate the Council undertakes PM10 monitoring approximately every 5 years. As New Plymouth is the largest and fastest growing urban area with the greatest concentration of industry and traffic in the region, a central location was selected to measure PM10 levels and to enable comparison of these data with previous results and also provide direction with respect to guiding future air quality management programmes.

1.2.2 Monitoring equipment and method

The USEPA categorises particulate monitoring methodologies as either reference or equivalent methods. Reference methods are gravimetric (e.g. direct measurement of collected sample by weight), and equivalent methods are alternative methodologies that have been granted (following stringent inter-comparison studies) equivalency to the reference methods.

Beta attenuation monitor or BAM is recognized by Ministry for the Environment as an equivalent to the reference method[3].

Particle mass density is measured using beta radiation attenuation. A pump draws ambient air through a paper-band filter and the reduction in intensity of beta radiation measured at the detector is proportional to the mass of particulate deposited on the filter. As the mass of PM_{10} increases, the beta count is reduced. The relationship between the decrease in count and particulate mass is computed according to a known equation (the Beer-Lambert law).

The Thermo FH62 BAM monitor with PM_{10} SSI (Size Selective Inlet) was operated and configured during this monitoring programme as per the requirements detailed in:

AS3580.1.1-2007: Ambient Air-Guide for the siting of sampling units,
AS3580.9.11-2008: Methods for sampling and analysis of ambient air-Determination of PM_{10} by BAM,
MfE Good Practice Gide for Air Quality Monitoring and Data Management 2009. and the *Manufacturer's manual.*

The monitoring site was also additionally equipped with an ambient air temperature and relative humidity sensors. Rainfall and wind data which had been used for this project were collected at the nearest meteorological site, situated four kilometres to the west in Port Taranaki.

The instrument is shown in Figure 6 during installation.

Figure 6 Thermo FH62 BAM monitor equipped with PM_{10} SSI during installation by QEMS ltd.

[3] See bibliography and references

2. Results

2.1 Results of PM10 monitoring

A total of 138 days were continuously monitored, with no gaps in the dataset throughout the entire five months monitoring period. The data have been analysed in three separate datasets. The first set covers the entire 138 days, while the two other sets cover the periods when the prevailing wind was blowing onshore (19 days) and offshore (41 days). A summary of those three datasets is given in Table 1 below.

Table 1 Summary of PM10 results

All results in µg/m³	**Mean**	**Median**	**Minimum**	**Maximum**	**95%ile**
Full set of results (138 days)	16	15	5	47	30[(1)]
Set of results[(1)] with **ONSHORE** wind* (19 days) ***(247.5º to 360º to 67.4º) – (WSW to N to ENE)***	26	24	13	47	44[(2)]
Set of results[(1)] with **OFFSHORE** wind* (41 days) ***(67.5º to 247.4º) – (ENE to WSW)***	12	11	5	21	20[(3)]

* wind direction towards (1) 131st highest of 138 (2) 18th highest of 19 (3) 39th highest of 41

(1) For statistical analysis sixty days in total were selected. This selection was based on the following rule:
If during any 24-hour period the wind was from one direction for greater then 18 hours (75%), the prevailing wind direction is deemed to be from this direction only (onshore or offshore) for the full 24-hour period.

A wind rose for the duration of sampling is presented in Appendix II, together with numerical wind statistics. It shows a strong domination of winds from the south-east, south-west and west, with 63% of all winds from these three directions. Winds from the other five octants were distributed almost equally, for periods ranging from six to nine percent of time. Wind speed varied from 0 to 53 km/hr, with an average wind speed of 17 km/hr.

The values in Table 1 clearly show the increase in PM10 levels when the wind is blowing from the sea. All statistical parameters presented in the table increased under these circumstances, roughly doubling in value by comparison with values measured during offshore wind episodes. Also of note is that a few events have values significantly higher than the typical range. More detailed discussions of this result will be presented in the following sections of this report.

3. Discussion

3.1 Earlier PM10 monitoring work

The Taranaki Regional Council has previously undertaken or accessed the results of other monitoring at various locations around the region[a,b,c], including sites within New Plymouth. The sampling periods or protocols, or analytical methodologies, have not in every case been consistent with the methodology set out in the 'Good Practice Guide for Air Quality Monitoring and Data Management 2009' and National Environmental Standards (NES). For these reasons, earlier results should not be compared directly with the work now being reported. However, the results are presented in Table 2, Figure 7 and Figure 8 below for indicative purposes (TRC 2010).

Table 2 Comparative results of other PM10 monitoring in the Taranaki region

Site identification and description	Average μgm^{-3}	Range μgm^{-3}
New Plymouth 2003 (urban)	12.0	0.6-30.9
New Plymouth 2000 (urban)	9.6	0.7-26.0
Stratford (rural town)	9.2	1.7-24.1
Oaonui (coastal)	7.2	1.0-16.5
Egmont National Park (pristine)	1.6	0.2-3.6

The results for the earlier New Plymouth work indicated that levels of PM10 were elevated when the wind blew from the sea, implicating salt spray as a major source. A similar result occurred at Oaonui, on the west coast of the region, where sea breezes typically had three times the concentrations of fine particulate found in breezes blowing across land towards the monitor. Peak values at the Stratford site were characterised as very brief and comparatively very high, and were probably caused by wood fires near by. At New Plymouth, the higher concentrations persisted for longer (e.g. overnight), indicating natural prevailing sources linked with particular meteorological conditions.

[a,b,c] See bibliography and references

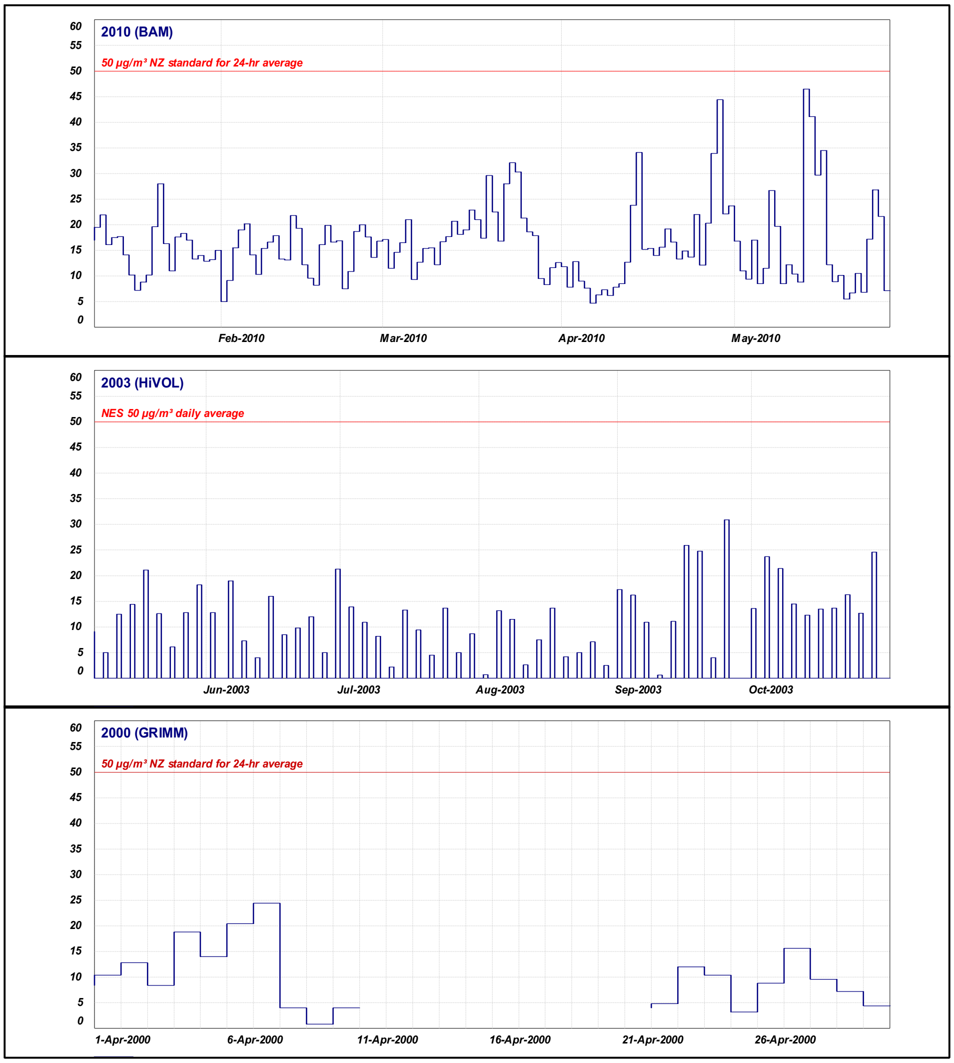

Figure 7 Entire datasets of daily PM10 concentrations during three monitoring runs in New Plymouth

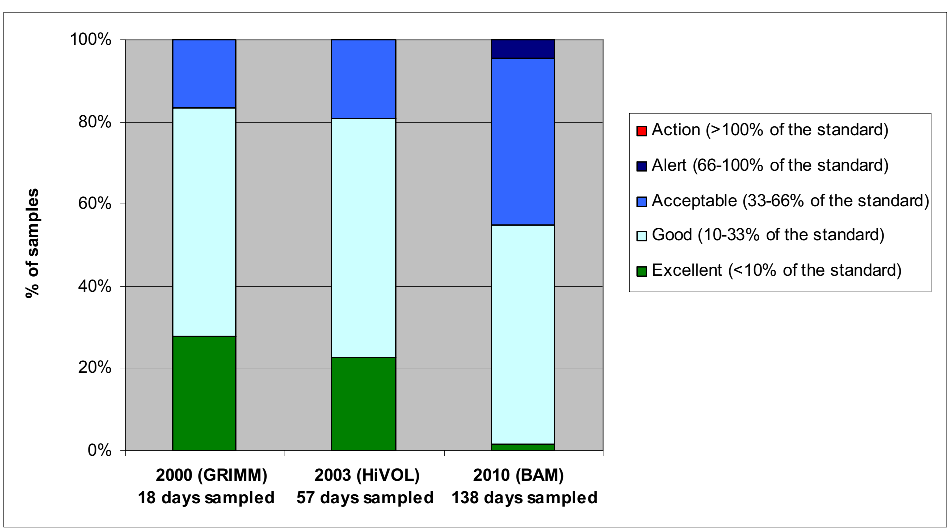

Figure 8 Proportions of PM10 samples belonging to different air quality categories

3.2 Discussion of New Plymouth results

Atmospheric particulate matter can arise from a number of sources, both natural and from human activity e.g., vegetation pollens, smoke and ash, sea spray, dust from soils and paved surfaces, and manufacturing processes. While extremely fine particles may remain floating in the atmosphere for weeks or months, coarser dusts may settle out within timeframes ranging from a few seconds to minutes.

MfE uses an environmental performance indicator to categorise air quality. These categories are set out in Table 3.

Table 3 Environmental Performance Indicator air quality categories

Measured value	Less than 10% of NES	10-33% of NES	33-66% of NES	66-100% of NES	More than 100% of NES
Category	*excellent*	*good*	*acceptable*	*alert*	*action*

The results obtained in the current work had an average of 16µg/m³, and the peak value was 46µg/m³ which occurred during a heavy rainfall event with a fresh onshore wind. The air in New Plymouth can be considered as 'excellent' or 'good' for 56 % of the time and 'acceptable' at 40% of the time- (see Figure 8).

Further details are set out in Tables 4-6. They again show that there are significant variations in air quality in the region, depending on whether the wind is from or towards the sea. For offshore winds, levels of PM10 fell within the 'excellent' or 'good' categories more than 75% of the time. When the wind was onshore, this proportion fell to 16% of the time, with 84% of all results falling into the 'acceptable' and 'alert' category - more than three times the frequency encountered when the wind was offshore.

Table 4 Categorisation of results - entire dataset

National Environmental Standard for PM10 = 50 µg/m³- 24 hour average.		
Category	Measured values	Days (%)
Excellent	<10% of the NES, (0-5µg/m³)	**2** (2%)
Good	10-33% of the NES, (5-17µg/m³)	**74** (54 %)
Acceptable	33-66% of the NES, (17-33 µg/m³)	**56** (40%)
Alert	66-100% of the NES, (33-50 µg/m³)	**6** (4%)
Total number of days sampled		**138** (100%)

Table 5 Categorisation of results - prevailing onshore wind*

National Environmental Standard for PM10 = 50 µg/m³- 24 hour average.		
Category	Measured values	
Excellent	<10% of the NES, (0-5µg/m³)	**0** (00%)
Good	10-33% of the NES, (5-17µg/m³)	**3** (16 %)
Acceptable	33-66% of the NES, (17-33 µg/m³)	**12** (63%)
Alert	66-100% of the NES, (33-50 µg/m³)	**4** (21%)
Total number of samples*		**19** (100%)

Table 6 Categorisation of results - prevailing offshore wind*

National Environmental Standard for PM10 = 50 µg/m³- 24 hour average.		
Category	Measured values	
Excellent	<10% of the NES, (0-5µg/m³)	**2** (5%)
Good	10-33% of the NES, (5-17µg/m³)	**29** (71 %)
Acceptable	33-66% of the NES, (17-33 µg/m³)	**10** (24%)
Total number of samples*		**41** (100%)

* when wind blew offshore or onshore for more than 18 hours (75%) per day

3.3 Correlation of results with meteorological condition

3.3.1 Wind direction versus PM10 results

Wind directions are rarely stable for long periods in Taranaki. It is rare for the wind direction to remain constant for more than 12 hours, and wind directions can often oscillate through 360° over a brief period. Therefore, if the direct correlation of the continuous wind direction and PM10 datasets were used it would show wide variations and the results would be largely meaningless. Instead of plotting direct scattering, the wind direction data were divided into two groups (onshore/offshore) depending on the percentage of time when wind was within one or the other semicircle for an extended duration. This method is discussed in section 2.1 and shown in Figure 4 of this report. Figure 9 below shows daily PM10 data which are plotted together with daily prevailing wind data. This graph also shows nineteen flagged days when wind was onshore for greater than 18 hours.

This graph clearly demonstrates that the highest PM10 daily results correspond with stable onshore winds. PM10 concentrations decrease sharply when the wind direction swings to the offshore semicircle. As the corresponding offshore wind graph would be the inverse of the onshore graph, it has not been shown.

This finding again confirmed those found in previous studies, that the largest proportion of fine particles in New Plymouth's air are sourced from sea.

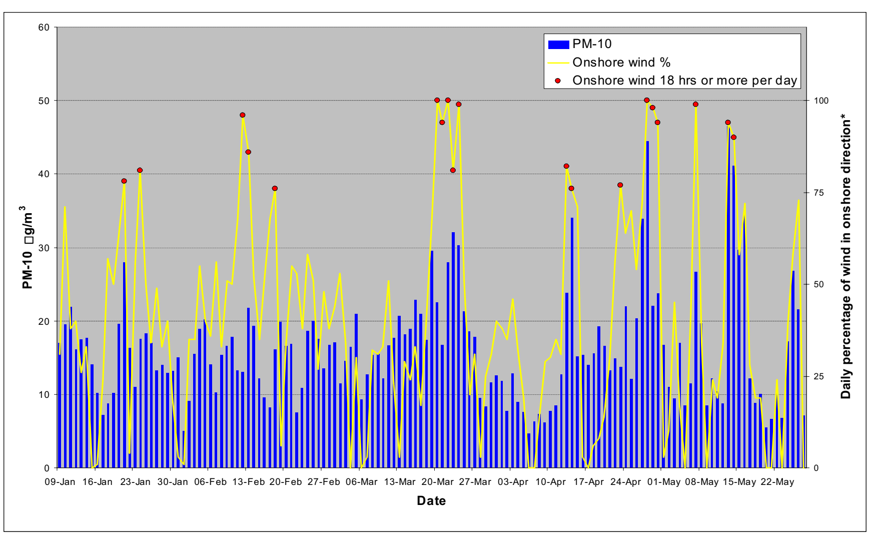

Figure 9 PM10 daily averages versus on-shore winds

3.3.2 Rainfall versus PM10 results

Figure 10 below shows entire datasets of PM10 and rainfall expressed as daily mean and daily totals respectively. It is noted that highest PM10 results happened during moderate to heavy rainfall events and, in the majority of cases, during fresh onshore winds. It appears that the combination of rainfall with offshore winds does not elevate PM10 levels and in some cases it even decreases them. Therefore correlation analyses between fine particle concentrations and rainfall events must be conducted in conjunction with wind data. Rainfall can contribute to PM10 changes in two different ways: it can act as a suppressor and scrubber of the suspended particles from the air; or as a carrier of sea salt particles through the air.

These findings confirm those of the previous inhalable particulate surveys that found sea salt spray to be a major PM10 source in Taranaki.

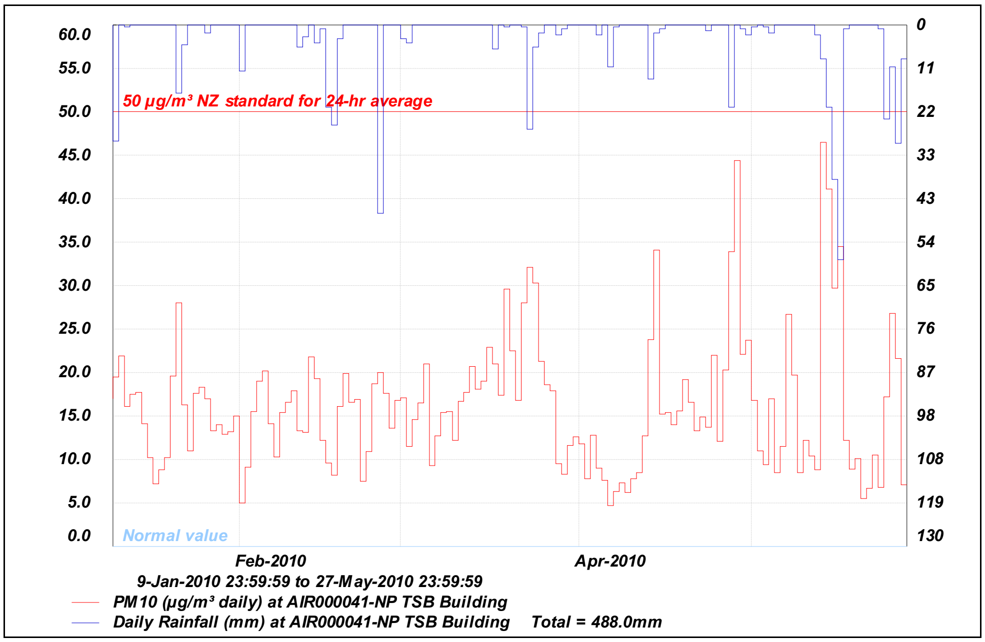

Figure 10 Daily PM10 (red, left axis) and Rainfall (Blue, right axis) throughout entire dataset

3.4 Correlation of results with traffic counts

3.4.1 Traffic counts versus PM10 results

The traffic counting methods employed at the two sites were different from each other. On Devon Street the traffic counters used two pneumatic tubes placed on the road one metre apart. Each time an axle hits a tube a 'hit' is logged at the recorder. This counting method is accurate and allows the determination of the traffic volume as well as speed and size of the vehicles. The pneumatic counter is more suitable for occasional, campaign-type monitoring. On the other hand, at the Courtenay Street counting site induction loops in the road are employed to record a 'hit' when a large metal object (vehicle) passes a set induction threshold over the loop in the road. This non-contact traffic counting method allows continuous recording of traffic volumes.

TRC has access to three traffic data sets (provided by the New Plymouth District Council). The first set of data was collected at the Courtenay Street site. This set covers the entire five-month monitoring period. Two other sets of data were collected, at the Devon Street site, over a period of twenty days in total.

Figure 11 presents traffic volumes at the two traffic counting sites together with one-hour average PM10 results for the period of 10 days when all three parameters (PM10, Courtenay and Devon Streets) were monitored simultaneously.

The pattern of traffic densities on Courtenay Street is constant. Three clear peaks in traffic volumes can be observed during week days (morning, midday and afternoon rush hours) with only one midday peak during weekends. At the Devon Street monitoring site the traffic pattern is less consistent, with wider variations. Traffic movement at the Devon Street site can be described as ‘driving in and driving out’ in contrast to Courtenay Street site where ‘traffic goes through’.

Figure 11 shows that all three datasets in general have a similarity in diurnal variations. However, from the correlation analysis of the entire datasets the association between PM10 and traffic volumes was almost non-existent, (R^2=0.0109 for the Courtenay Street site and R^2=0.0881 for the Devon Street site). Similarly for the period shown in Figure 10 the R^2 results are equal to 0.0343 and 0.0881 respectively. These findings would suggest that there is no relationship between a particular traffic density event and PM10 values. Visual similarity of diurnal variations between traffic volumes and PM10 concentrations most likely result from the general re-suspension of particulates into the air, or indeed the co-incidence of higher on-shore breezes during the day and higher traffic flows during daylight hours.

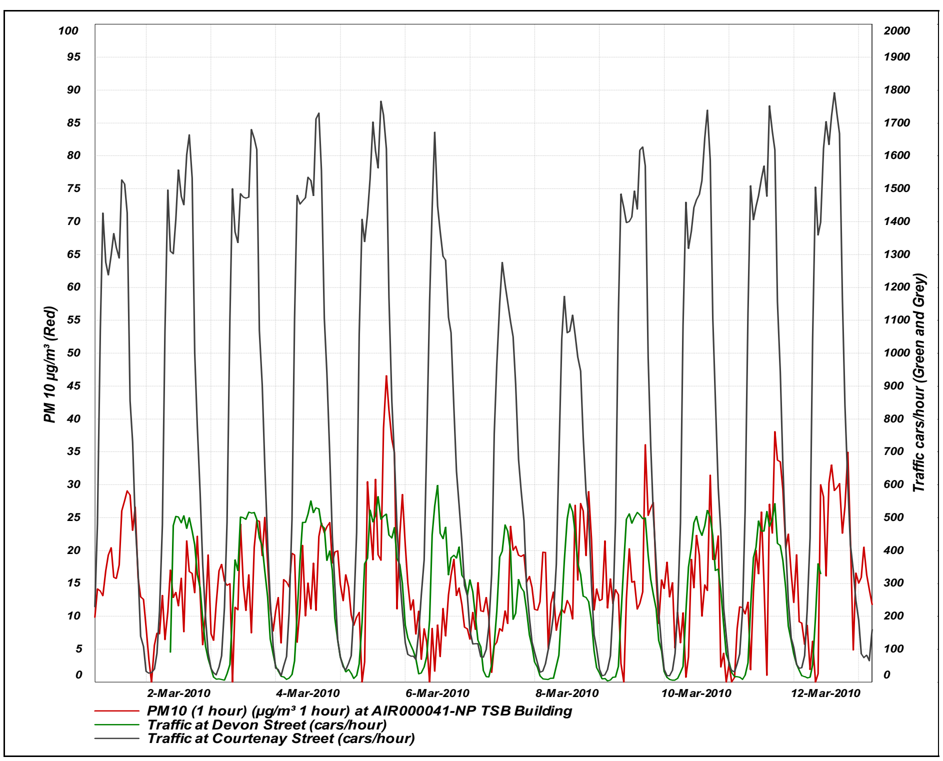

Figure 11 PM10 One hour averages versus traffic counts

3.5 Future monitoring requirements for PM10

In designing and implementing the state of the environment monitoring programmes for air in the region, the Taranaki Regional Council has taken into account the extent of information generated by other authorities, its relevance under the Resource Management Act, the obligations of the Act in terms of monitoring the state of the region's environment, and subsequently reporting to the regional community, the scope of assessments required at the time of renewal of permits, and the need to maintain a sound understanding of the environment within Taranaki.

For PM10 monitoring, five yearly repeat programmes for the Inhalable Particulate Regional Monitoring are suggested to be appropriate.

Taranaki Regional Council is proposing to purchase a TSI 8533 DRX Portable Dust Monitor. This real-time laser based instrument is capable of simultaneously measuring four PM fractions (PM1, PM2.5, PM4 and PM10). It is also equipped with a filter cartridge for gravimetric, microscopic and/or chemical analysis. Comparison studies between TEOM and DustTrak DRX in Arizona US[4] have shown very strong correlation between two sets of results, where R^2=0.9879.

MfE suggests that light-scattering instruments are not suitable for compliance monitoring[2], however USEPA at present is evaluating the possibility of the introduction of light scattering instruments for EPA monitoring networks to support the PM secondary standard[3].

From the Council's perspective, it is most desirable that any technique should measure PM2.5 and PM10 simultaneously and on an instantaneous basis.

Implementation of the new technique (such as DustTrak DRX) for future PM monitoring would help to better understand the fractional and chemical composition of fine particulates in Taranaki's air.

The Policy and Planning department of TRC has identified the potential need for monitoring a residential/commercial area in New Plymouth to assess the impact of Heavy Goods Vehicles on surrounding residential areas for air quality purposes. A suggestion has been made for a site to be located at, or near to, the Moturoa Shopping centre on St Aubyn Street, due to its proximity to Port Taranaki and a high flow of heavy goods vehicles to and from this key transport hub. It is recommended to undertake a one month PM10 monitoring within this area as an additional part of the future inhalable particulate monitoring in Taranaki region. It is essential for this study also to monitor traffic flows on St Aubyn Street. TRC's 'DustTrak PM10 monitor' can be used at this stage as a screening devise to determine if further, more rigorous investigations are required.

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[4] See bibliography and references

[2]

[3]

4. Recommendations

1. THAT it be noted that Taranaki Regional Council has now carried out three separate studies in New Plymouth's CBD gathering PM10 data, which in combination cover an entire year. This data has shown no major seasonal variations of PM10 in New Plymouth air.

2. THAT it be noted that PM10 monitoring of ambient air in New Plymouth has shown no exceedances of the National Environmental Standard.

3. THAT it be noted that sea spray is a major contributor to PM10 in the Taranaki region.

4. That the Taranaki Regional Council continues to conduct inhalable particulate monitoring from time to time at a frequency reflecting the low level of anthropogenic sources and high existing air quality in the region

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3. William T. Winberry, Jr. ,2010: “US EPA’s NAAQS, Potential Effects On Present EPA Monitoring Networks.”

4. TSI Incorporated USA: “Mass Concentration Comparison between the DustTrak DRX Aerosol Monitor and TEOM”

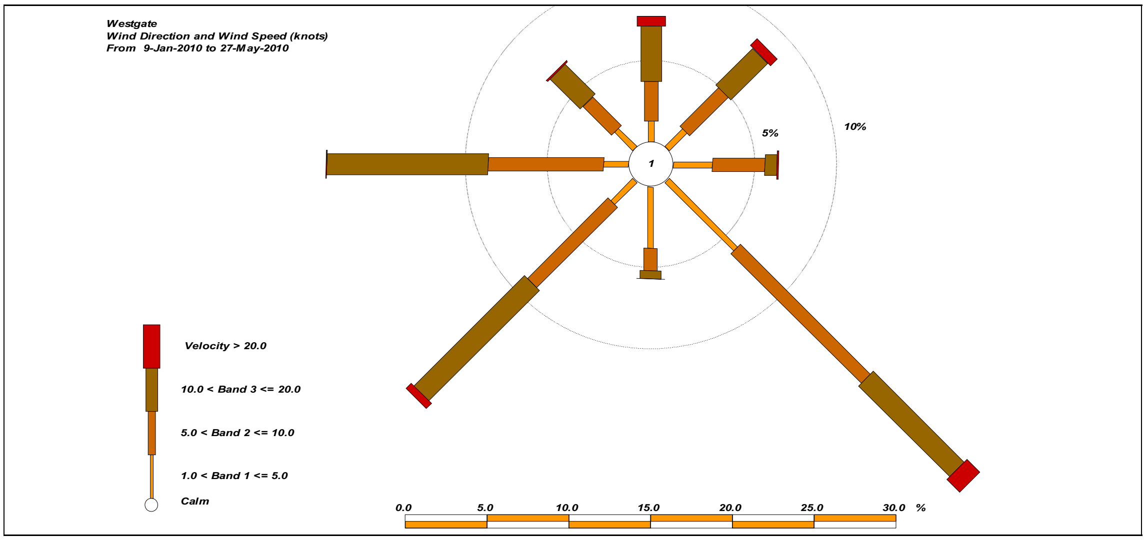
Appendix I

Aerial map of New Plymouth CBD


Businesses/Retail Outlets/Food Premises
PM10 Monitoring Site
Devon Street East
Traffic Counter
Food Premises
Traffic Counter
The Warehouse
Spudz
Fruit & Veg
Courtney Street
Gover Road
New World
Supermarket

Appendix II

Wind rose and numerical wind statistics for the duration of monitoring



Percentage of time in each band

Direction	Band 1	Band 2	Band 3	Band 4	Total
337.5 - 22.4	1.3	2.4	3.4	0.6	7.7
22.5 - 67.4	1.6	3.4	3.2	0.6	8.7
67.5 - 112.4	2.4	3.2	0.8	0.1	*6.4*
112.5 - 157.4	6.0	11.2	7.9	1.1	*26.1*
157.5 - 202.4	3.8	1.4	0.5	0.0	*5.6*
202.5 - 247.4	1.9	6.9	9.6	0.4	*18.9*
247.5 - 292.4	1.5	7.1	9.8	0.1	18.5
292.5 - 337.4	1.6	2.5	2.6	0.1	6.8
Total	20.1	38.1	37.6	3.0	98.7
				Percentage Calm	1.3

On-shore (from sea) 41.7%
Off-shore (from land) *57.1%*