STAFF REPORT

TO: Environment & Planning Committee

FROM: Trevor James, Resource Scientist

REFERENCE: C301

SUBJECT: **AIR QUALITY IN RICHMOND, MOTUEKA AND WAKEFIELD – AN UPDATE 2006 – REPORT EP06/11/11** – Report prepared for 22 November 2006 Meeting

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1. INTRODUCTION

The purpose of this report is to present results for air quality monitoring for the 2006 year to date and compare these to previous years and to other monitored air-sheds in New Zealand. New meteorological monitoring equipment has significantly advanced our understanding of the patterns in air movement. Similarly the new equipment for continuously monitoring fine particulate (PM_{10}) has considerably advanced our understanding of daily variations in concentration of this contaminant. Combining this information has allowed us to get insights into where the major sources of PM_{10} are coming from.

2. BACKGROUND

The overall aim of the Tasman District 'State of the Environment' air quality monitoring programme is to determine the condition of ambient air for the purpose of understanding potential effects on human health. More specifically, the programme aims to determine the concentration of fine particulate (PM_{10}) and determine trends over time. We will not be in a position to comment conclusively on trends until we have at least another two years of data from our continuous PM_{10} monitoring equipment.

In a first for Council, we have been reporting our air quality data directly to the web. This began in May 2006 and included graphs of the past 48 hours, 24 hour PM_{10} over the past week and a graph of the year to date. The Nelson Evening Mail took information from this website to produce their graphs for the newspaper with Richmond data being displayed alongside data form Nelson City. Formal reports listing the date and level of exceedence above standards were provided to the media as required by the national standards a copy of this is appended to the end of this report.

Photo 1 View of Richmond from West to East on 29 June 2006, the day of the highest ever recorded 24 hour average PM_{10} in Richmond (State Highway 60 is clearly visible in the foreground)

Photo 2 View of Richmond West-South-West to East-North-East on 8th June 2006 (Gladstone Road is clearly visible to the bottom left of the photo).

3. METHODS

From late August 2005 Tasman District Council operated a continuous PM_{10} monitoring device (Beta Gauge) at the Plunket Rooms in Central Richmond. The Partisol sampler was co-located with the continuous monitor in accordance with quality control protocols. Due to the less-than-satisfactory initial correlation between the two machines, particularly at lower concentrations, the Partisol had to be retained at the site for the whole season and therefore could not be used elsewhere in the town or district. Auditing of the monitoring site and methods was undertaken by staff and independent experts at various intervals throughout the last year.

Both methods sample particulate material by drawing in air through a size-selective inlet (this only lets in the particles under 10 micron in size) and depositing the particulate material on a filter. Both methods are USEPA reference or equivalent and ANZ Standards are either approved or pending. All equipment is maintained and calibrated according to this standard and quality control measures such as the use of blanks are employed. Partisol filters are sent to an IANZ accredited laboratory where it is weighed under precise humidity control. Sampling frequency for the Partisol was 1 day in 2 for May-August inclusive (apart from daily sampling for three weeks in May-June) and for the October-May 2005-06 the frequency was generally 1 day in 4.

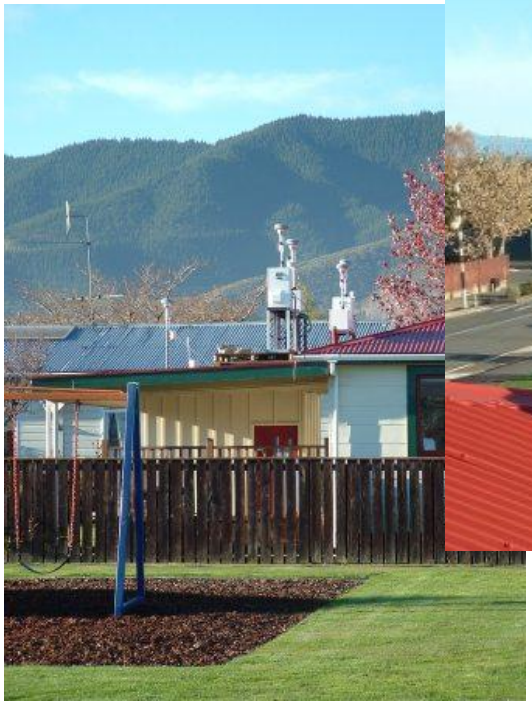


Figure 1a: Richmond Central monitoring site viewed West to East

Figure 1b: Richmond Central monitoring site viewed East to West

One of Nelson City Council's Partisol monitoring units was used at Motueka to collect samples every second day from late June to early August.

A Micro-Vol sampler was operated in Wakefield for six samples in July. Equipment malfunctions meant fewer samples were taken than planned. The Micro-Vol sampler works the same way as the Partisol, but is not USEPA or ANZS approved and can only be used to get indicative results. This method is useful in determining if there is a particulate air quality problem or not.

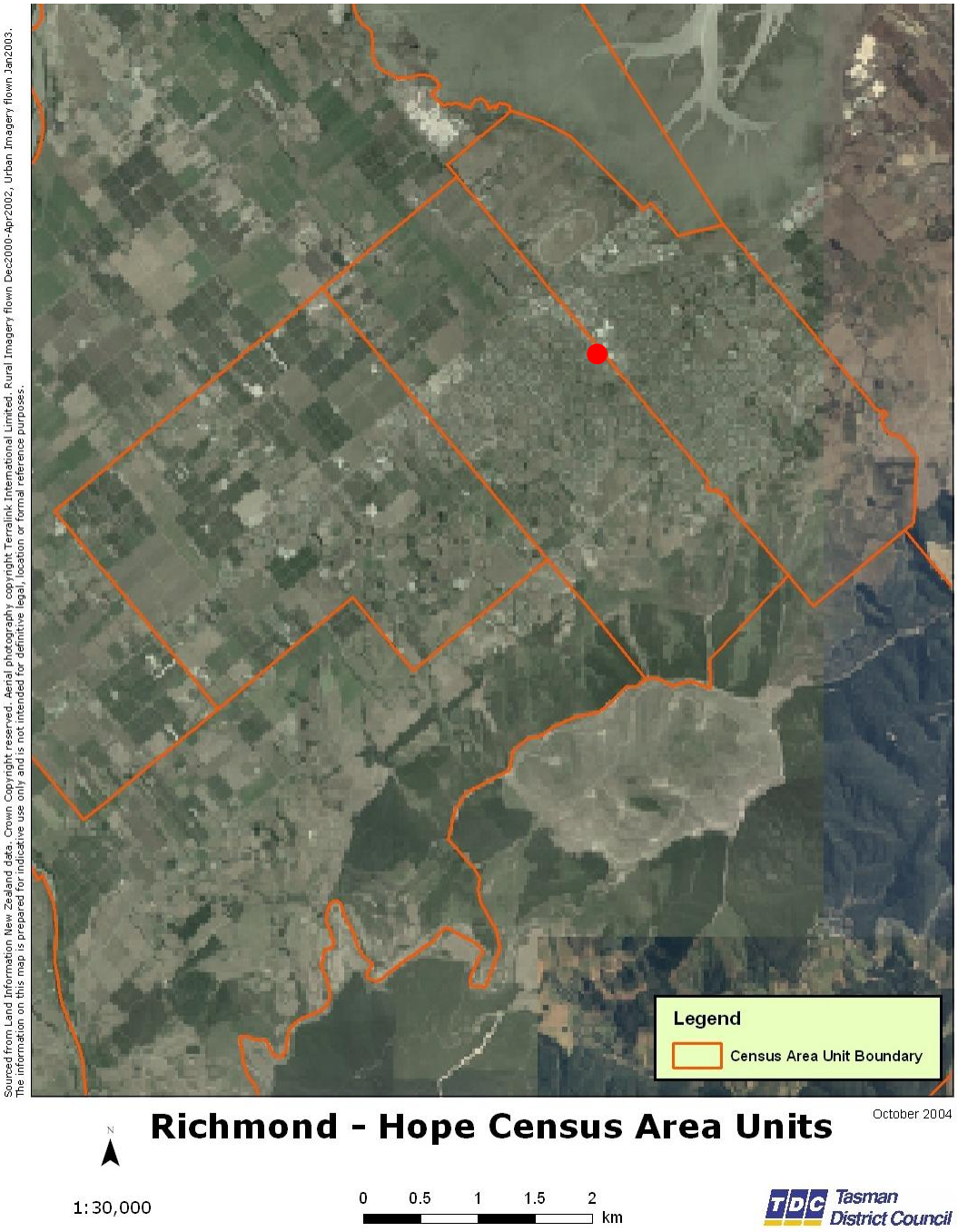


Figure 2 Map showing the location of the Richmond Air Quality Monitoring Site

4. RESULTS AND DISCUSSION

In 2006 there were 31 measured exceedences of the standard for 24-hour average PM_{10} (as measured by either the Partisol or Beta Gauge). Figure 3 shows exceedences recorded on the Partisol only. The highest ever recorded maximum concentration (115 µg/m^3; recorded on the Beta Gauge) occurred this winter on the 29th June.

If you extrapolate from Beta Gauge data, based on its rate of under-reporting for the days when the Partisol was not running, you get a further six exceedences, bringing the total to 37. Extrapolating the maximum concentration recorded on the Beta Gauge produces a result of 130 µg/m^3; clearly a result of concern. The continuous monitor (Beta Gauge) almost always under-reported the result compared to the Partisol. The average rate of under-reporting was 13%. While it is not desirable to have such a discrepancy between the two monitors, it is considered reasonable by external peer reviewers to extrapolate in these circumstances. Several potential reasons for this were investigated but no cause found. Several other Councils with air-sheds dominated by domestic home-heating emissions have found a similar correlation.

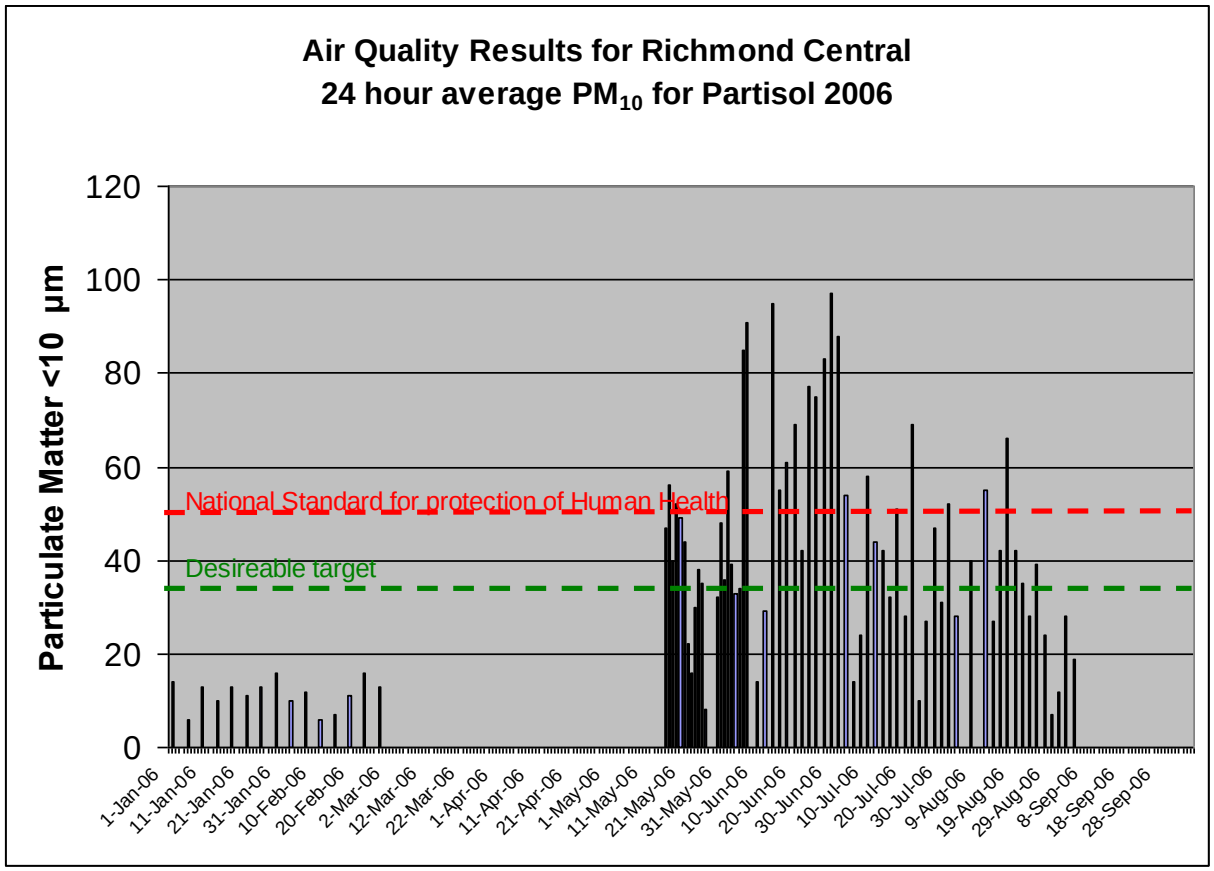


Figure 3 PM_{10} 24 hour Average for Richmond Central

An appreciation of the variation within each 24 hour period can be gleaned from the graph of continuous 30min averages from the Beta Gauge (see Figure 4). Like the Partisol results, the difference between winter and non-winter is clear.

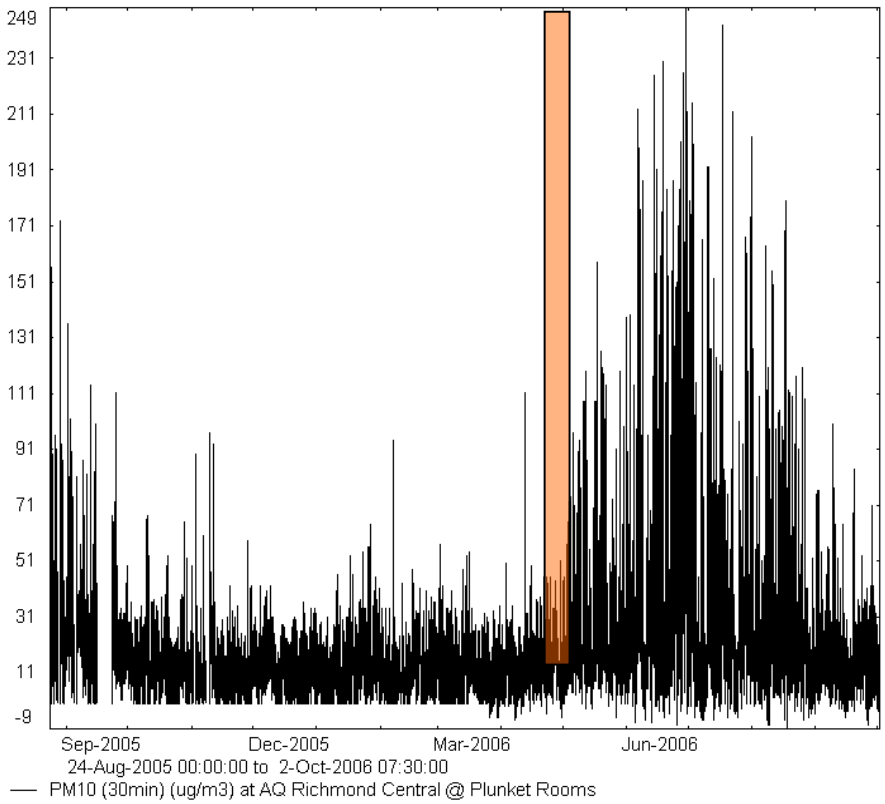


Figure 4 PM_{10} 30 min average values for Richmond Central (the part of the plot highlighted is shown in Figure 5)

Figure 5 shows the period of worst air quality in Richmond in 2006. It is important to note that around the 5th July the weather pattern changed to windy south-westerlies which caused much lower PM_{10} concentrations.

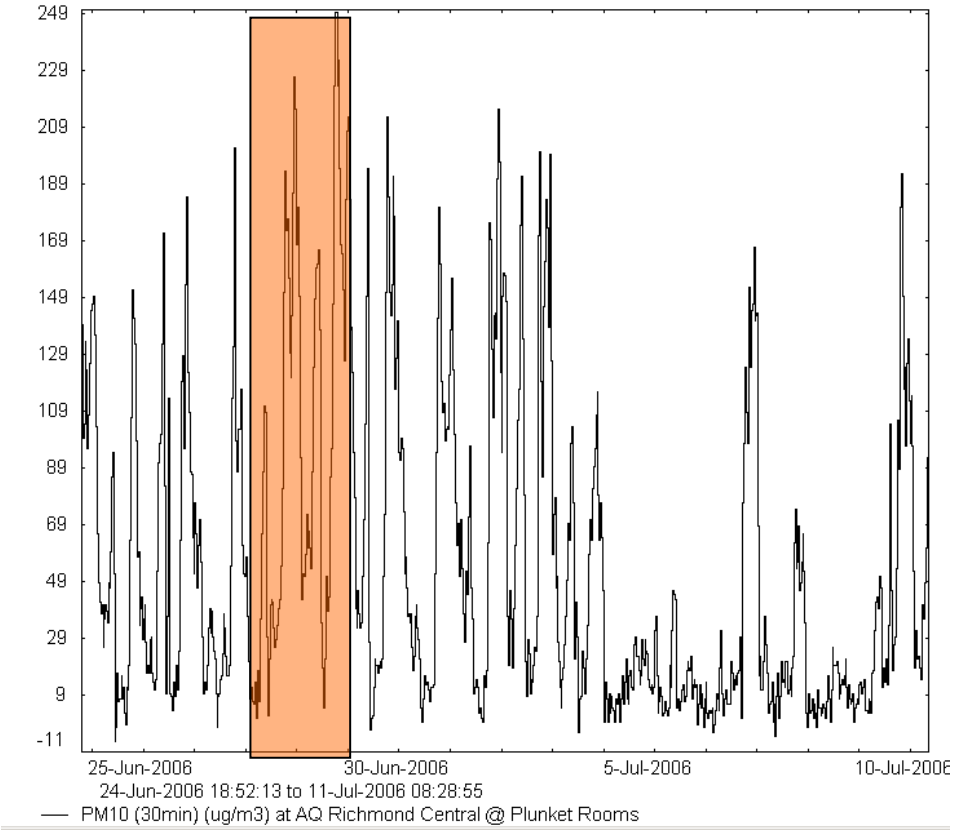


Figure 5 Graph of typical daily variation (the part of the plot highlighted is shown in Figure 6)

The daily variation in PM_{10} concentration shows repeating patterns correlating with the use of domestic fires for home heating. Typically in the early evening (4-6pm) the concentration starts to rise, presumably from people returning home from work and lighting the fires. This builds up in the air-shed producing an initial peak concentration around 7-8pm. The concentration then typically falls, presumably from the burner's being hot and working at optimum efficiency. It is likely that the peak around 11-12pm is caused by fires being stoked up to keep the house warm over the night. This practice of stoking up a fire and dampening down the air flow to make the heat output last over a longer period is known to cause much higher emission rates from the burner. In the morning there usually is a lower peak around 9am, presumably caused by fires being relit.

It is notable how quickly the concentration returns to almost background in the period from late morning to early evening on most days, with the exception of slightly elevated concentrations extending toward midday on some weekends.

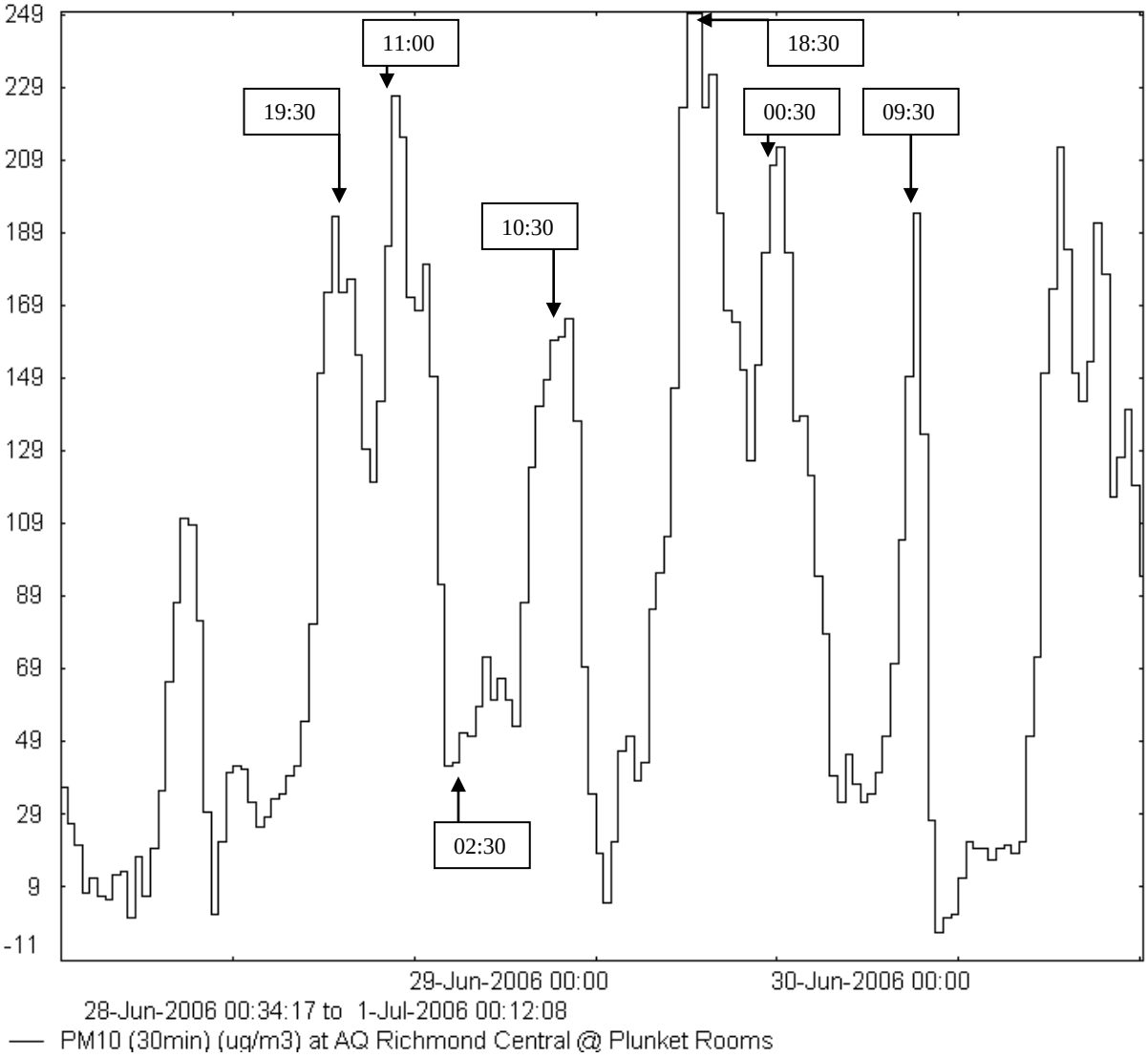


Figure 6 Typical Daily Variation During the peak PM_{10} concentrations

The Influence of Meteorology

One of the benefits of continuous monitoring of PM_{10} is that we can determine where most of the air pollution is coming from. This is because we can use 10min interval data for both wind direction and PM_{10}, a period which wind direction is unlikely to fluctuate. This is impossible for 24-hour average data.

Figure 7 below shows that the contribution of industry in the Beach Road industrial area, Nelson Pine Industries, major traffic zones & central business district do not appear to be contributing significant PM_{10} load. This situation is confirmed by the emissions inventory which shows Richmond industry accounts for only 10% of PM_{10} in Richmond.

Figure 7 also shows that our monitoring station is not being unduly affected by point-source emissions from chimneys within 100m of the monitor. This is deduced from the result that no one wind direction stands out.

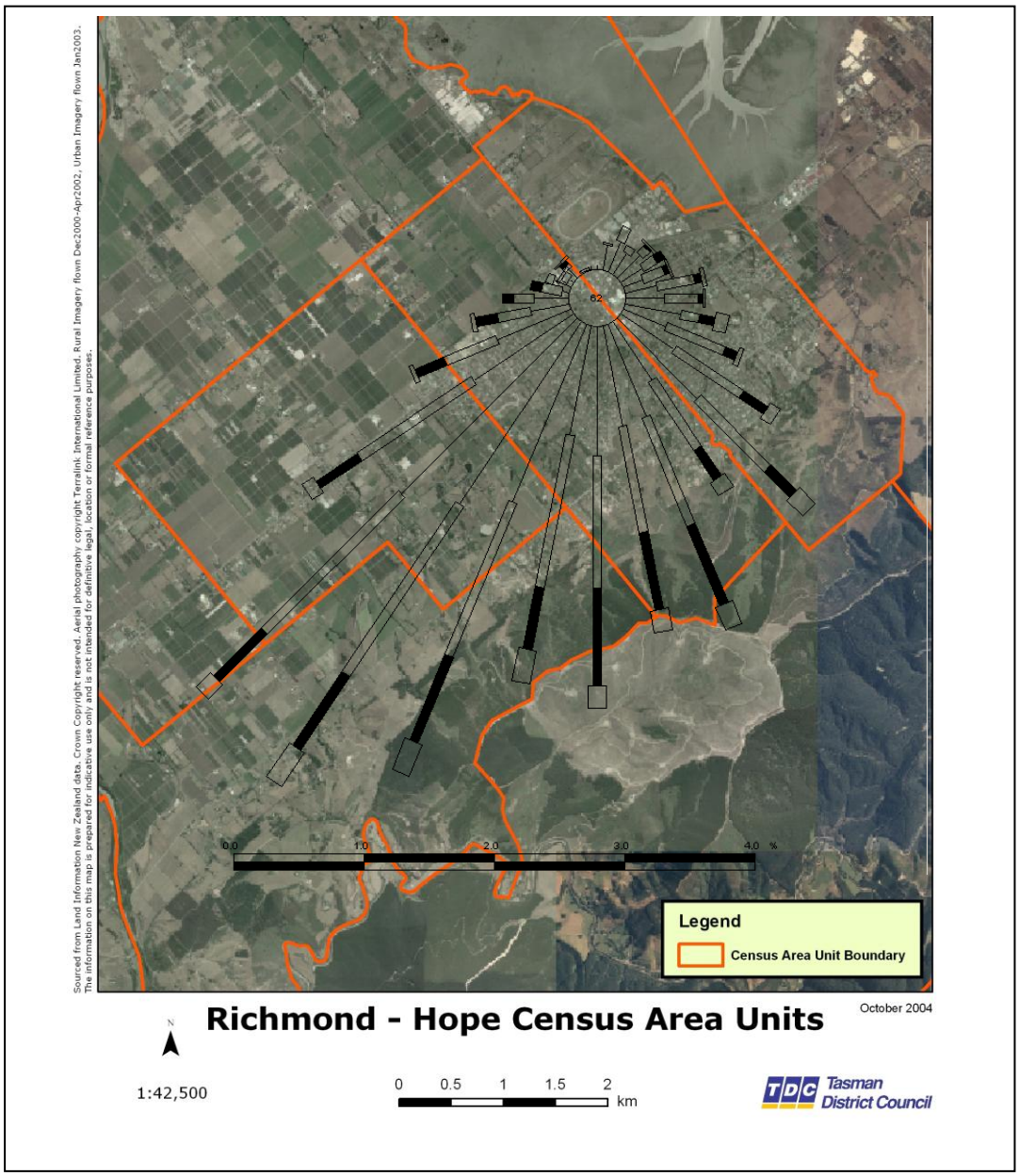


Figure 7 Pollution Rose for Richmond over-plotted on the Richmond Central monitoring site

When comparing the pollution rose to the wind rose it appears that the contribution of particulate air pollutants is greater from the east to south-south west than from other directions (see Figure 8). This also correlates with longer wind runs over densely populated residential areas.

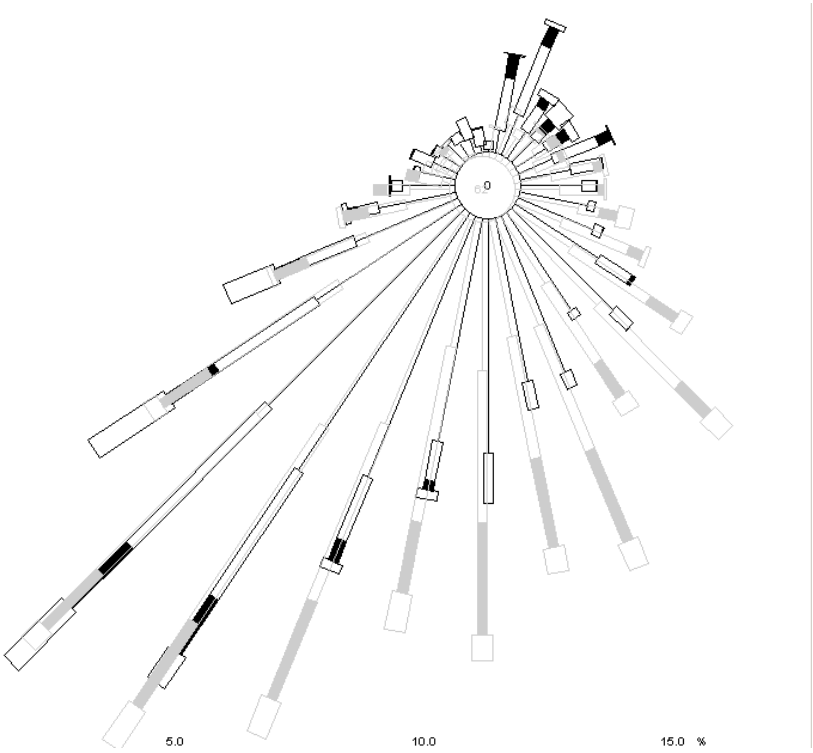


Figure 8 Wind rose over-plotted on the pollution rose for Richmond

The general pattern of wintertime wind-speed and direction were similar for previous years (see Figures 9a-e). It is difficult to compare the pre-2006 data with more recent data as the meteorology equipment was upgraded in February 2006. This new equipment has much lower stall speeds than the old equipment. This can be seen from the percentage of the wind speed data that is less than 0.1 km/hour; with 2006 having no data less than this speed and pre-2006 had between 23 and 35% of the data at these low speeds. While it appears from the 2006 winter data that there is a greater frequency of east to south winds than typical, this is likely to be an artifact of the lighter winds from these directions being recorded by the new equipment that were not able to be monitored by the old equipment we were operating..

Having this accurate low wind-speed data is critical for air dispersion modeling that will be carried out in 2009.

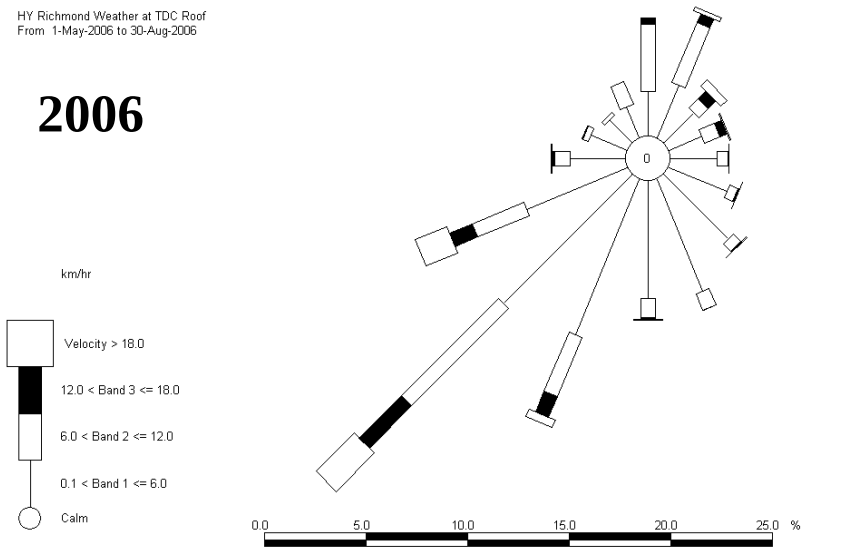


Figure 9a Wind rose for Richmond Central for winter 2006

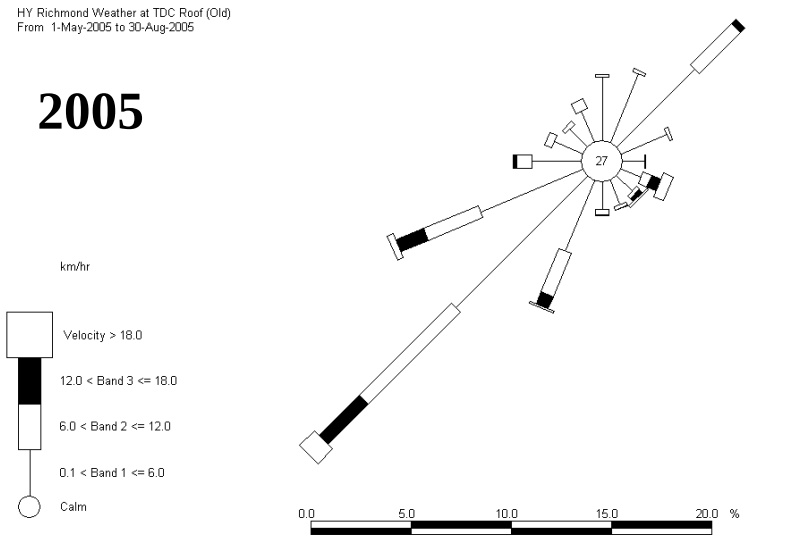


Figure 9b Wind rose for Richmond Central for winter 2005

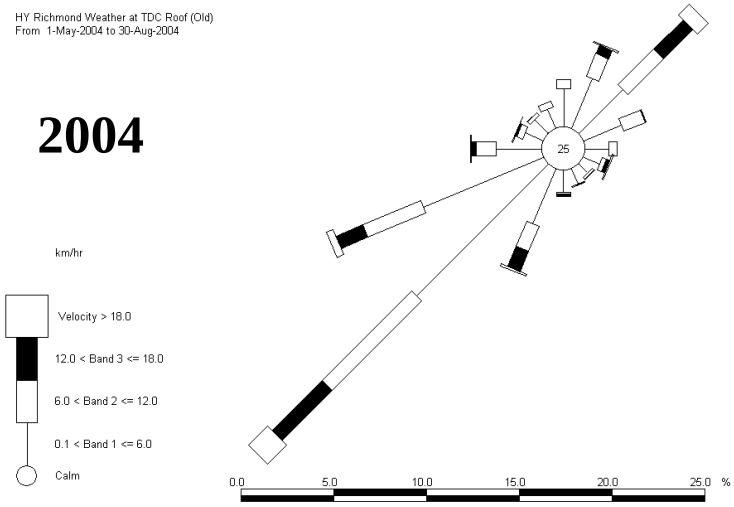


Figure 9c Wind rose for Richmond Central for winter 2004

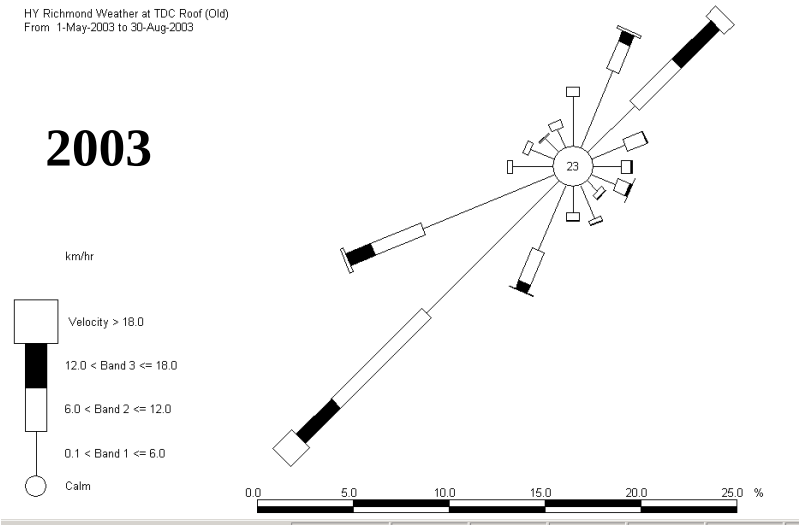


Figure 9d Wind rose for Richmond Central for winter 2003

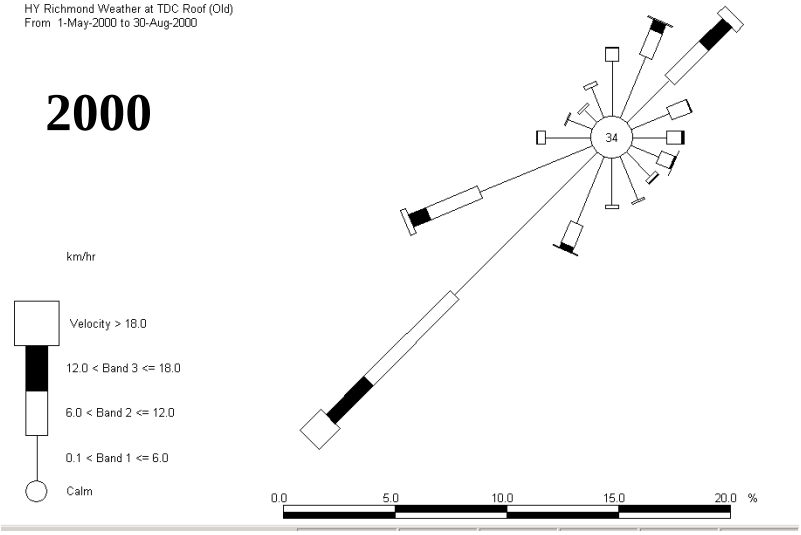


Figure 9e Wind rose for Richmond Central for winter 2000

Comparing wind speed and direction in central Richmond with that of the new site on the Waimea Plains at the Racecourse, we see that Richmond town is more influenced by east and southeast winds coming off the Barnicoat Range (see Figure 10a and b). At the Racecourse site there is a focused corridor of wind with south-west winds dominating most of the time and north-north east winds dominating in the afternoon (see Figure 12b). These data are directly comparable as they were collected using exactly the same equipment.

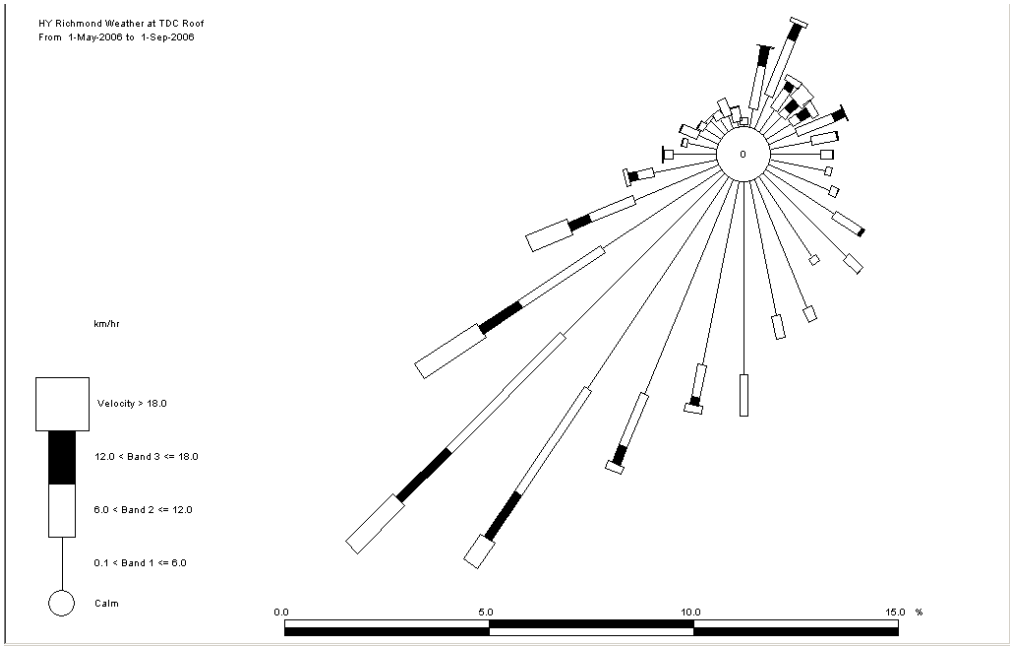


Figure 10a Wind Rose for Tasman District Council office for Winter 2006

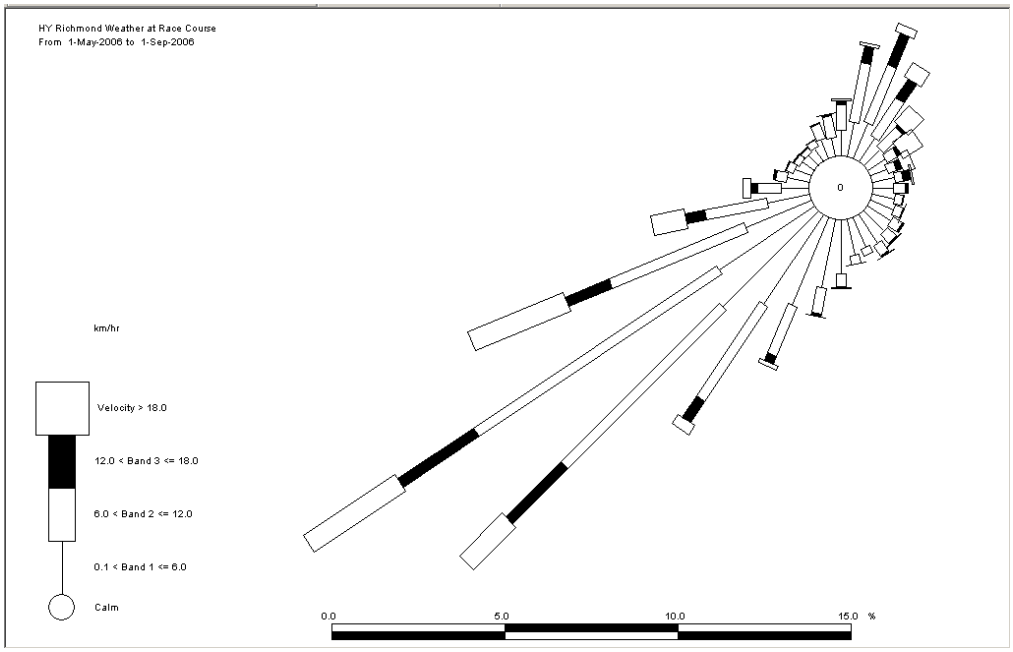


Figure 10b Wind Rose for Richmond Racecourse for Winter 2006

Lighter east-south-east to south winds more frequent during morning and night in central Richmond than on the Waimea plains near the Richmond Racecourse (see Figure 11a and b). Even though the south-west winds also dominate Richmond Central they are not nearly as strong as on the Waimea plains. Stronger north-north east and northeast winds are present on the Waimea Plains near the Racecourse compared to Richmond central.

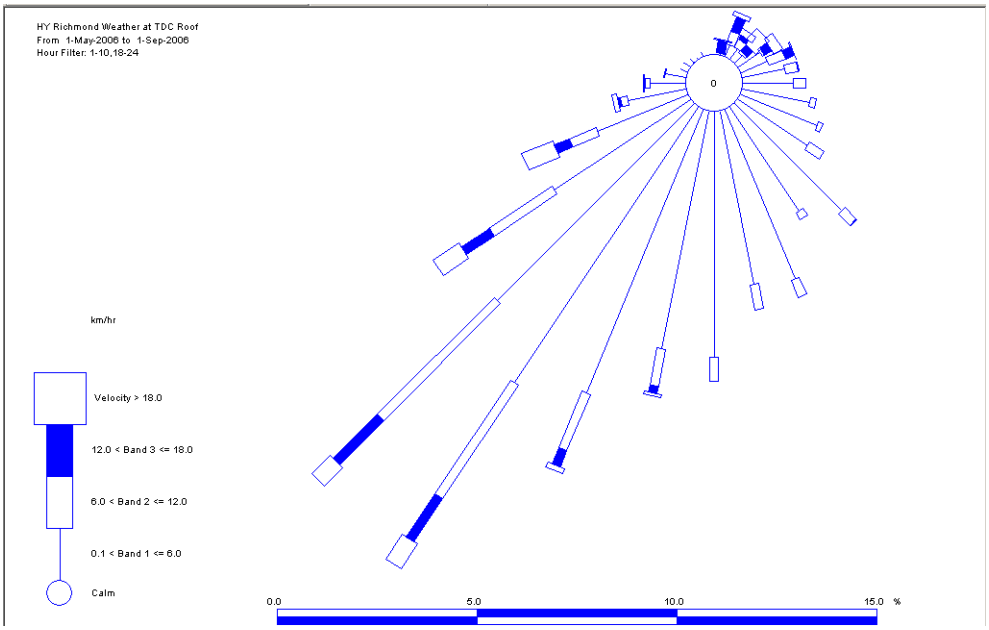


Figure 11a Wind Rose for Tasman District Council office for Morning and night for Winter 2006

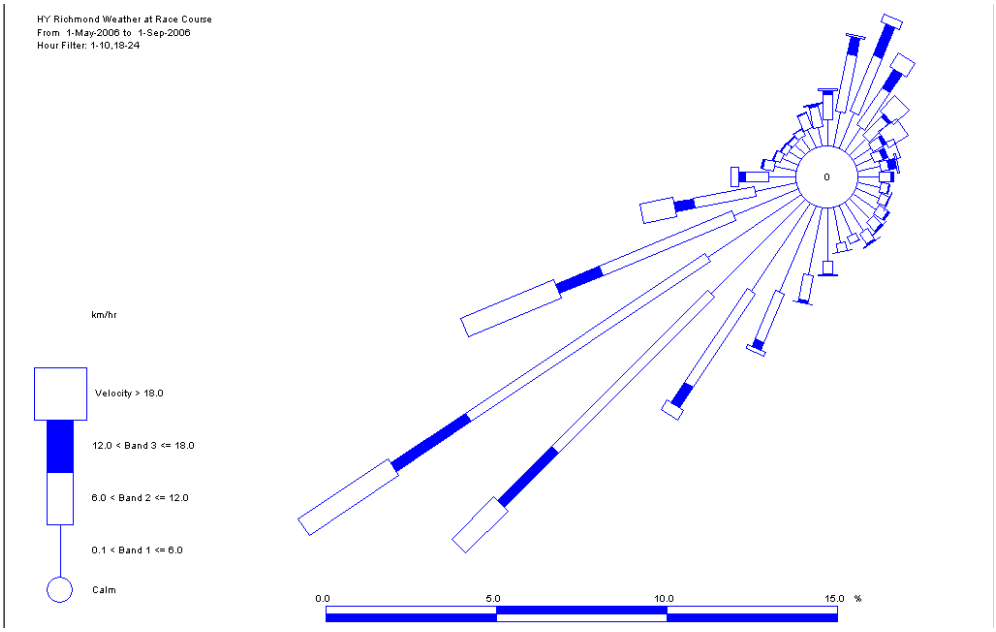


Figure 11b Wind Rose for Richmond Racecourse for morning and night of Winter 2006

There is a much greater occurrence of north and north-east winds at both sites in the afternoon compared to the morning (see Figure 12 a and b). East to South-east winds are much less prevalent.

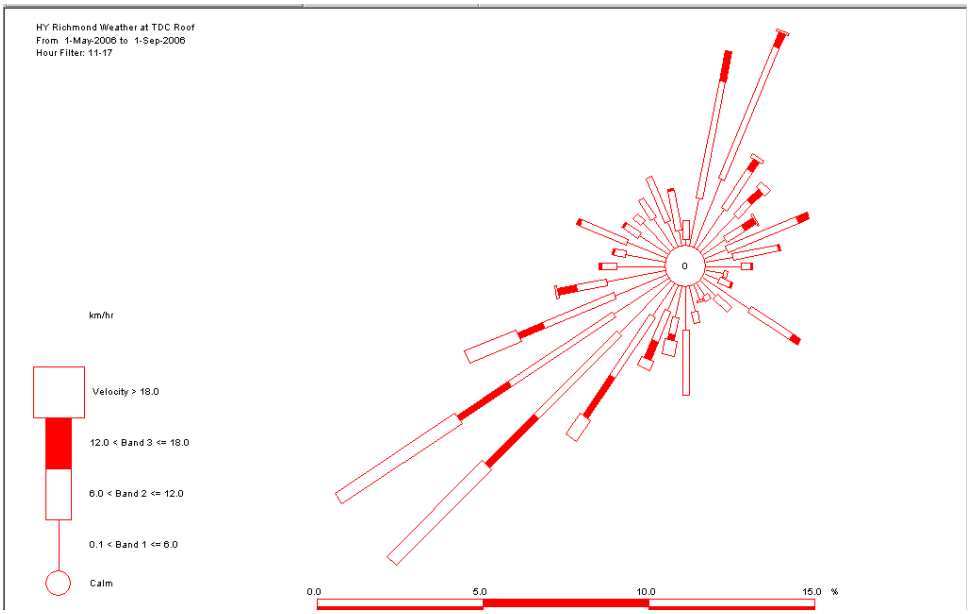


Figure 12a Wind Rose for Tasman District Council office for afternoons for Winter 2006

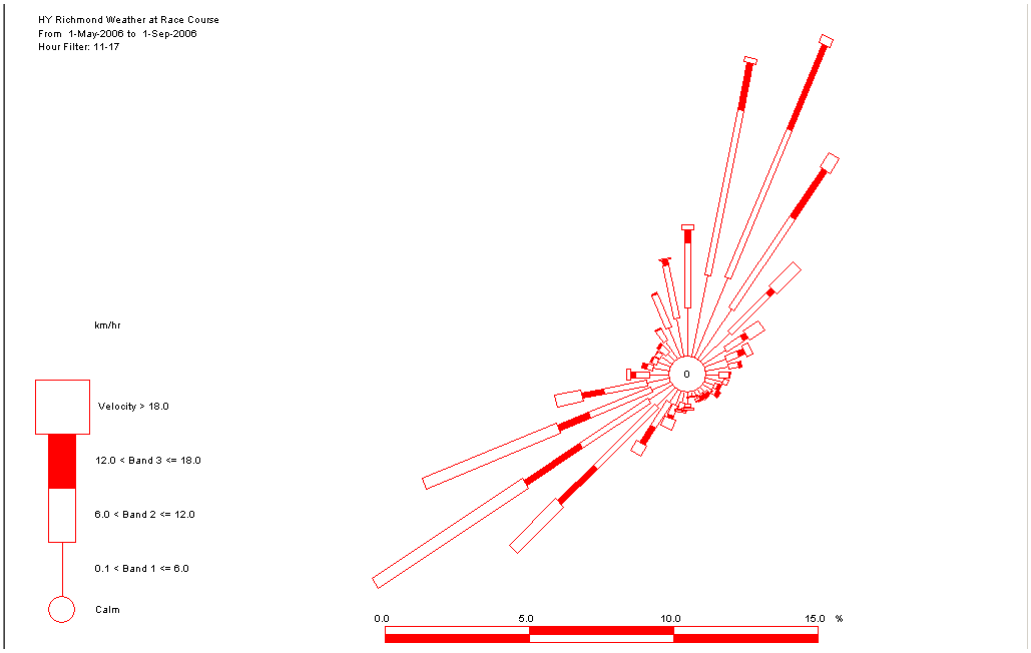


Figure 12b Wind Rose for Richmond Racecourse for afternoons of Winter 2006

In September 2005 the national standard (NES) for air quality was introduced. This sets out a path for compliance with the standard by 2013. Any 24 hour average PM_{10} results above this line since this date must be highlighted. In this case it was our continuous instrument that recorded the result that deviated above the straight line path (see Figure 13).

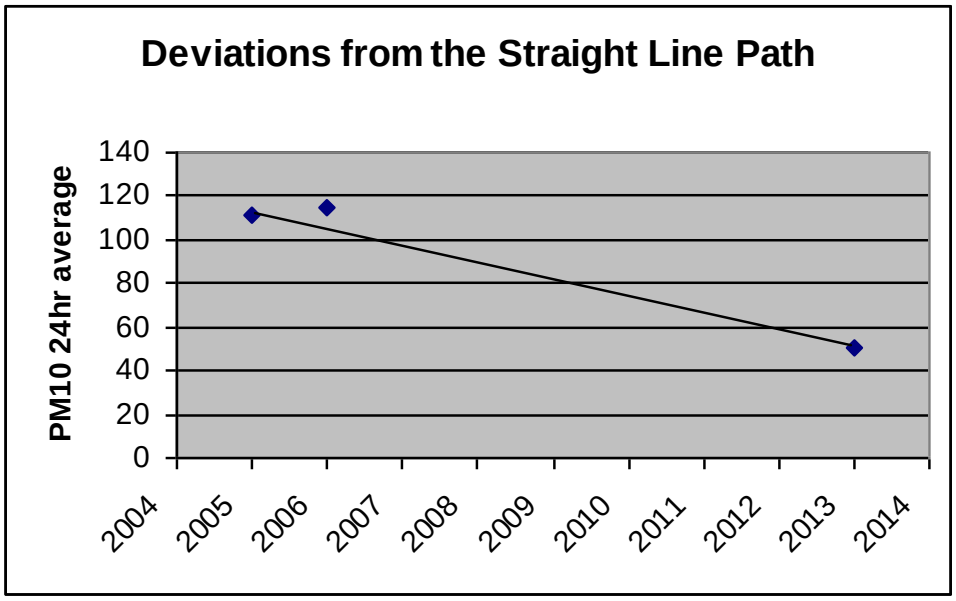


Figure 13 Maximum 24 hour concentrations as plotted on the straight line path set down by the NES

Indicative Trends

Figure 14 shows the exceedences per year using only data from the Partisol at one-day-in-two frequency and annualizing by multiplying by two. This is the approach used since monitoring began in 2000 and is therefore the most valid for comparing results over time. Using this approach forty exceedences were recorded in Richmond which is second highest out of the five years of measurement. As described earlier the alternative approach for 2006 would be to use Beta Gauge data to fill in days when the Partisol was not operating instead of multiplying by two. Using this approach yields 37 exceedences. While it may appear that there is a general downward trend in PM_{10} concentrations in Richmond, this could be due to meteorological factors and further analysis will have to be done to determine whether or not this is a real trend. This work will be possible with at least three years of continuous data and is programmed for 2009.

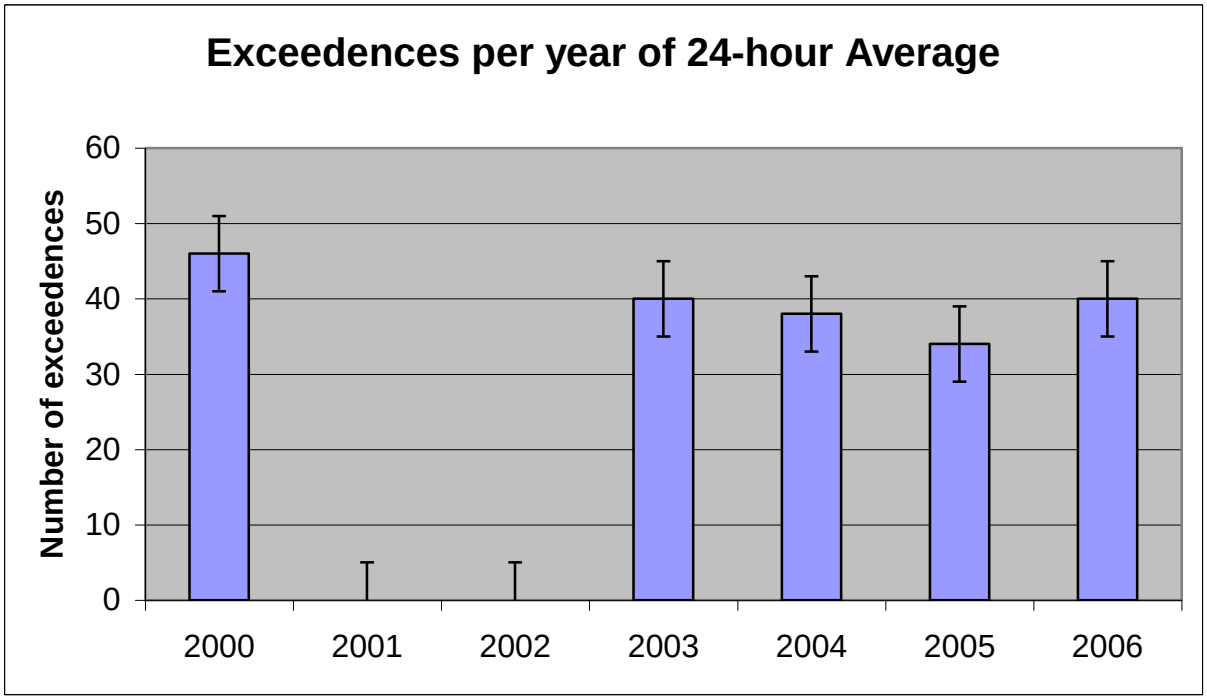


Figure 14 Exceedences each year since monitoring of PM_{10} began

The average magnitude of exceedence above national standard (measured 24 hour average concentration minus the standard of 50 µg/m^3) has not changed significantly since records began (see Figure 15).

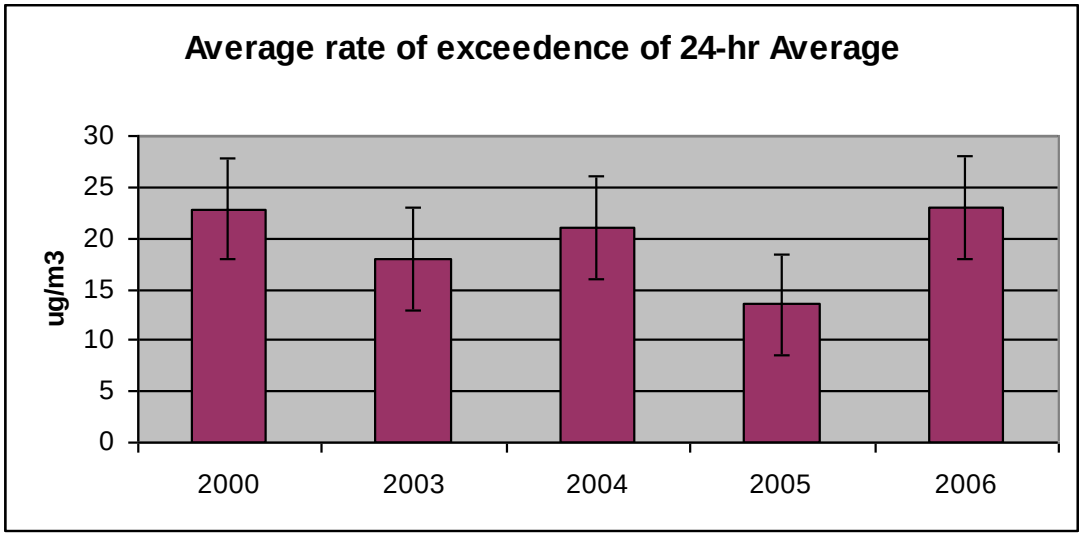


Figure 15 Mean magnitude (or rate) of exceedence of the standard

With respect to annual averages, there appears to be no significant change of the years (see Figure 16). While annual averages are not part of the national standard for assessing PM_{10} condition the Ministry for the Environment provides a guideline for annual average PM10 at 20 µg/m^3. Because the year is not up averages for the remainder of the year have been calculated based on previous years. This is considered valid as the variability between years of non-winter data is not great.

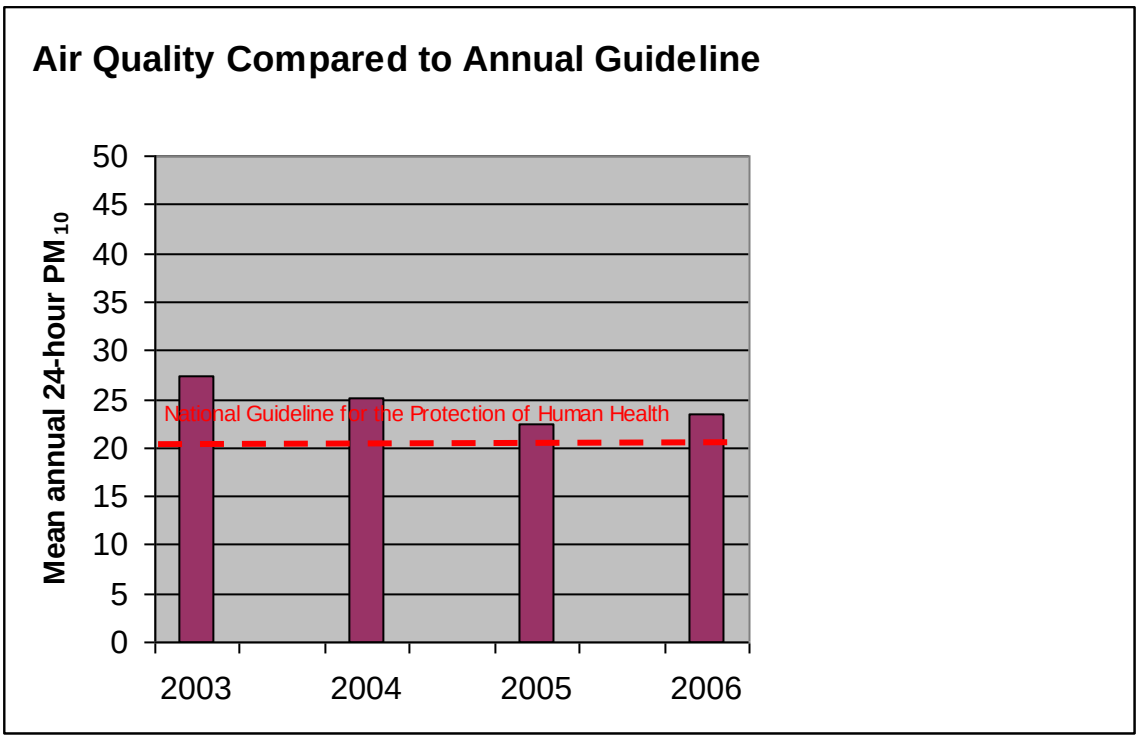


Figure 16 Mean annual PM_{10} compared to the Ministry for the Environment Annual Guideline

Comparing Richmond to other New Zealand Cities

Modelling using emissions inventory data supplied by Councils and other agencies in 2001 (relating to Census Area Unit boundaries), local meteorological modelling of peak concentrations and the number of local exceedences has been undertaken (see Figure 17 a and 17b). This modelling is produces a result that is assumed to be more representative of the air-shed as a whole than the monitoring site as it is designed to take account of the whole population exposed to the pollutant. This information has been compared to actual monitoring data and generally compares well.

Richmond ranks 18th highest out of 66 cities throughout the country for the peak concentrations and 14th highest for number of individual exceedences of the standard.

In terms of concentration this winter, number of exceedences for Christchurch was 32 with Nelson's St Vincent St site recording 51 exceedences. This is very close to the model results shown in Figure 17b. Richmond had 37 exceedences which is higher than predicted by the model. The reason for this is likely to be that areas on the edge of Richmond have better air quality and the model takes this spatial variation into account. However the main value of this information is to place Richmond in context of the national picture.

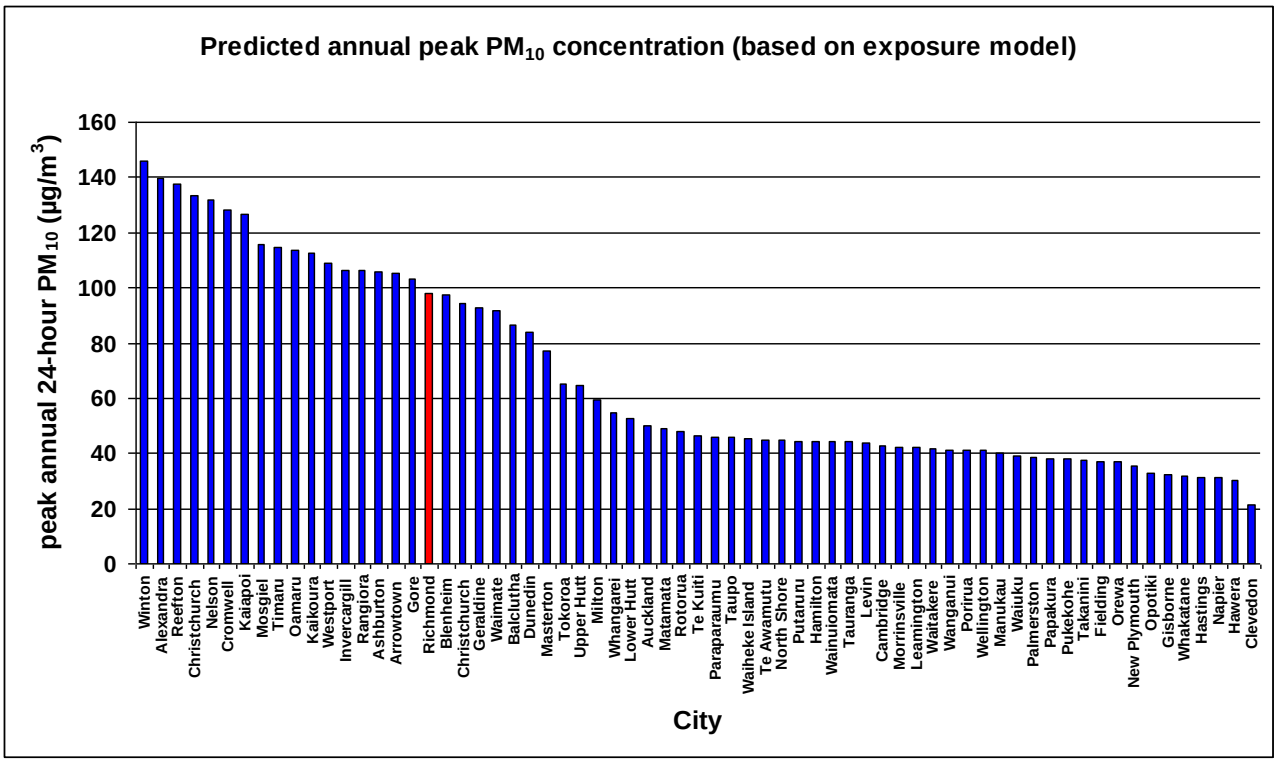


Figure 17a The predicted annual peak PM_{10} concentration of Richmond compared to 66 other cities in New Zealand.

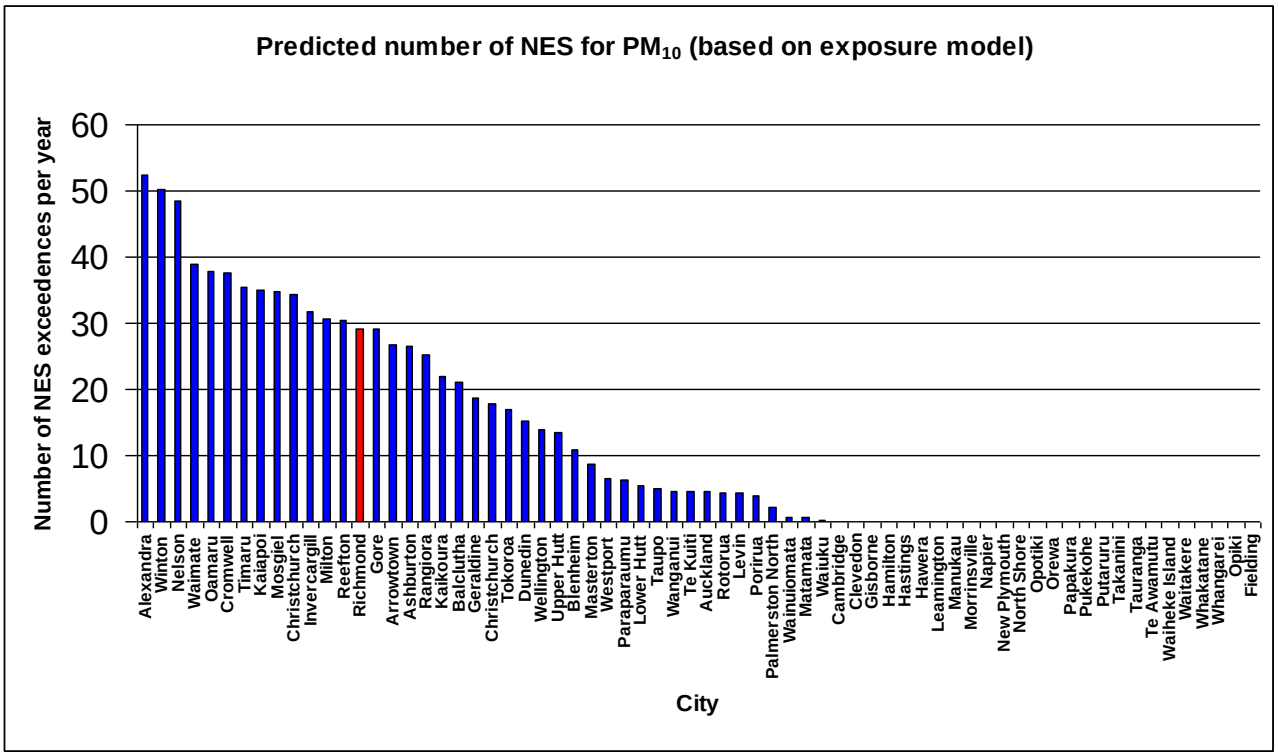


Figure 17b Predicted number of exceedences of the national standard in Richmond compared to other cities in New Zealand.

PM_{10} Results for Motueka

No exceedences of national guidelines were recorded at Motueka using a Partisol monitor (see Figure 18). While monitoring did not span the whole winter season, monitoring did occur over the peak of the winter season, including the period when the highest results were recorded in Richmond. It is therefore considered unlikely that Motueka exceeds the standard. Only three exceedences of the desirable target of 35 µg/m^3 were recorded suggesting that there is likely to be a small adverse effect on the population of Motueka from poor air quality and that measures to control emissions from domestic fires should not ignore towns like Motueka, especially as the town grows and new emissions are added to the air shed.

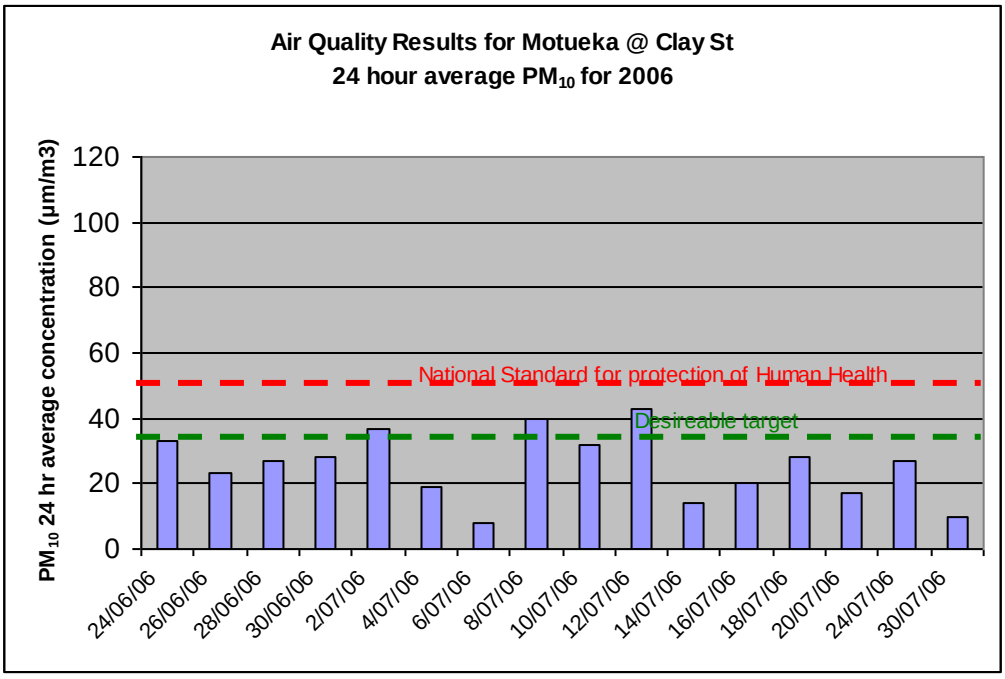


Figure 18 PM_{10} results for Motueka

PM_{10} Results for Wakefield

No exceedences of national guidelines occurred at Wakefield using a Micro-Vol monitor during the period of deployment (see Figure 19). At this stage it is too early to determine if this indicates compliance with the standard over the whole season as only six samples were collected over a relatively windy period. While the quality of data produced by this monitor is not as good at that of the Partisol comparisons when co-located with the Mini-Vol showed good agreement (Micro-Vol tended to over-report slightly). It is unfortunate that problems with this equipment meant we did not capture more of the season.

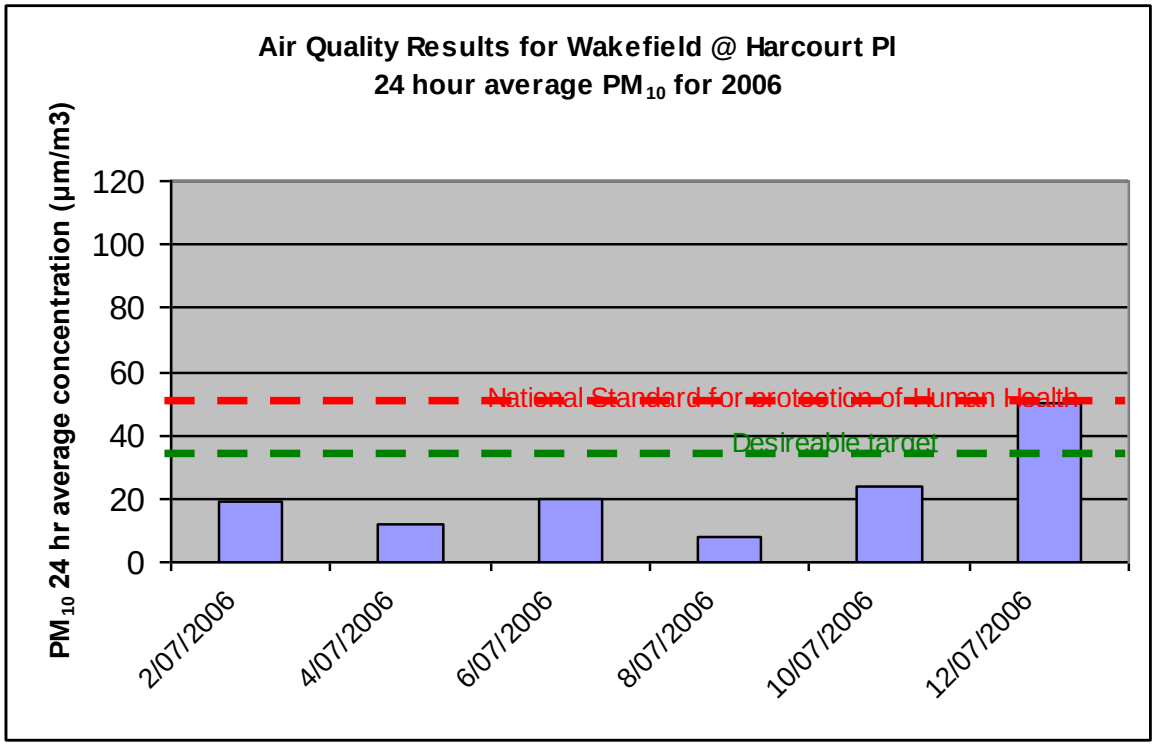


Figure 19 PM_{10} results for Wakefield

5. CONCLUSION

Air quality in Richmond the past year continues to exceed national standards. The 24-hour average standard for PM_{10} was exceeded 37 times (using Partisol and extrapolated Beta Gauge data). All exceedences occurred during May to August. The highest ever recorded maximum concentration (115 µg/m^3) occurred this winter on the 29th June. This concentration is above the straight-line path required under the NES. Diurnal patterns of PM_{10} concentration were typical of those in an air-shed dominated by wood smoke with peaks in the evening and smaller peaks about 9am. The annual average also exceeded guidelines but by only by a small amount. There appears to be no significant trend in PM_{10} concentrations, as well as the number and magnitude of exceedence. Trend information will be confirmed in 2-3 years time when we have enough data from our continuous monitor. Motueka appears to be meeting the 24-hour PM_{10} standard.

6. FURTHER MONITORING

The following initiatives are planned:

1. Install an automatic camera to take pictures at 15 minute intervals in order to determine inversion heights for air quality modeling purposes.

2. Use the Partisol monitor at other locations in Richmond or Hope to determine how PM_{10} concentrations vary across the town (as quality assurance conditions allow).

3. Use the Micro-Vol at Wakefield in winter 2007 and in Murchison in 2008.

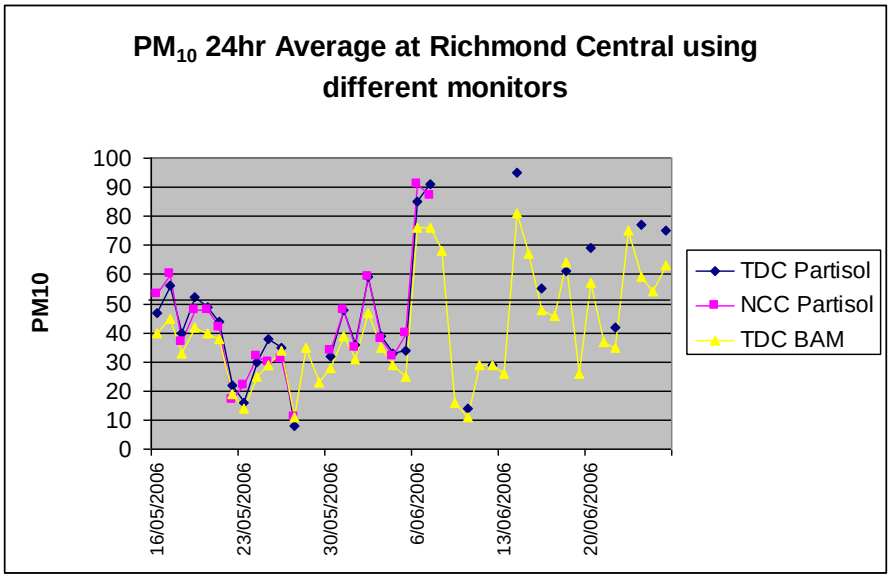
4. Undertake 3D fine particulate dispersion modeling in 2009 for the Richmond air shed in cooperation with Nelson City Council for the purpose of determining spatial distribution of PM_{10} and to support decisions about siting of various landuses including industries with PM_{10} emissions.
5. No further monitoring is recommended in Motueka at this stage.

7. RECOMMENDATIONS:

1. The Committee receives this report.

2. The Committee, subject to inclusion in the 2008 / 2009 Annual Plan, support in principle a contract to model air dispersion in the greater Richmond area (to be carried out in conjunction with Nelson City Council) and detailed trend analysis.

Trevor James
Resource Scientist


PM10 24hr Average at Richmond Central using different monitors
PM10
100
90
80
70
60
50
40
30
20
10
0
16/05/2006
23/05/2006
30/05/2006
6/06/2006
13/06/2006
20/06/2006
TDC Partisol
NCC Partisol
TDC BAM

Public Notice pursuant to Clause 16 of the Resource Management (National Environmental Standards Relation to Certain Air Pollutants, Dioxins, and Other Toxics) Regulations 2004, of Breach of National Environmental Standard for PM10.

Tasman District Council hereby gives notice that, PM10 concentrations exceeded an average 24 hour concentration of 50 micrograms per cubic metre ($\mu g/m^3$) as specified in Schedule 1 of the above Regulations within the area gazetted as Richmond Air Shed 31 times this winter (2006). The dates and extent of the exceedences are listed below. Please note that this is uncalibrated data and my actually be an underestimate.

Day	PM10 Concentration measured ($\mu g/m^3$)	Extent of PM10 Exceedence ($\mu g/m^3$)	Location at which Exceedence was Measured
May 16	53	3	Richmond Central
May 17	60	10	Richmond Central
May 19	52	2	Richmond Central
June 2	59	9	Richmond Central
June 6	91	41	Richmond Central
June 7	91	41	Richmond Central
June 8	68	18	Richmond Central
June 14	95	45	Richmond Central
June 15	67	17	Richmond Central
June 16	55	5	Richmond Central
June 18	61	11	Richmond Central
June 20	69	19	Richmond Central
June 23	75	25	Richmond Central
June 24	77	27	Richmond Central
June 25	54	4	Richmond Central
June 26	75	25	Richmond Central
June 28	83	33	Richmond Central
June 29	115	65	Richmond Central
June 30	97	47	Richmond Central
July 1	57	7	Richmond Central
July 2	88	38	Richmond Central
July 3	91	41	Richmond Central
July 4	54	4	Richmond Central
July 10	58	8	Richmond Central
July 17	71	21	Richmond Central
July 18	56	6	Richmond Central
July 22	69	19	Richmond Central
July 29	55	5	Richmond Central
Aug 1	52	2	Richmond Central
Aug 11	55	5	Richmond Central
Aug 17	66	16	Richmond Central

This data was collected from two (and on a few occasions a three) instruments at the Richmond Central site. In line with advice from Ministry for the Environment we have used the highest reading from any instrument on any given day. See Tasman District Council's website for further information www.tasman.govt.nz