Whakatane West Air Quality Monitoring Report

Prepared by Shane Iremonger, Environmental Scientist

Environment Bay of Plenty
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5 Quay Street
P O Box 364
Whakatane
NEW ZEALAND

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Working with our communities for a better environment
E mahi ngatahi e pai ake ai te tiaio
Executive summary

Approximately six months of PM$_{10}$ data was collected at a Henderson Street location in the western area of Whakatane township. Monitoring results showed that the National Environmental Standard for this contaminant was not exceeded on any occasion. Several elevated values were monitored, and the filters from these samples were investigated further.

This report also involves correlation with the Kopeopeo PM$_{10}$ dataset, stereo and electron microscope analysis, and comparisons with wind datasets.

The PM$_{10}$ data collected during the six month period showed no evidence that the CHH mill boiler emission were elevating the concentrations of PM$_{10}$ at the monitoring site beyond that which has been outlined in the Assessment of Environmental Effects lodged with the recent consent change application.

At this time no further monitoring is required at this location.
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Whakatane West monitoring report 2009
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.

This report –

- summarises PM$_{10}$ data collected within the residential area in the western area of the Whakatane township (Figure 1), hereafter referred to as the Whakatane West site.
- investigates the relationship of the Whakatane West dataset with the nearby Kopeopeo PM$_{10}$ dataset.
Figure 1  Whakatane West air quality monitoring site location.
Chapter 2: Background information

In 2008 Carter Holt Harvey Limited, Whakatane (CHH) requested a change to their air discharge permit number 61756. The change to this resource consent was approved under delegated authority of the Bay of Plenty Regional Council, dated 14 February 2008.

At the time of application CHH operated four boilers at the Whakatane site (paperboard). Boiler 1 and 2 use coal as fuel source, Boiler 3 can use wood waste or coal and Boiler 4 is a gas fired boiler. The permit specifies that Boiler 3 has to be burning mainly wood waste. Also, the permit does not allow Boiler 1, 2 and 3 to be operated simultaneously for more than 28 days per year, usually this situation occurs when Boiler 4 is shut down for its annual survey.

Due to increased costs associated with the combustion of natural gas (Boiler 4), CHH is proposing to use Boiler 1, 2 and 3 as the main source of steam for the site, all year round, as well as removing the restriction for burning mainly wood waste in Boiler 3 in favour of coal. CHH was also proposing to lower the particulate matter emission limit from 18 kg/hr to 14 kg/hr when Boilers 1, 2 and 3 are operating. The applicant has provided an atmospheric dispersion study of their stack discharge in support of their change application.

To better understand the PM$_{10}$ concentrations in the area impacted by the CHH activity and domestic emissions from residential dwellings a continuous PM$_{10}$ sampler was installed at a residential property in Henderson Street. CHH supported this monitoring, with partial funding (50%) to help cover operational costs.

Historical monitoring within Whakatane has been undertaken from 1998 to 2005 at Quay Street$^1$. Generally the quality of air in this locale is ‘Acceptable’ or better, while most of the time (~70%) it is classified as being of a “Good” quality$^2$. There is a trend that this “Good” category has increased over the period of PM$_{10}$ monitoring which is probably the effect of meteorology rather than variations in the significant sources.

Limited data has also been collected at the newly installed Kopeopeo air quality monitoring site (1.3km due east of Whakatane West). This site was installed in mid 2006, correlation analysis with the Whakatane West dataset will be discussed in Chapter 4 of this report.

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$^2$ “Good” - 10-33% of the PM$_{10}$ National Environmental Standard. “Acceptable – 33-66% of the PM$_{10}$ National Environmental Standard.
Chapter 3: Monitoring method

A Rupprecht and Patashnick Sequential Partisol 2025 PM$_{10}$ instrument was installed 500m to the southeast of the CHH John Thompson boilers shared stack on the 14th May 2008. Sampling continued to 30th October 2008.

This instrument store-sample-stores up to 15 pre-conditioned 47mm filters. Filters were exposed for 24 hour periods (midnight to midnight) and then post-conditioned and re-weighed to determine collected mass. The volume of air passing through the filter is recorded and thus a 24 hr PM$_{10}$ concentration can be determined.

Figure 2 Whakatane West air quality sampler (Whakatane River and CHH mill in the background).
Chapter 4: Results

4.1 Whakatane West dataset

During the 5½ month sampling period 135 samples were collected (Figure 3). All samples were below the National Environmental Standard of 50 \( \mu g/m^3 \). Three values did fall into the MfE Environmental Performance Indicator “Alert” category\(^3\), which is described as a warning level, which can lead to exceedances if trends are not curbed. A domestic heating season effect is seen within the dataset. However this seasonal effect is not as pronounced as that witnessed within the Rotorua airshed.

<table>
<thead>
<tr>
<th>Date of Sample</th>
<th>24hr PM(_{10}) ((\mu g/m^3))</th>
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<tbody>
<tr>
<td>1/05/08</td>
<td>0.4</td>
</tr>
<tr>
<td>1/06/08</td>
<td>10.3</td>
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<td>1/07/08</td>
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<td>10.3</td>
</tr>
<tr>
<td>1/11/08</td>
<td>10.3</td>
</tr>
<tr>
<td>Mean</td>
<td>10.3</td>
</tr>
<tr>
<td>Median</td>
<td>8.3</td>
</tr>
<tr>
<td>Minimum</td>
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</tr>
<tr>
<td>Maximum</td>
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<tr>
<td>99%ile</td>
<td>40.5</td>
</tr>
<tr>
<td>Count</td>
<td>135</td>
</tr>
</tbody>
</table>

\(24\)hr PM\(_{10}\) dataset.

4.1.1 Elevated events

Investigation of the basic meteorology during the three highest PM\(_{10}\) values is shown in Figure 4. No common pattern is evident within these events. On the 17\(^{th}\) May predominantly light southerlies are experienced. Based on domestic heating surveys from similar residential area’s this date falls within the “heating season” window, and domestic heating may well be the source

\(^3\) “Alert” - 66-100% of the PM\(_{10}\) National Environmental Standard.

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Figure 4  Meteorology at Kopeopeo during three highest PM$_{10}$ values at Whakatane West.
for this elevated value. On the 31st July, fresh north westerlies throughout the day resulted in the highest value (Sample ID WW70 - 47.1 μg/m³) recorded at Whakatane West.

The immediate activity northwest of the sampler is the CHH mill, it should be noted that the s.92 response letter dated 28 May 2007 from URS New Zealand Limited shows total particulate concentration from the proposed operation of ~12 μg/m³.

The operation of the mill was as follows (supplied by the CHH Environmental Risk Manager) for the period of this sample:

- average stack opacity of 16%, maximum of 44% and 99%ile of 32%,
- boiler fuel was coal,
- no abnormal operational factors where noted.

4.1.2 **Microscope analysis**

Visual inspection of the filter WW70 (exposed on 31st July 2008), using stereo microscope (max magnification 66x) shows a dominance of dark angular particles (Figure 5). SEM⁴ analysis of the sample shows the matrix of the filter medium and a general pattern of heterogeneous particles. The magnification of the SEM allows the ability to inspect individual particles and an attempt was undertaken to determine dominant particles (bearing in mind that thousands of particles are present). A general particle representation is presented in Figure 5. Figure 5a represents the larger sized black particle fraction that is evident in the stereo microscope image. The elemental signature has a dominant carbon peak, sulphur is absent and this would have been an indicator for a combustion char particle from the CHH boiler, these char particles also have a distinctive surface appearance as shown in Figure 6. This particle was from a separate sample collected following a complaint from a property owner to the north of the CHH mill.

Figure 5b has a unique spherical appearance and more than likely is a by-product of the boiler combustion. Literature states the presence of spherical silica based particle as an output of coal fired boilers, the SEM shows silica is the dominant element present. Another possible source of such a particle (based on physical appearance), are metal welding emissions, but the elemental signature doesn’t support a source of this type.

Finally, Figure 5c is a salt crystal, this is not unexpected due to the proximity of the sampler to the open coast environment. These types of crystals were dominant at the Quay Street site and generally resulted in an increase in concentration for samples collected at this site (Figure 7).

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⁴ Scanning electron microscope.
Figure 5 Stereo microscope image (top), scanning electron microscope image (bottom).
<table>
<thead>
<tr>
<th>Figure 5a</th>
<th>Dominant elements – C, Si, Cl(^5)</th>
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</thead>
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<td><img src="graph1.png" alt="Graph" /></td>
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</table>

<table>
<thead>
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<th>Dominant elements – Si, Na</th>
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<table>
<thead>
<tr>
<th>Figure 5c</th>
<th>Dominant elements – Na, Cl</th>
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<tbody>
<tr>
<td><img src="image3.png" alt="Image" /></td>
<td><img src="graph3.png" alt="Graph" /></td>
</tr>
</tbody>
</table>

\(^5\) Note the platinum (Pt) peak is from the material used to coat the filter prior to SEM analysis.
Figure 6 Char particle from CHH boiler.

Figure 7 Concentration pattern during varying percentages of time with wind from the northern quadrant.
4.1.3 **Wind and concentration analysis**

For Whakatane the annual wind directional pattern (Figure 8) is evenly spread from north to south through west. Winds from the eastern quadrant are not as common. Seasonally the pattern differs with a dominance of southerlies and south westerlies during winter and northerlies and north easterlies during summer. Calms occur typically <3% of the time.

![Wind patterns for the Bay of Plenty.](image)

*Figure 8 Wind patterns for the Bay of Plenty.*

For the period of sampling the following wind data was collected at the Kopeopeo monitoring station (Figure 9). Winds were predominantly from the south and southwest (~52% of the time), winds were often above 15kph. This pattern aligns well with that shown for the longer time period winter rose in Figure 8. The % calms are higher due to the sheltered nature of the Kopeopeo site.

![Wind rose for the period of sampling from Whakatane West.](image)

*Figure 9 Wind rose for the period of sampling from Whakatane West.*
The following exercise attempts to link the Whakatane West PM10 data with the meteorological data from Kopeopeo. Because the PM$_{10}$ sampling provides only a single 24-hr value, relationships with finer resolution wind data (say 10 minute) is not a straight forward exercise. A general investigation of the finer resolution wind data is undertaken by screening the meteorological data so that days with dominant wind direction patterns can be retrieved from the larger dataset. For this exercise two zones have been defined based on the following arcs$^6$, (i) 320° to 20° and (ii) 90° to 270° these represent directions whereby winds would have passed over the CHH industrial area and the residential area respectively before impacting on the sampler.

A second criteria was then applied which required 60% of the wind values for the 24-hr period to be from the particular arc before it was deemed as the prevailing wind condition for that sample. This simple analysis would determine if a pattern existed when winds were from a particular source direction (e.g. industrial or residential).

Figure 10 shows the output of this analysis. Eight samples were collected when the wind was in the ‘Industrial arc’. The largest recorded value did occur during this time but the remaining samples, averaged approximately the same value (10.8μg/m$^3$) as the average value recorded for the ‘Residential arc’ dataset.

$^6$ The arcs are in a clockwise direction based on True bearings.
4.2 Whakatane West – Kopeopeo comparison

A comparison was undertaken between PM$_{10}$ data that was collected at the Whakatane West and Kopeopeo sites (Figure 11). A slight positive relationship exists, although the correlation is poor ($R^2=0.16$). A general clustering of values above the 1:1 line suggests the Kopeopeo site is generally “dustier”. However several occasions exist where this case is reversed.

![Figure 11 Whakatane West / Kopeopeo comparison.](image)

This relationship doesn’t support the use of using Kopeopeo as an indication for the western area of the township. This is not surprising, as urban areas elsewhere in the region with multiple sites have different concentration profiles. Additional sites would need to be installed or more commonly a dispersion modelling exercise would be undertaken to highlight this spatial variability.
Chapter 5: Conclusion

Approximately six months of PM$_{10}$ data was collected at a Henderson Street location in the western area of Whakatane township (Whakatane West). Results showed that the NES for this contaminant was not exceeded on any occasion. Several elevated values were monitored, and the filters from these samples were further investigated. This investigation involved correlation with the Kopeopeo PM$_{10}$ dataset, stereo and electron microscope analysis, and comparisons with the wind data for the 24 hour periods of sampling.

The correlation analysis showed that the Kopeopeo site is not a good indicator for concentrations experienced in the western end of the township, this is not surprising as the source profile is quite different with higher transport volumes and a greater density of adjacent residential development impacting on the Kopeopeo site. The relation between the two sites was slightly positive but the correlation coefficient was poor. One useful pattern from this plotting exercise was that the Kopeopeo site was generally “dustier” than the Henderson Street site.

The stereo microscope analysis (maximum 66x magnification) of the highest concentration filter highlighted a reasonably homogenous (visually) collection of particles, exhibiting a dark angular profile. Particle/dust investigations elsewhere in the region have shown that these particles are often associated with yard dust sources and are identified as soil particles.

Scanning electron microscope analysis of the highest concentration filter highlighted a heterogeneous particle profile indicating multiple sources. Particles were representative of general urban dust with the presence of particles from the coastal environment and also a contribution from possibly the CHH coal fired boiler.

Wind analysis also supported this mixture of sources but highlighted that elevated results can also occur when winds are from the southern quadrant.

The data collected during the six month period showed no evidence that the CHH mill boiler activities were elevating the concentrations of PM$_{10}$ at the monitoring site beyond that which has been outlined in the Assessment of Environmental Effects lodged with the consent change application (Appendix 1). At this time no further monitoring is warranted.

The greatest contribution from sources in the Whakatane urban area is occurring during winter, when the domestic heating profile is at its maximum. An emission inventory is currently being compiled for the Whakatane urban area with the aim of undertaking an airshed modelling exercise similar to that conducted for the Rotorua urban area. This exercise will use this recent monitoring along with the Kopeopeo dataset to provide validation for a model which will determine particulate concentrations throughout the Whakatane urban area.
Appendix 1

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Table 3 Maximum Predicted Off-Site PM\textsubscript{10} Concentrations – Proposed Operation

<table>
<thead>
<tr>
<th>Compound</th>
<th>Maximum Predicted Off-site Concentration</th>
<th>Guideline Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>PM\textsubscript{10} (24 hour)</td>
<td>27</td>
<td>50</td>
</tr>
<tr>
<td>PM\textsubscript{10} (Annual)</td>
<td>5.7</td>
<td>20</td>
</tr>
</tbody>
</table>

Figure A.1 Excerpt from material supplied as part of s.92 request