# Whakatane Air Emissions Inventory 2007

Bay of Plenty Regional Council
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Bay of Plenty REGIONAL COUNCIL

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Cover Photo: Whakatane township, May 2003, Jos van da Laar.

# Executive Summary

The Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins, and Other Toxics) Regulations 2004 has set a limit for $PM_{10}$ in air. In areas of our region where the limit for $PM_{10}$ is already being exceeded Environment Bay of Plenty is required to take action to ensure the limit can be complied with by 1 September 2013. The regulations also specify that monitoring is required where possible exceedances of the standards might exist.

This report describes an air emission inventory with a specific focus on the Whakatane Urban Area. An air emissions inventory is used to determine the contribution of $PM_{10}$ emissions (and other contaminants) from specific sources or groups of sources.

To date ambient air quality monitoring within the Whakatane Urban Area shows that during the winter period exceedances of the National Environmental Standards have not been recorded. Values recorded for 24 hour $PM_{10}$ concentrations have however on several occasions approached this air quality standard at the King Street monitoring site. Hence $PM_{10}$ has been the primary focus of this emission inventory. Ambient monitoring of the other contaminants, in similar locations within the region (CO, $SO_2$, $NO_x$ and VOC's) show no exceedences of their respective standards or guidelines.

The results from the inventory show that during the critical (in relation to elevated levels of $PM_{10}$) time of the year, domestic sources are the leading although not dominant producer of $PM_{10}$ emissions (47%) for the Whakatane Urban Area.

Industry is the major contributor to $PM_{10}$ emissions within the Whakatane Urban Area (58% of the estimated emissions) on an annual basis. This is a result of the scale of this operation and also a function of the level of activity (24 hour, 7 day process). Regular stack testing and opacity monitoring is required by their air discharge consent. This regular auditing ensures emissions are maintained below the stipulated discharge limits for particulate matter.

Transport sources are only a moderate contributor to the $PM_{10}$ profile. During winter time their contribution is estimated at 6%. Emissions from these sources are controlled primarily at the central government level through import regulations, WOF requirements, and fuel specifications.

Population growth is a strong driver for emission production. For the Whakatane Urban Area a decrease of 1.0% (Section 1.3.3) for the resident population is projected, this will have a potentially positive effect (albeit slight) of decreasing emissions.

Meteorology and to a lesser degree topography are also strong drivers when looking at what happens to the emissions once they enter the Whakatane Urban Area. These complex interactions have been flagged within this report and will be investigated in more detail in the dispersion modelling component of this air quality programme.

# Contents

# Chapter 1: Introduction

## 1.1 Purpose

The Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins, and Other Toxics) Regulations 2004 has set a limit for $PM_{10}$ in air. In areas of our region where the limit for $PM_{10}$ is already being exceeded Environment Bay of Plenty is required to take action to ensure the limit can be complied with by 1 September 2013.

At this time the only area identified as exceeding the $PM_{10}$ limit is urban Rotorua. An airshed has been designated for Rotorua.

This report describes an air emission inventory with a specific focus on the Whakatane Urban Area (WUA) (Figure 1). An air emissions inventory is used to determine the contribution of $PM_{10}$ emissions (and other contaminants) from specific sources or groups of sources. This inventory also provides several key inputs required for the accompanying airshed modelling study (in progress).

This inventory builds on previous region wide inventories undertaken by Opus International Consultants (1997) and Sinclair Knight Merz (2003).

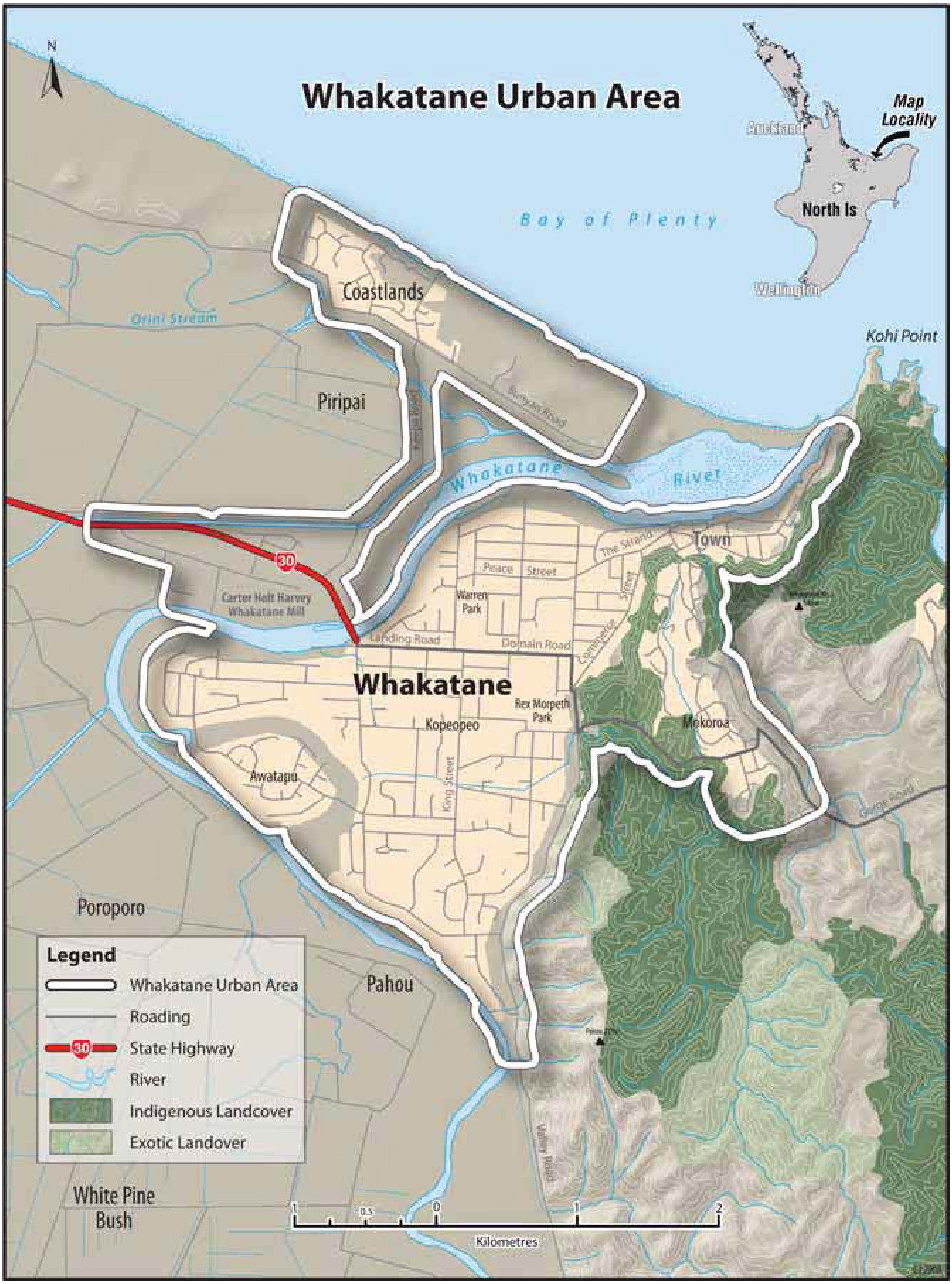



Figure 1 Whakatane Urban Area

## 1.2 Scope

The reference years for this inventory are 2006/07. When this information is not available the nearest information to 2006/07 has been used and referenced accordingly.

This inventory has been compiled by source type and the spatial distribution is presented for the WUA.

This inventory assesses the contaminants shown in Table 1. $PM_{10}$ is of greatest interest due to already measured exceedences of the standard elsewhere in the region. Where practicable calculations are also undertaken for the remaining contaminants.

*Table 1 Contaminants for the Whakatane Urban Area inventory.*

| Contaminant type |
|---|
| Particulate matter ($PM_{10}$) |
| Carbon monoxide (CO) |
| Sulphur dioxide ($SO_2$) |
| Oxides of nitrogen ($NO_x$) |
| Selected volatile organic compounds (VOC) |

Software developments and the improvement in the detail of activity data has meant that this inventory has used different estimation methodologies and included some different sources when compared with the last regional inventory undertaken for the year 2001.

## 1.3 Characteristics of the Whakatane Urban Area (WUA)

In order to better understand the geographical situation and meteorological factors affecting the LAMA and ultimately the distribution of contaminants the following section has been included. Further investigation of these important interactions will be undertaken in more detail in the accompanying airshed modelling investigation.

### 1.3.1 Geophysical

The district can be divided into three distinctive landscape features: eastern greywacke hill country, western ignimbrite sheets and low-lying plains (in particular the Rangitaiki).

The WUA is located at the north eastern corner of the Rangitaiki Plains. The plains extend from the coastline inland for 14 kilometres in a southerly direction to the Awakeri foothills. The topography is gentle sloping from south to north. Immediately to the east of the WUA is the greywacke escarpment rising to several hundred metres forming the eastern horst block of this horst – graben (plains) tectonic structure.

The WUA is confined on the western and southern margins by the Whakatane River.

## 1.3.2 Meteorology

The WUA is sheltered by elevated land to the east. For the remaining quadrants of the compass the area is open and flat for at least 15km. To the north (~1km) is the Pacific Ocean. The proximity to the sea is important when understanding localised wind patterns under light conditions. Being within the coastal margin, a moderate range of temperature is experienced (Figure 2). Warm, dry and settled weather predominates during summer. Typical summer daytime maximum air temperatures range from 23°C to 28°C, rarely exceeding 30°C. Winters are mild and this is normally the most unsettled time of the year. Typical winter daytime maximum air temperatures range from 12°C to 16°C (Figure 3). Frosts occur in clear, calm conditions in winter along with the frequent development of temperature inversions. Sunshine hours average 2100 per annum. Southwesterlies prevail. Sea breezes dominate the climate on warm summer days.

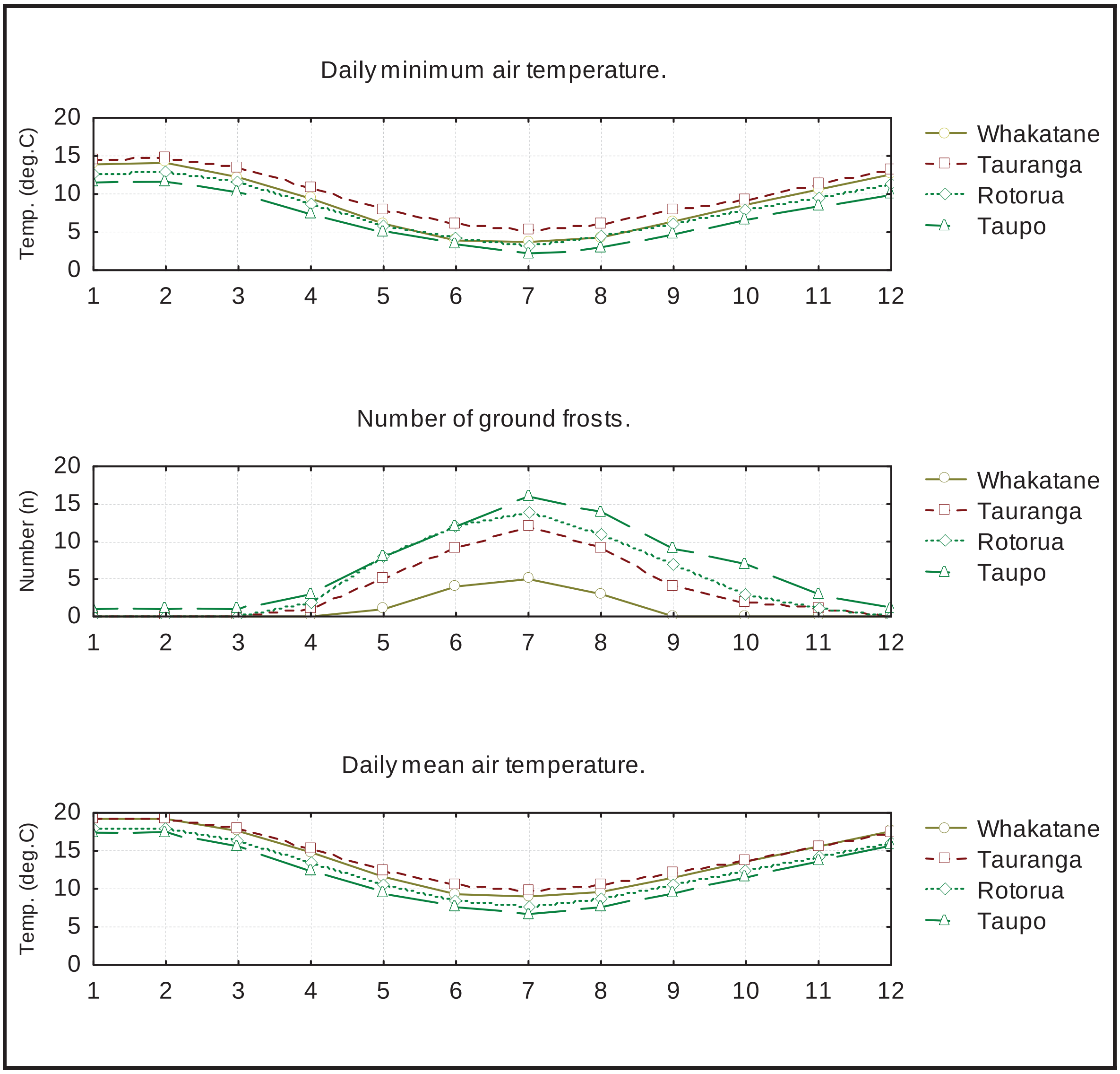
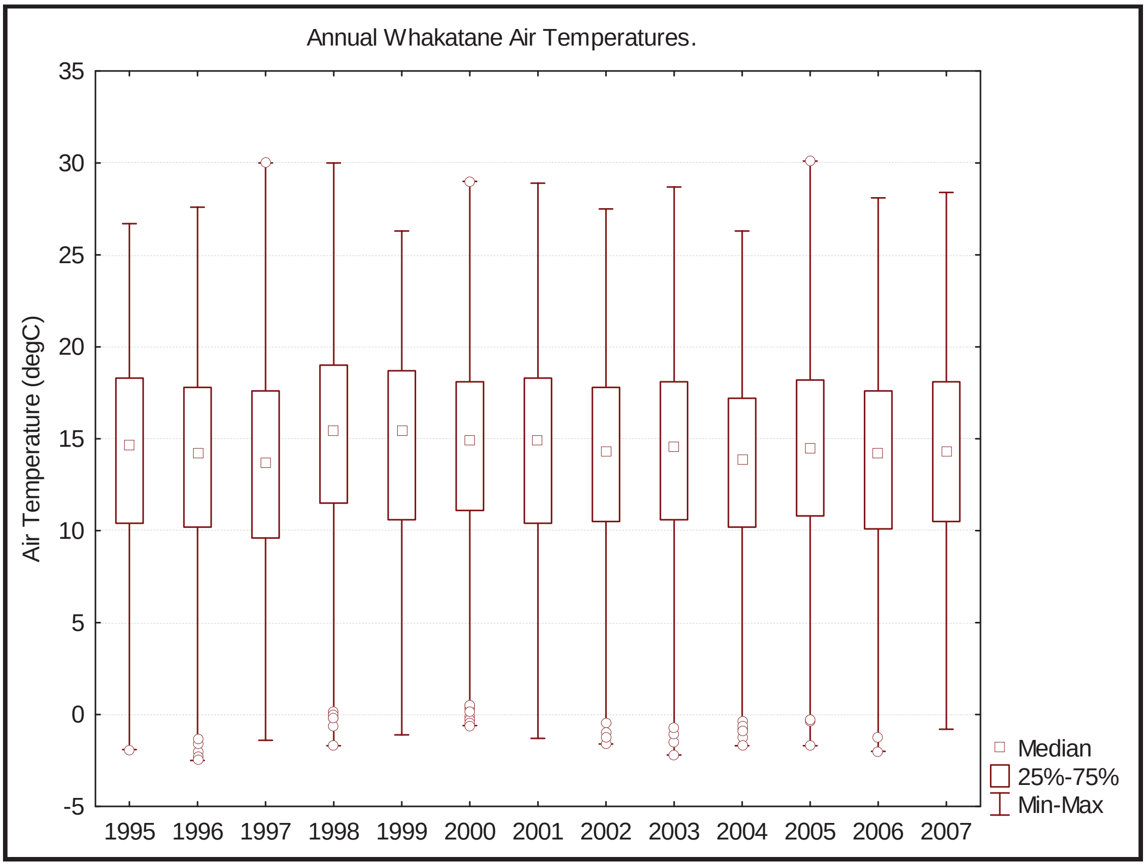



*Figure 2 Monthly climate summary for Whakatane Aero (and comparison sites) – 1995 – 2000 (Source: NIWA Climate Database).*



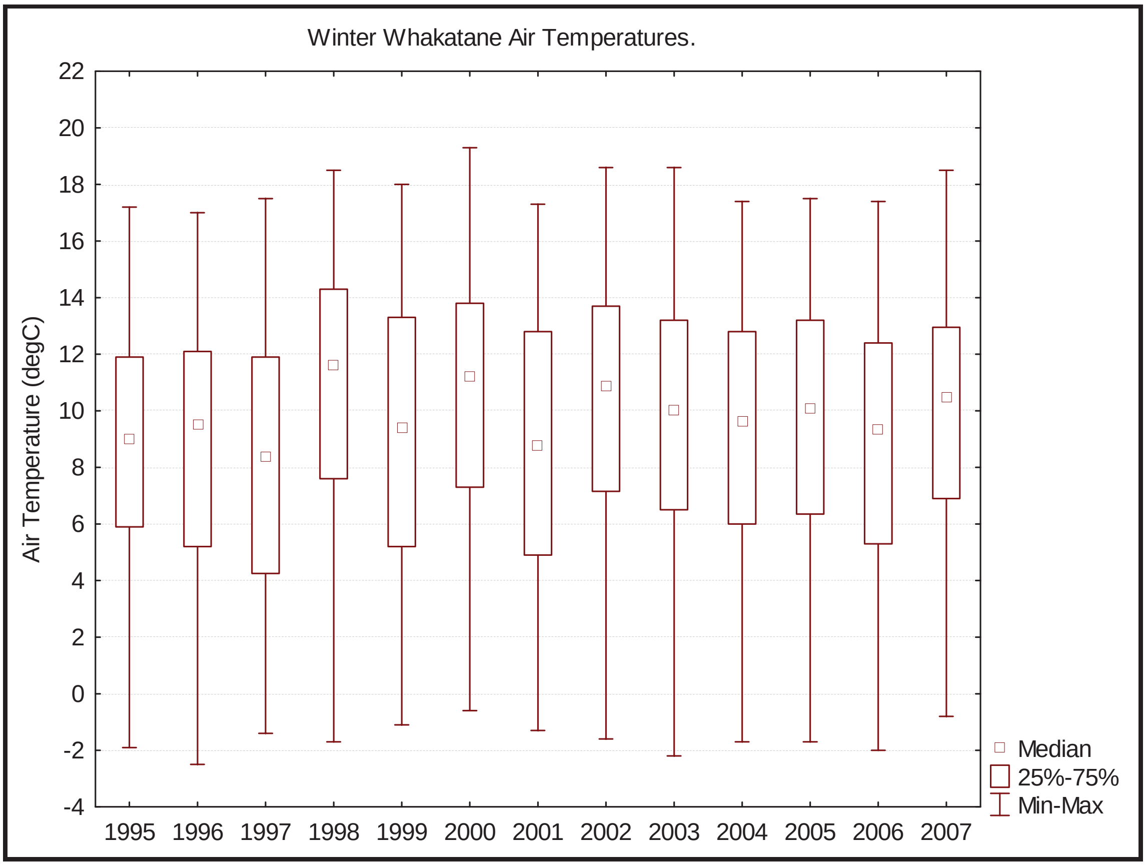




*Figure 3 Air temperature summaries recorded at Whakatane Aero (Source: NIWA Climate Database).*

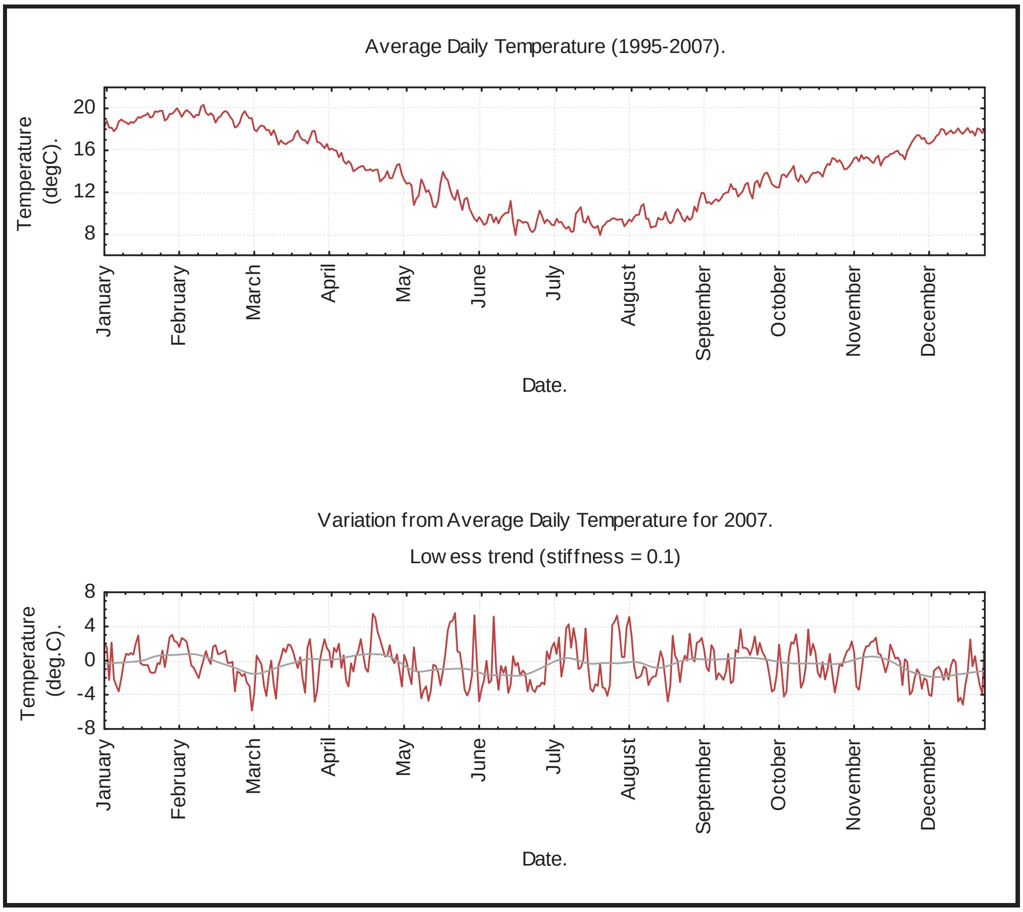



*Figure 4 Annual air temperature time series for 2007 and the variation from the long term mean (1995-2007).*

Figure 4 shows the temperature profile for the Whakatane for 2007 along with the variation of this time series from the long term mean. Trend analysis shows the average daily temperature to be below average for nearly the entirety of 2007. A closer investigation of June shows a extended period of negative variation (up to -5°C) which would probably result in periods of increased domestic emissions.

The wind climate is also important when discussing air quality. Detailed analysis will be undertaken in the accompanying modelling investigation, but a summary of a period of record from the Whakatane Aero meteorological site shows the effect of medium term climatic patterns (i.e. Southern Oscillation Index) (Figure 5). The La Nina period shows expected significant northerly contributions to the measured wind field. This will change the natural $PM_{10}$ composition (increase in sea borne particulate) impacting on the WUA (Figures 6 & 7). Calm conditions contribute less than 5% at this site.

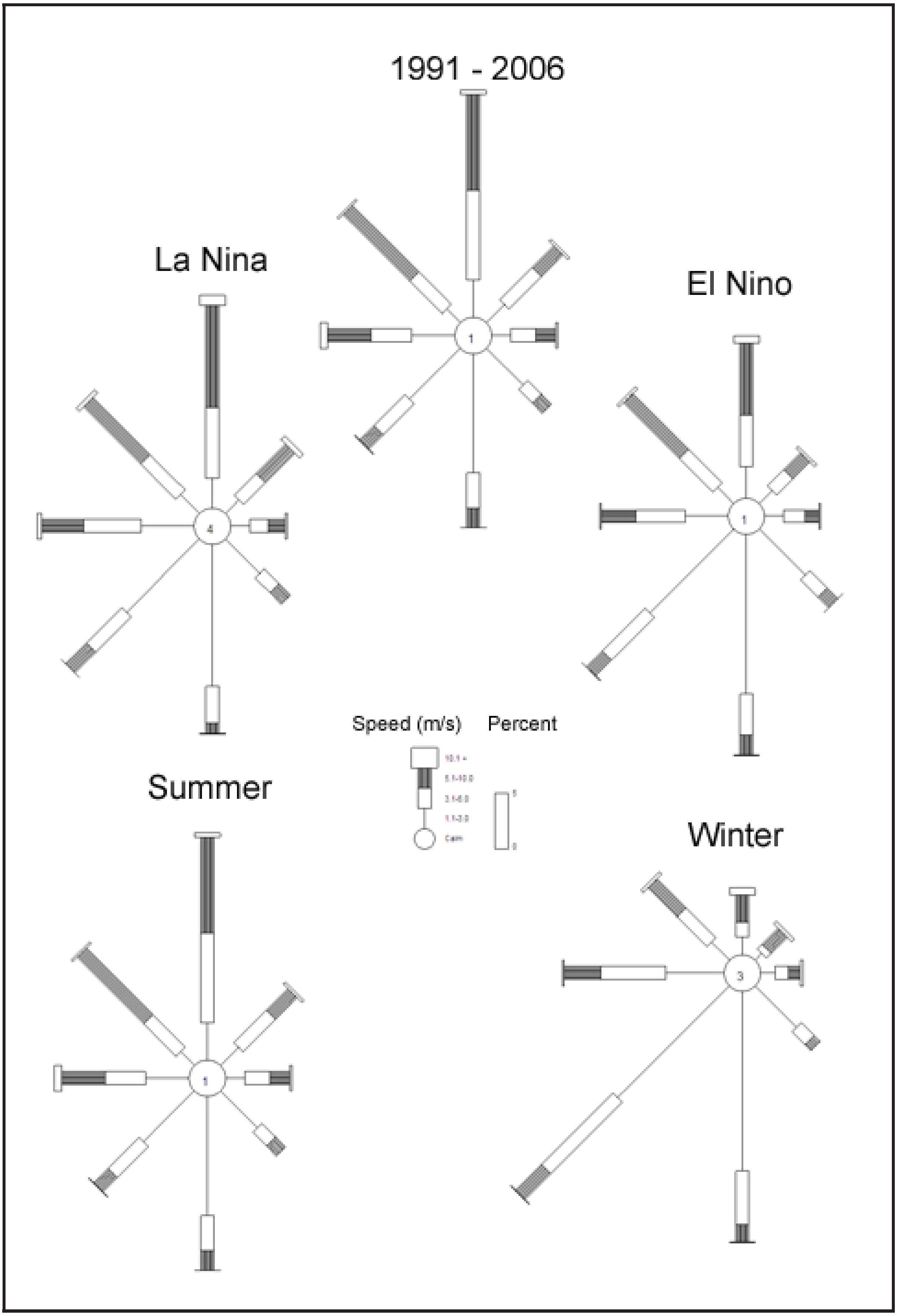



*Figure 5* *Wind record from the Whakatane Aero meteorological site. (1998 was deemed a La Nina year and 2003 an El Nino period).*

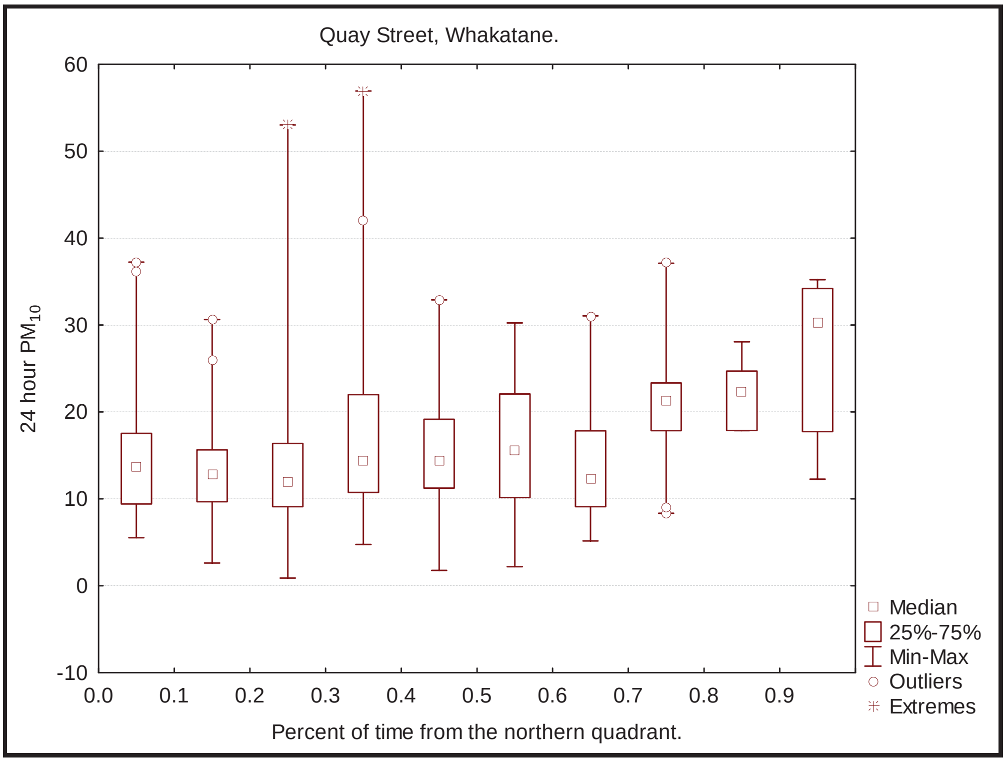



*Figure 6* *Change in particulate concentration for winds from the northern quadrant recorded at the Quay Street $PM_{10}$ sampler.*

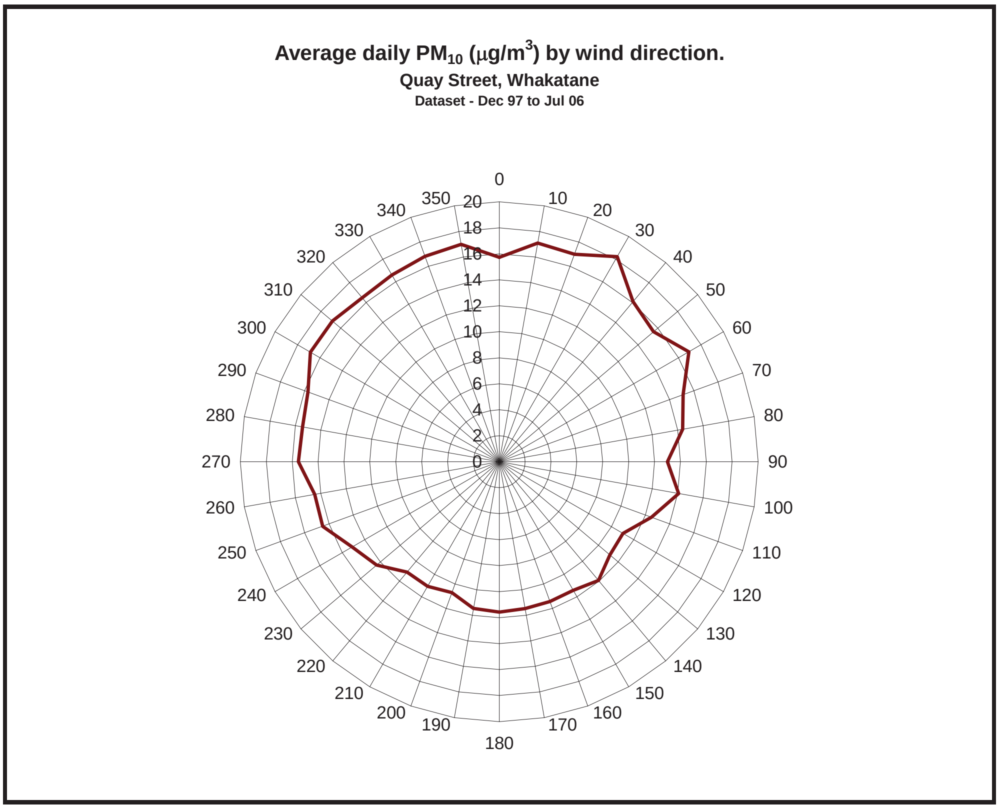



*Figure 7* *Particulate concentration by wind direction at the Quay Street $PM_{10}$ sampler.*

The proximity of the land/sea boundary also affects the local meteorology. Environment Bay of Plenty operates a wave buoy which records sea surface temperature at a central Bay of Plenty location, 13 kilometres offshore. A comparison of sea and land temperature (Figure 8) shows a marked seasonal pattern and also diurnal variations which drive wind patterns (Figure 9) on a finer scale.

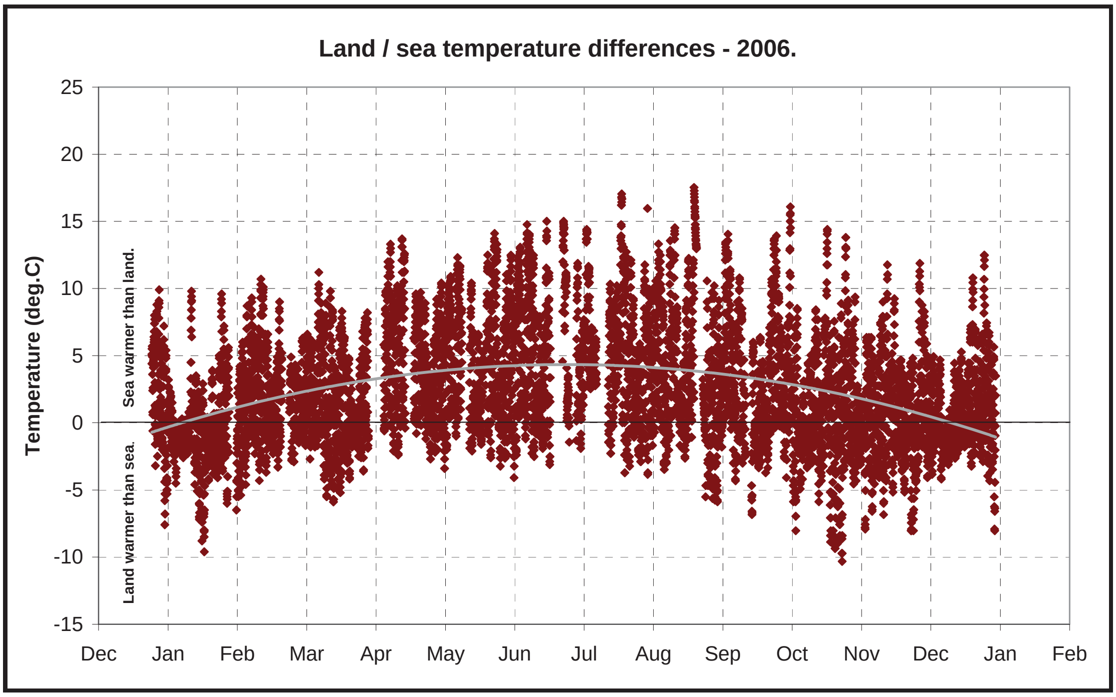



*Figure 8 Land / sea temperature differences for the Whakatane coastal area.*

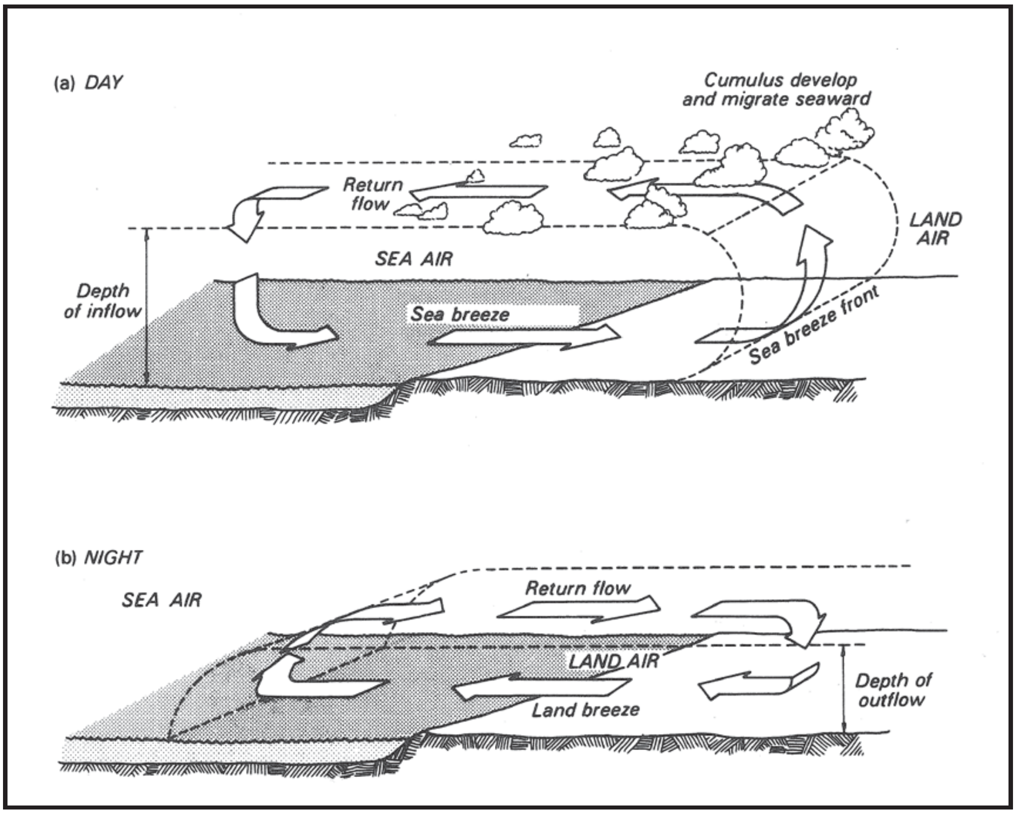



*Figure 9 Land / sea breeze circulations across a shoreline (a) by day and (b) at night, during anticyclonic weather (Oke, 1987).*

A typical situation during stable onshore flow conditions is shown in Figure 10. In this case a narrow plume imbedded in the stable layer above the shallow marine surface is intercepted by a growing Thermal Internal Boundary Layer (TIBL) over land. The growth of the TIBL is caused by the sensible heat flux associated with solar heating of the land surface. The convection over land can rapidly bring the elevated pollutant to ground, causing locally high ground level concentrations. This situation would only develop from sunrise to 10am and would typically have a duration of about 1 to 2 hours.

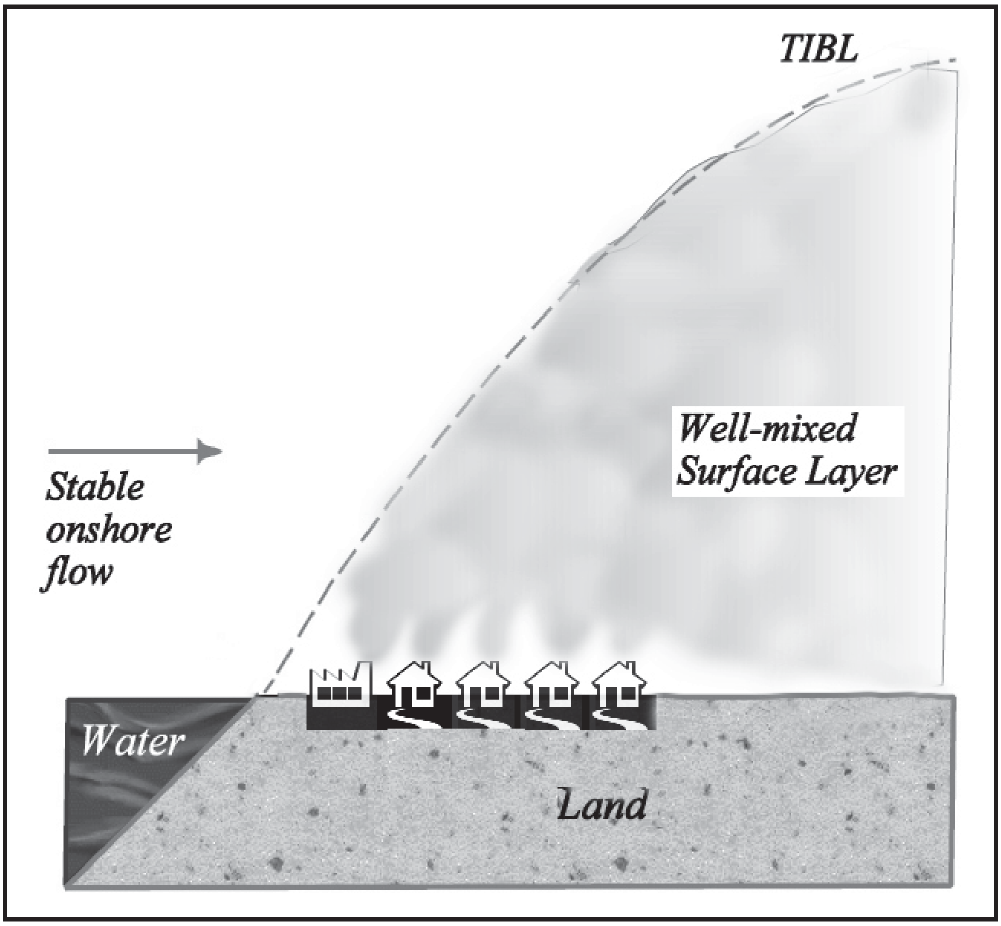



*Figure 10 Schematic of a typical coastal fumigation situation.*

Rainfall has the ability to affect air quality, for the WUA rainfall occurs on average 120 days of the year (Ellery, 2007). This precipitation, through the process of particle deposition, in particularly wet deposition scavenges particles when falling rain droplets and these particles collide (washout). Due to the varying scale of this process it is difficult to quantify the effect of localized precipitation on domestic emissions but it is recognized that it occurs.

### 1.3.3 Population and dwellings

Population figures from the last three censuses are reported in Table 2. For the last 5 years there has been a population increase of 3.1% for the WUA.

According to the medium projection series, the resident population of Whakatane District is projected to decrease by around 300, from 34,500 in 2006 to 34,200 in 2031. This is a 1 percent decrease and compares with a projected national increase of 22 percent during the same period (Statistics New Zealand, 2007).

*Table 2 Census night population counts (Statistics NZ, 2007).*

| Area Unit Code (2006 Areas) | Area Unit Description | 1996 Census, Census Night Population Count | 2001 Census, Census Night Population Count | 2006 Census, Census Night Population Count |
|---|---|---|---|---|
| 542410 | Whakatane North | 3183 | 3264 | 3252 |
| 542421 | Coastlands | 522 | 630 | 852 |
| 542422 | Whakatane West | 3000 | 3015 | 3063 |
| 542430 | Trident | 3135 | 3150 | 3258 |
| 542440 | Allandale-Mokorua | 3582 | 3747 | 3846 |
| 542511 | Orini | 555 | 573 | 558 |
| **WUA Total** | | **13977** | **14379** | **14829** |
| **WUA Population Gain/Loss** | | | **+402** | **+450** |
| **WUA Percentage change** | | | **+2.88%** | **+3.13%** |

The number of dwellings (Table 3) has increased by 4.4% from 2001 to 2006 (Statistics NZ, 2007).

*Table 3 Census dwelling counts (Statistics NZ, 2007).*

| Area Unit Code (2006 Areas) | Area Unit Description | 1996 Census, Total Private Occupied Dwellings | 2001 Census, Total Private Occupied Dwellings | 2006 Census, Total Private Occupied Dwellings |
|---|---|---|---|---|
| 542410 | Whakatane North | 1212 | 1248 | 1236 |
| 542421 | Coastlands | 165 | 207 | 294 |
| 542422 | Whakatane West | 963 | 993 | 1038 |
| 542430 | Trident | 1086 | 1110 | 1164 |
| 542440 | Allandale-Mokorua | 1422 | 1512 | 1569 |
| 542511 | Orini | 168 | 168 | 168 |
| **WUA Total** | | **5016** | **5238** | **5469** |
| **WUA Dwelling Gain/Loss** | | | **+222** | **+231** |
| **WUA Percentage change** | | | **+4.43** | **+4.41** |

Increases in population are theoretically positively correlated with an increase in emissions (eg. greater traffic volumes, greater domestic heating demands), however the significance of the increase can be offset by improvements in technology, although due to financial constraints the new technology usage may not be as dominant as the population effect. Decreases in population would theoretically have the reverse effect.

## 1.3.4 Deprivation index

The prosperity of the population can also be linked with emissions. Anecdotal evidence suggests lower socio-economic groups favour wood burning as a means of heating as the fuel can often be sourced more cheaply than other heating methods.

This section is based on the index of deprivation, which is an academically rigorous integration of nine variables from the census data.

For further information on the development of this index see Salmond et.al, (2007).

While this index was developed from a health sector perspective for three main purposes — resource allocation, research and advocacy — it has application in other sectors. For example, it can be used as a basis for development of funding formulae and community advocacy. In environmental resource management, the index can assist the assessment of the social and economic well-being of people and communities, an element of sustainable management under the Resource Management Act 1991.

The index of deprivation is listed as 1 being least deprived and 10 being most deprived. The index is calculated from income, employment, communication, transport, support, qualifications, home ownership and living space parameters.

The WUA has a highly polarised population with proportionally more people at the outer Index of Deprivation levels 7, 8, 9 and 10 and fewer people in the higher and middle levels (1 to 6) than the New Zealand average (10%) (Figure 11).

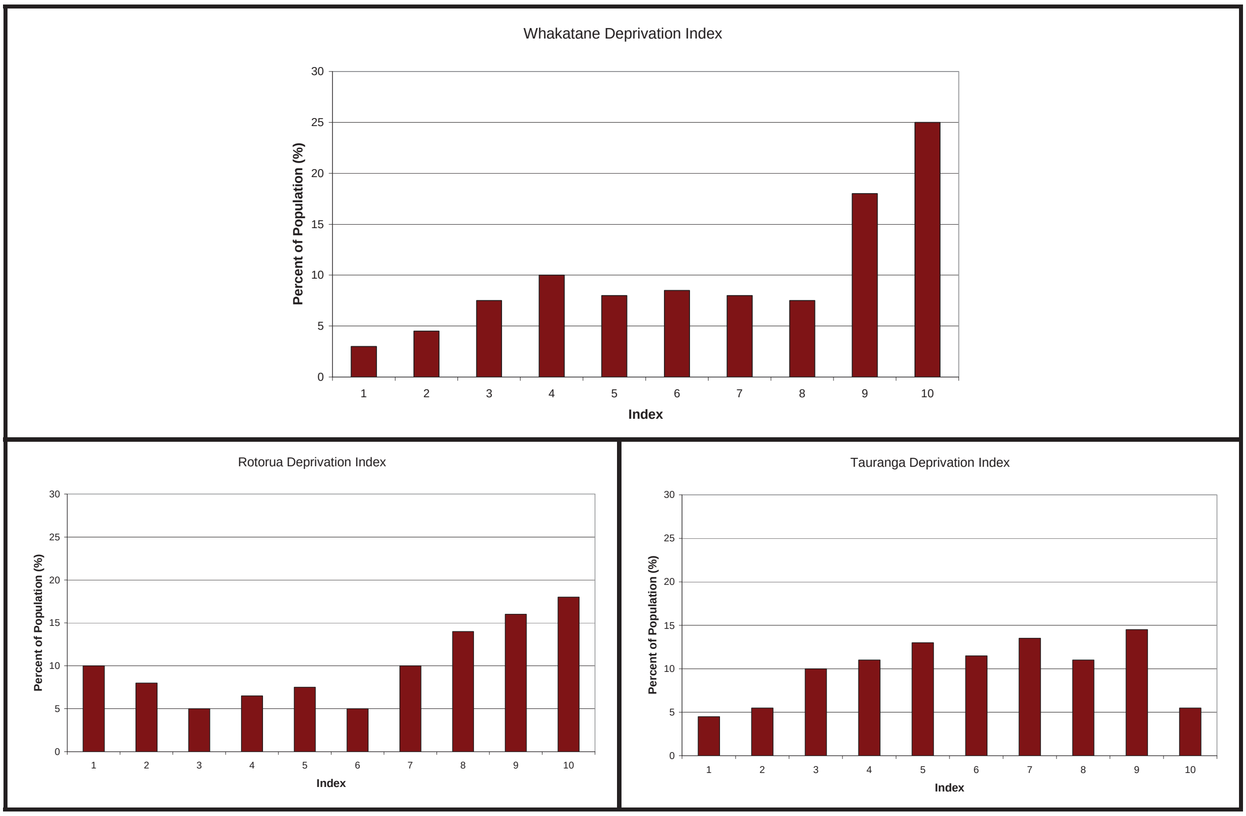



*Figure 11 Deprivation index results for Bay of Plenty centres.*

# Chapter 2: Air Contaminants Sources and Effects

The contaminants (Table 4) included in this emission inventory are particulate matter, carbon monoxide, sulphur dioxide, the oxides of nitrogen, and VOC's. These are commonly referred to as the primary or indicator air pollutants, and are produced by a variety of sources throughout the WUA.

*Table 4 Contaminants determined in this report (modified from SKM, 2001).*

| Contaminant | Comment |
|---|---|
| Particulate matter (PM) | PM includes dust, smoke, aerosols, haze and fallout. Airborne PM arises from many sources including combustion processes (especially coal and wood burning), motor vehicle emissions, vehicle movements on sealed and unsealed roads, road and building construction, agricultural practices as well as numerous industrial operations. Natural sources of PM include volcanoes, sea spray, plant and animal matter (e.g. pollens and fungal spores) and wind blown dust and dirt. Sea spray will be a significant contributor for the WUA due to is coastal location. PM can cause nuisance effects when it settles on surfaces such as cars, window ledges, washing, etc. |
| $PM_{10}$ | Particles below 10 microns or $PM_{10}$ can affect visual air quality and can have respiratory effects because they are small enough to be inhaled. $PM_{10}$ has been of increasing concern with no threshold level for effects known because it has been shown to endanger human health. $PM_{10}$ can be estimated relatively easily with emission factors and particle size distribution data. |
| Carbon Monoxide (CO) | CO is formed as a product of incomplete combustion in burning fossil fuels. The main source in the WUA is motor vehicle emissions. Other sources can include domestic fires, and industrial combustion. CO is a poisonous gas, which acts by displacing oxygen from the blood. Prolonged exposure at moderate levels can lead to symptoms such as headaches and dizziness. Chronic exposure at lower levels has been linked to an increased incidence of heart disease. |
| Sulphur dioxide ($SO_2$) | $SO_2$ is mainly produced by the burning of fossil fuels. The primary sources are coal (<0.5 – 3.0 % sulphur), fuel oil (0.5 - 3.5 % sulphur) and diesel (0.3 % sulphur). There is no significant sulphur in natural gas, petrol, or in wood. A number of industrial processes also emit sulphur dioxide, while volcanoes are a major natural source. The primary effect of $SO_2$ is as a respiratory irritant, although on a global scale it is also of concern in the production of acid rain and acidification of soils. |

| Contaminant | Comment |
|---|---|
| Oxides of Nitrogen ($NO_x$) | $NO_x$ describes nitric oxide (NO) and nitrogen dioxide ($NO_2$) which are formed in combustion processes by oxidation of the nitrogen present in combustion air. Nitric oxide is the primary product, which is then oxidised to $NO_2$ in ambient air. Motor vehicles are the major source of $NO_x$ in most parts of NZ. Large combustion sources may be significant localised sources. The main health effects are due to $NO_2$, which is a respiratory irritant. In major urban areas (e.g. Los Angeles) both gases are a concern as precursors for photochemical smog, produced from $NO_x$ reacting with hydrocarbons under the influence of sunlight. |
| Volatile Organic Compounds (VOC's) | Priority hazardous air contaminants have been selected for air-shed management in the updated NZ Ambient Air Quality Guidelines (MfE, 2002). Emission factors are currently being developed for these contaminants, in particular, for vehicles by the Ministry of Transport. Some emission factors for these pollutants are available from Australia and the USA. |

# Chapter 3: Methodology and Data Sources

## 3.1 Data collection criteria

The various sources selected for the inventory represent the most significant sources in the WUA encompassing: transport, industrial, residential and commercial.

## 3.2 Data sources

### 3.2.1 Consented industry

Assessing emissions from consented industry involves the collection of data relating to the process, referred to as activity data, and the application of emission factors to these data. The activity data required for industry depends on the type of discharge.

The main consented industry within the WUA is CHH Paperboard Limited which operates a mill located on the northern side of the Whakatane River. This company currently operates 3 boilers (sharing the same stack) which are fuelled with primarily coal but often supplemented with woodwaste. The consented total emission limit for these 3 boilers is 14kg/hr.

For the $PM_{10}$ emission calculation for the CHH Paperboard Ltd plant a figure of 6kg/hr (average of recent test results x0.75 (for $PM_{10}$)) has been used (see Figure 12). For other contaminants fuel consumed multiplied by the appropriate emission factor was used.

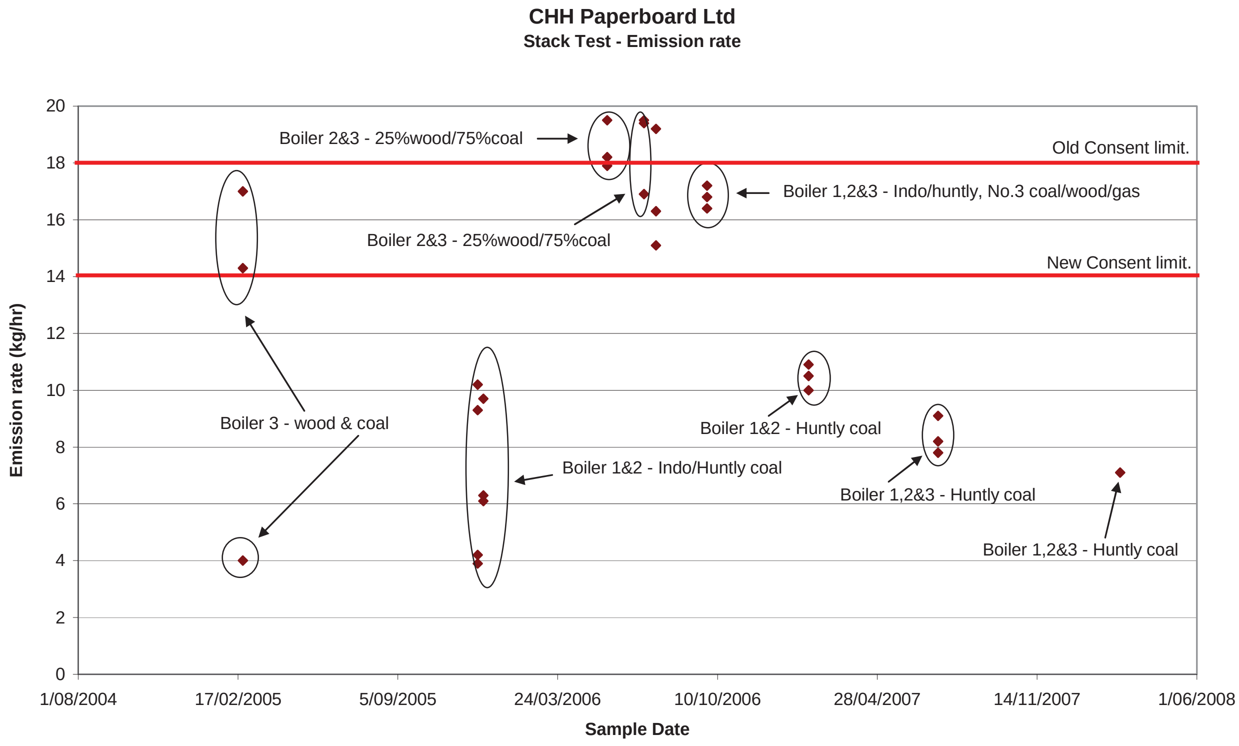



*Figure 12 Stack test results for CHH Paperboard Ltd.*

Other smaller contributors are also consented to operate within the WUA (Figure 13). These are categorised as spraypainting (7), waste transfer (1) and an asphalt plant (1).

One limitation with using data from resource consent files is that in some instances data is limited to the maximum allowable fuel or material used. If this data is to be used, assumptions are required as to what proportion of the maximum allowed is actually used. For this inventory the maximum consented discharge limit has been primarily used because our main interest is in the worst-case scenario.

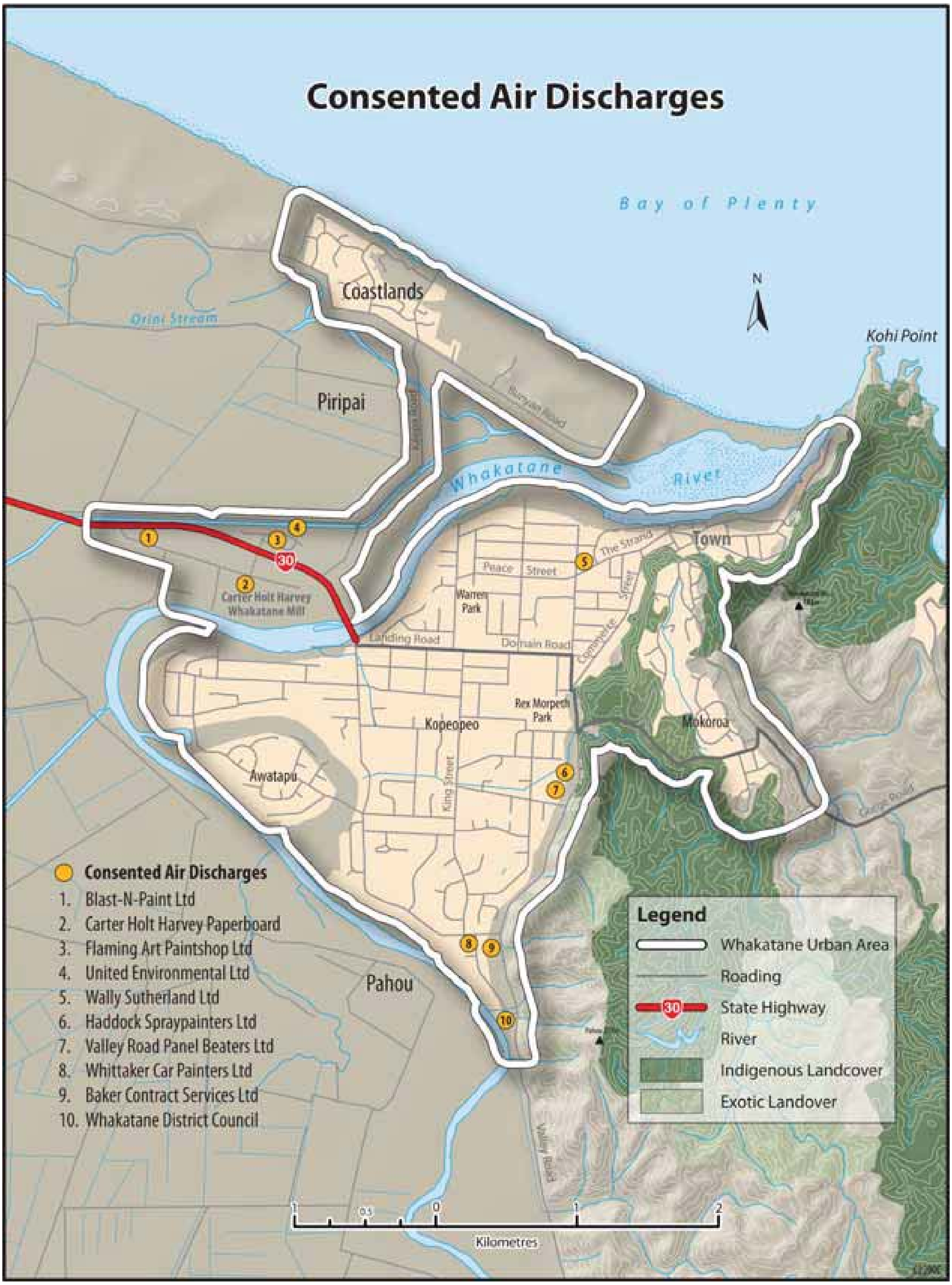



*Figure 13 Consented air discharges.*

### 3.2.2 Transport

Calculations for PM, CO, $NO_x$ and VOC's are included for this source. $SO_2$ has been omitted as the appropriate emission factors were not available for use at a neighbourhood level. A simplistic description of the emission process for this pollutant is - sulphur in equals sulphur out. This calculation is much easier to determine on a regional scale on the basis of total fuel consumption. On the neighbourhood scale which is being used in this report, an unnecessary level of complexity would need to be added. Central government initiatives are resulting in a reduction of sulphur levels in fuel, which will see a corresponding reduction in $SO_2$. NERMN monitoring (Iremonger, 2008) for $SO_2$ elsewhere in the region shows that levels are only elevated in areas in proximity to specific industrial processes.

(a) Urban Roads

Motor vehicle emission factors were derived from the MoT vehicle model for 2006 (NZTER v.1).

For the 2001 regional inventory, a default vehicle fleet profile was used, as recommended by the Ministry of Transport because it was considered that data from regional vehicle registrations would not necessarily be reflective of the local fleet. This differs from the approach used for the regional inventory in 1996, and may under estimate the contribution from diesel vehicles, which are expected to be higher than average due to the region's forestry and port activities.

For this inventory local traffic count data (Figure 14) and vehicle registration information was used to define the fleet profile for the WUA.

Various options for this fleet composition are shown in Table 5. The source of the data in each column is as follows:

- the default national profile for 2004 is taken from MoT,
- the vehicle registration data for Whakatane is from an analysis of local registrations for 2006, and has also been presented in an aggregated form in column 4,
- the final column gives vehicle count data for a selection of roads around Whakatane.

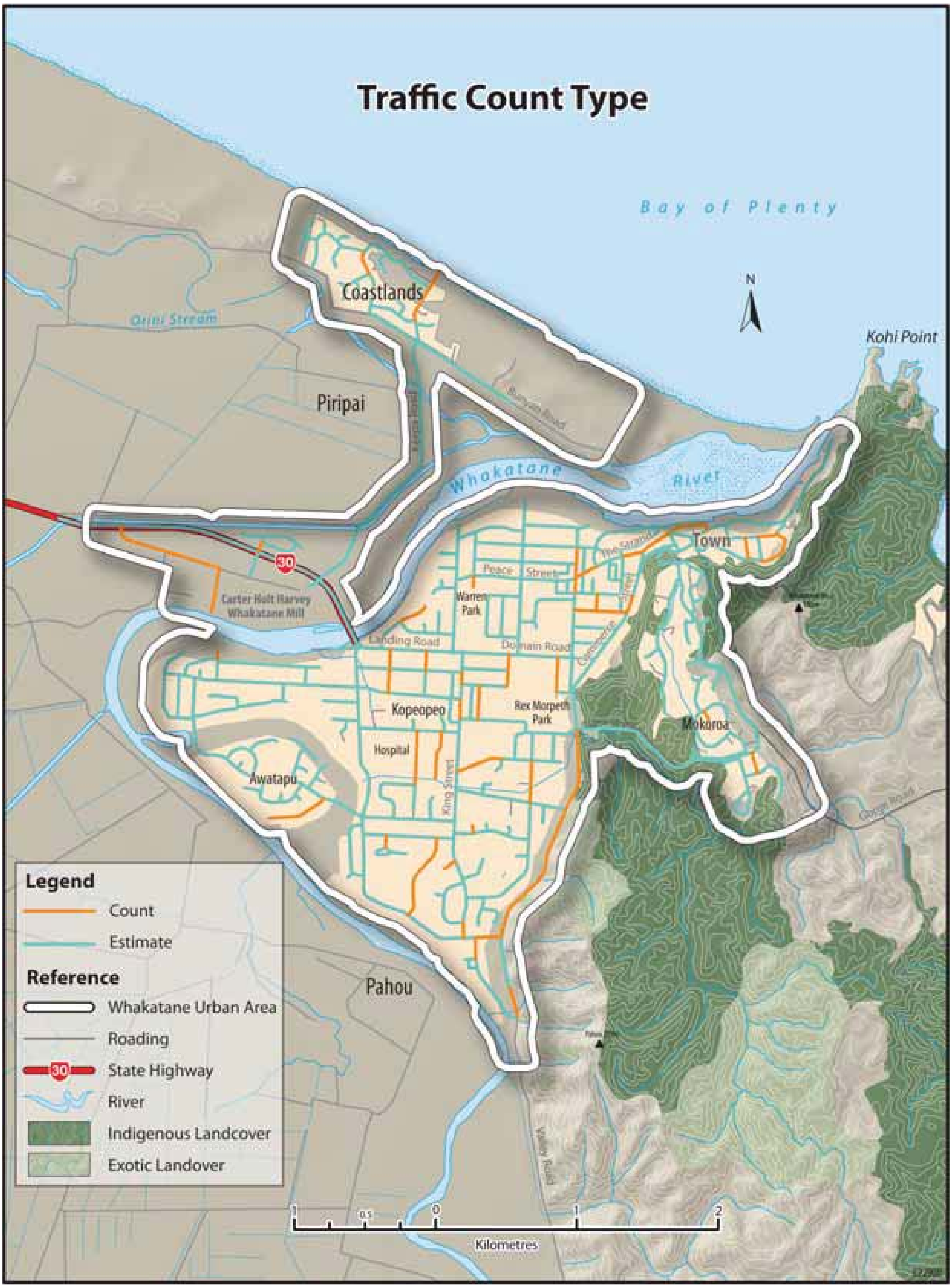



*Figure 14 Traffic count data type.*

*Table 5 Fleet composition for WUA urban road network.*

| Type | National fleet | Whakatane registrations | Registrations aggregated | WDC Rds |
|---|---|---|---|---|
| Motorcycles | 0.3% | 2.6% | 96.3% | 96.4% |
| Cars, petrol | 72.0% | 67.4% | | |
| Cars, diesel | 5.6% | 9.8% | | |
| LCV, petrol | 6.6% | 5.9% | | |
| LCV, diesel | 7.2% | 10.6% | | |
| HCV, sm, p | 0.2% | 0.0% | 2.5% | 3.3% |
| HCV, sm, d | 3.0% | 1.5% | | |
| HCV, med, p | 0.2% | 0.0% | | |
| HCV, med, d | 1.0% | 0.4% | | |
| HCV, lge, p | 0.1% | 0.0% | 1.2% | 0.3% |
| HCV, lge, d | 3.1% | 1.2% | | |
| Buses, med | 0.2% | 0.5% | part of HCV | part of HCV |
| Buses, large | 0.3% | | | |

Clearly, it would not be appropriate to use the national default fleet profile for Whakatane urban roads. In fact, the traffic count data for these roads very closely matches the registration data distribution, by broad categories. From Table 5 the following profile was chosen for the WUA (Table 6).

*Table 6 Fleet profile determined for the WUA road network.*

| | MC/MP | Cars | | LCVs | | HCV, small | | HCV, med | | HCV, lge | | Buses | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Petrol | Pet. | Dsl. | Pet. | Dsl. | Pet. | Dsl. | Pet. | Dsl. | Pet. | Dsl. | Pet. | Dsl. |
| **Profile (%)** | 2.6 | 67.4 | 9.8 | 5.9 | 10.6 | 0.0 | 1.5 | 0.0 | 0.4 | 0.0 | 1.2 | 0.0 | 0.5 |

The following corridor flow options from NZTER were determined to be representative for the WUA. Table 7 gives the emission factors for these chosen options, in g/VKT (grams/vehicle-kilometres travelled).

*Table 7 Emission factors for LAMA urban road network.*

| | CO | NOx | PM | VOC |
|---|---|---|---|---|
| **2006** | | | | |
| Suburban, cold start | 27.469 | 1.561 | 0.182 | 4.659 |
| Suburban, free flow | 5.015 | 1.168 | 0.079 | 0.772 |
| Suburban, interrupted | 7.576 | 1.279 | 0.098 | 0.913 |

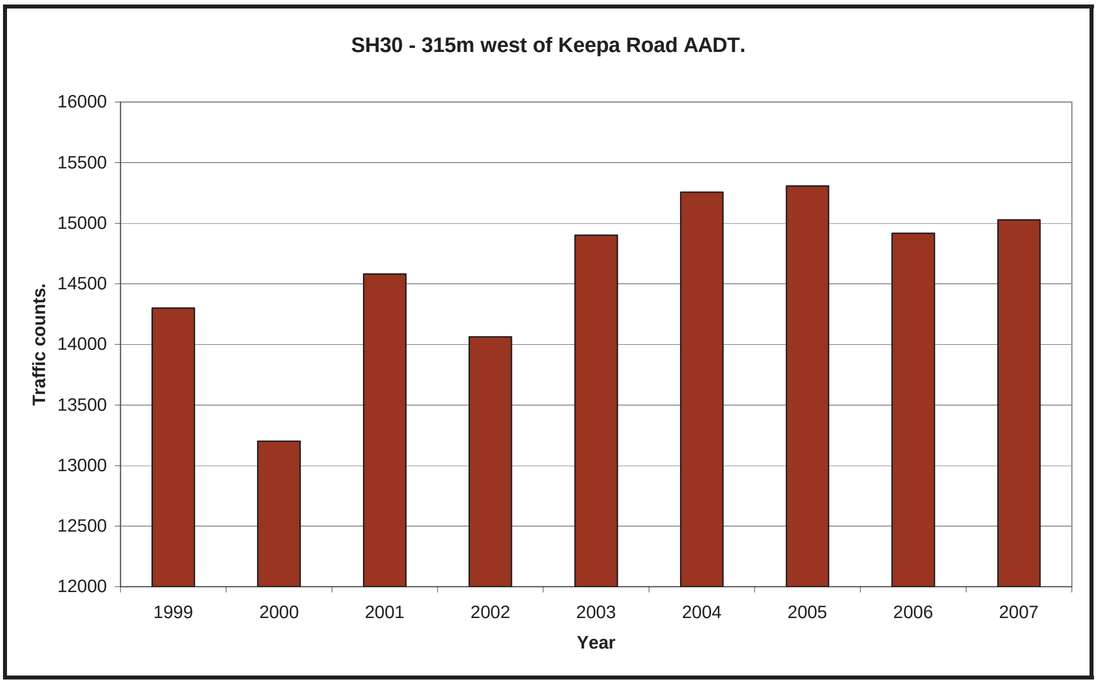
Hourly variations in traffic flow information are also taken from the analysis of traffic count data. As expected the distribution varies between different roads but some of this will be due simply to the counts being made on different days of the week. Also, many of the roads showing the greatest variations have quite small traffic volumes, and hence the percentage data is more susceptible to small variations. The distribution shown below (Table 8) is based on an average across all of the sites analysed, regardless of road type, this distribution has been applied universally across all roads in the study area.

*Table 8 Hourly flow variations for the WUA.*

| Time | Traffic distribution (%) |
|---|---|
| 0000-0100 | 0.2 |
| 0100-0200 | 0.1 |
| 0200-0300 | 0.1 |
| 0300-0400 | 0.1 |
| 0400-0500 | 0.4 |
| 0500-0600 | 0.9 |
| 0600-0700 | 2.3 |
| 0700-0800 | 4.9 |
| 0800-0900 | 7.3 |
| 0900-1000 | 6.7 |
| 1000-1100 | 7.2 |
| 1100-1200 | 7.2 |
| 1200-1300 | 8.3 |
| 1300-1400 | 7.4 |
| 1400-1500 | 8.5 |
| 1500-1600 | 8.7 |
| 1600-1700 | 7.7 |
| 1700-1800 | 7.0 |
| 1800-1900 | 5.4 |
| 1900-2000 | 4.1 |
| 2000-2100 | 2.6 |
| 2100-2200 | 1.7 |
| 2200-2300 | 0.9 |
| 2300-2400 | 0.5 |

(b) State Highway

Only a short portion (<2km) of State Highway 30 bisects the north western area of the WUA. Count information has been collected and analysed from the Traffic Monitoring System (Transit New Zealand, 2008). Annual ADT for this carriageway is 15027 for 2007. Variation over the last 5 years of monitoring record is approximately 2%. Weekly patterns are as expected with high volumes measured during the working days and 50 – 70% reductions for the weekend (Figure 15).



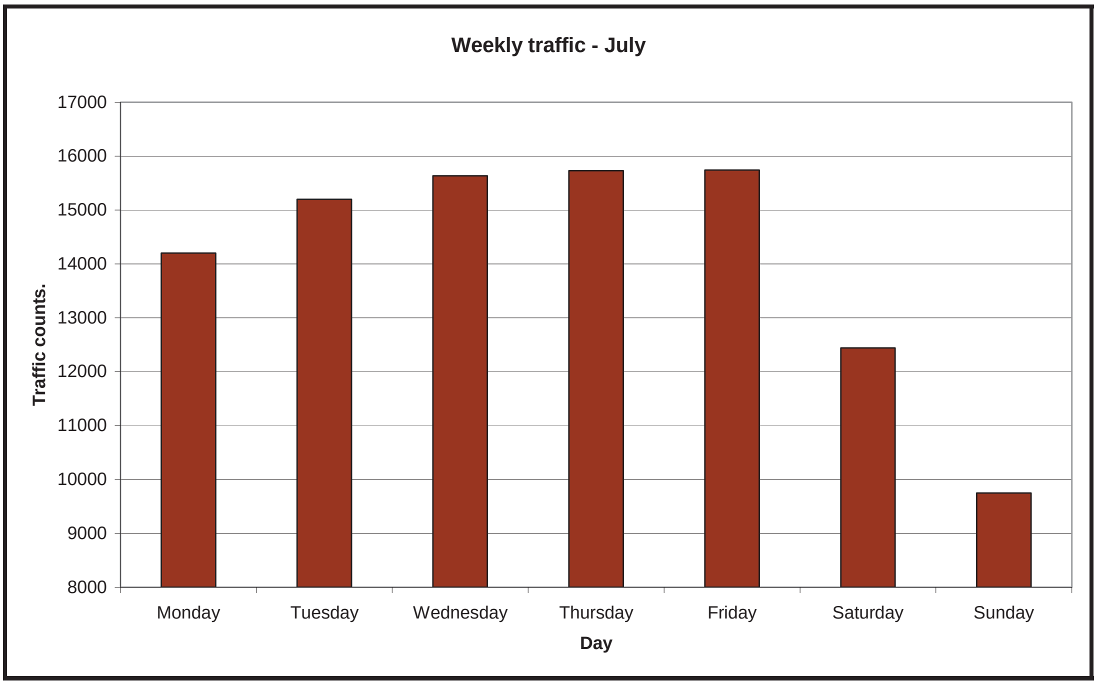




*Figure 15 SH30 traffic count summarised information.*

The determined profile for the state highways is shown in Table 9.

*Table 9 Fleet profile determined for SH30.*

| | **MC/MP** | **Cars** | | **LCVs** | | **HCV, small** | | **HCV, med** | | **HCV, lge** | | **Buses** | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Petrol | Pet. | Dsl. | Pet. | Dsl. | Pet. | Dsl. | Pet. | Dsl. | Pet. | Dsl. | Pet. | Dsl. |
| **Profile (%)** | 2 | 70 | 8 | 6 | 11 | 0.1 | 2 | 0 | 0.2 | 0 | 0.2 | 0 | 0.5 |

The corridor flow option of NZTER gives the following emission factors (Table 10), in g/VKT. Particulate matter factors are higher than those used for the urban road network (Table 7) as there is a greater proportion of large diesel vehicles present on the State Highway network.

*Table 10 Emission factors determined for SH30.*

| | CO | NOx | PM | VOC |
|---|---|---|---|---|
| **2006** | | | | |
| Suburban, cold start | 28.077 | 1.44 | 0.167 | 4.768 |
| Suburban, free flow | 5.102 | 1.066 | 0.07 | 0.779 |
| Suburban, interrupted | 7.722 | 1.179 | 0.088 | 0.922 |

### 3.2.3 Domestic Sources

A detailed domestic heating survey (as in Rotorua) has not been undertaken for the WUA. Instead the approach has been to use information from inventories from similar geographical areas, household energy use studies, investigations for the Rotorua LAMA and the Statistics NZ 2006 census datasets.

Iremonger & Graham (2006) gives a summary of the key results from the survey of home heating methods, frequency, fuel use and back yard rubbish burning in Rotorua. This information will differ slightly from what is experienced in the WUA but can be used as a suitable starting point for determining patterns in appliance type and use. Comparison of census data for a selection of districts within the region (Figure 16) shows similar appliance use patterns for Whakatane, Rotorua and Opotiki. The much lower wood use in Tauranga is consistent with the data for other large urban areas, especially Auckland and Wellington.

Schools within the WUA primarily use electricity for heating, no schools use coal. No further analysis has been required for this potential source category. General domestic annual coal volume has been supplied by Solid Energy and incorporated into the emission profile for this source.

The distribution of heating methods (Table 11) used by each household for heating for the WUA is as follows (based on the figures from 2006 census and the ratios of wood burning appliance from the Rotorua LAMA domestic heating survey).

*Table 11 WUA heating methods.*

| Appliance type. | Percentage of dwellings using this heating method. |
|---|---|
| Open fire | 4% |
| Wood (log) burner | 36% |
| Multi-fuel burner | 2% |
| Gas (reticulated) | 4% |
| Gas (bottled) | 23% |
| Electricity | 41% |
| Solar | 1% |

The heating season for the WUA was determined from the Rotorua LAMA survey results and data for Tauranga from the Energy Use in New Zealand Households report (Isaacs et al, 2005).

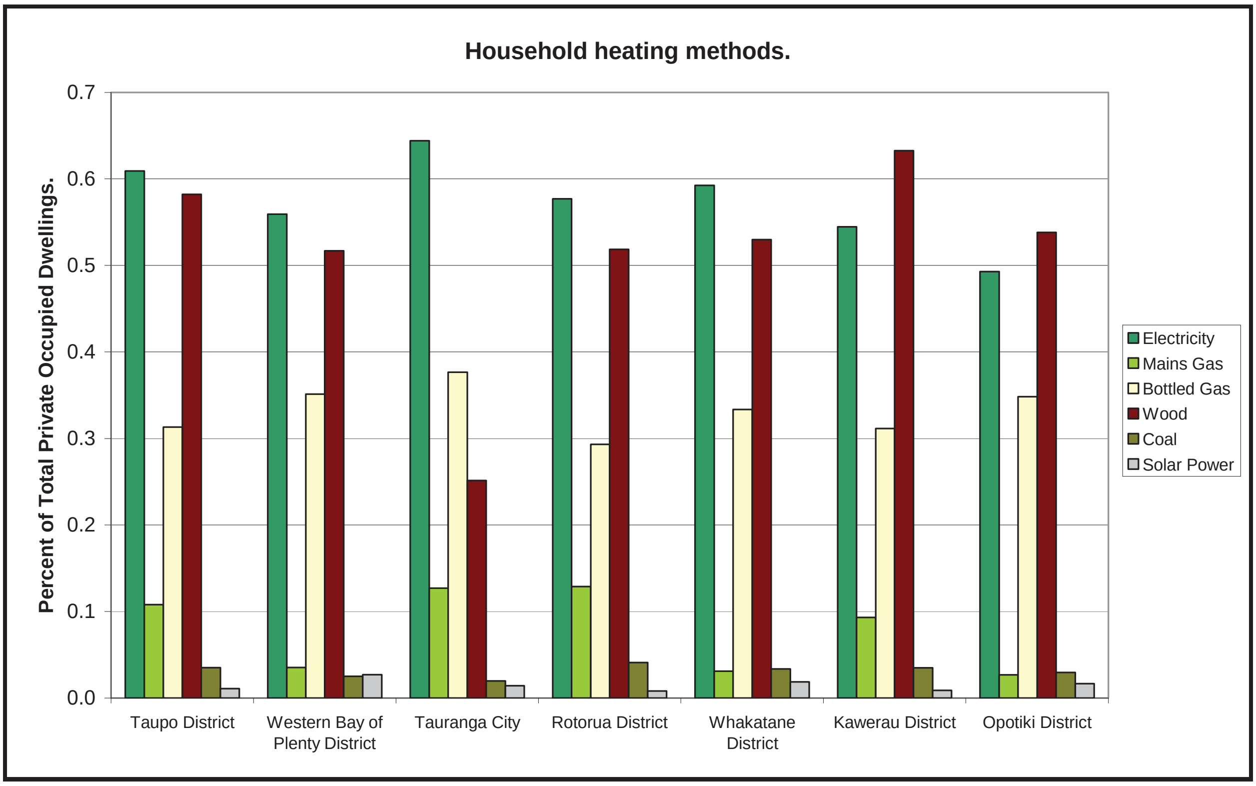



*Figure 16 Census home heating data comparisons for districts within the region.*

Within the Rotorua LAMA a very small proportion (<5%) of households reported heating their homes throughout the year, while the majority of homes were only heated between May and September. There was an additional shoulder period for April and October, during which 30 to 40% of homes were heated. The Isaacs report showed that for Tauranga the heating season was for 5 months (May-September). For the purpose of this inventory a heating season of 5 months from May to September has been used, this period is supported by the short period of record collected from the King Street air monitoring site (Figure 17) where maximum concentrations peak in June to August.

Based on the investigation undertaken in Rotorua a annual average daily wood usage of 6.5kg has been used for this study.

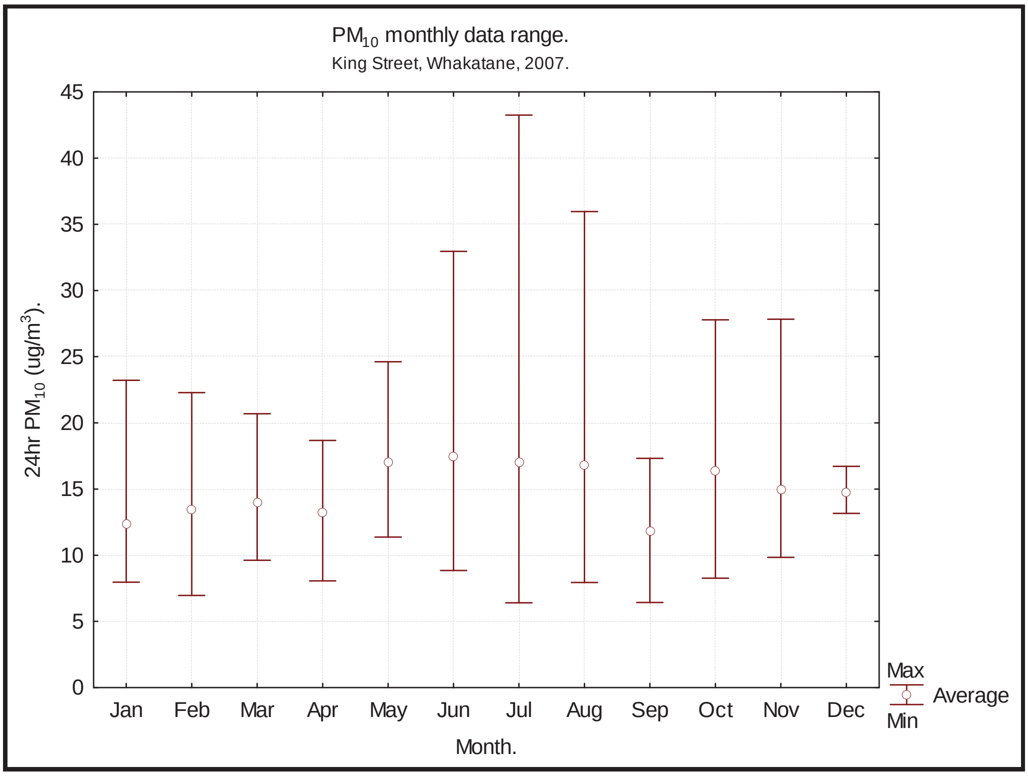



*Figure 17 Peak 24 hour values from the King Street monitoring site.*

### 3.2.4 Small Industrial / Commercial Sources of $PM_{10}$

Most emission inventories ignore the releases from small industrial and commercial sources because they are considered to be relatively insignificant at a regional or national scale. However, the WUA emissions inventory is being done at a much finer and more detailed scale than most others. Therefore it was considered important that these small sources should be included, at least to the extent of allowing their significance to be assessed.

There are no well-established guidelines on the inventory methodology that should be used for these small sources and, in particular, a complete lack of published emission factors. These factors were therefore developed from 'scratch', using the approach described below.

(a) Facility Types

The types of facilities considered for the inventory are listed in Table 12. These were derived from a database of 'waste producers' obtained from the Whakatane District Council, which was linked to property information in a GIS.

*Table 12 Facility types assessed for particulate matter contributions.*

| Facility types |
|---|
| Light metal fabrication |
| Heavy engineering/plant and equipment maintenance |
| Panel beaters (including spray painting) |
| Light vehicle workshops (motorbikes, cars, vans) |
| Heavy vehicle workshops (trucks, etc) |

| Facility types |
|---|
| Metal finishers - powder coating |
| Metal finishers - electroplating |
| Joinery factories (furniture manufacture, etc) |
| Bakeries |
| Wreckers (vehicle dismantlers) |
| Scrap metal dealers |
| Waste management (recycling, bins) depots |
| Appliance repairs |
| Paint and other solvents/chemicals (mixing, packaging) |

(b) Point Source Emission Data

Most, but not all, of the above sources will have some point sources emissions, mainly from building ventilation fans or from dust control equipment fitted to specific items of equipment. An indication of the possible magnitude of these emissions was obtained from a summary of test data provided by a company that specialises in stack testing. These results are summarised in Table 13, which indicates emissions varying from almost zero (ca. <0.02 kg/hr) up to relatively high rates of 1 to 4 kg/hr. However, it should be noted that these higher emission rates (ca. > 1 kg/hr) are considered to be atypical. Sources with this level of emissions would almost certainly give rise to complaints to the regional council, and subsequent action to ensure that the emissions are better controlled.

*Table 13 Point Source Emissions from Selected Industries (Graham, 2006b).*

| Industry type | kg/hr |
|---|---|
| timber & joinery, good control | 0.07, 0.07 |
| timber & joinery, poor control | 1.8, 3.6 |
| spray painting | 0.14, 0.03 |
| abrasive blasting | 0.05, 0.04 |
| metal fabrication, etc | 0.04, 0.07, 0.14, 0.01 |
| printing | 0.05 |
| packaging | 0.36, 0.72 |
| coffee roasting | 0.11 |
| coffee drying | 1.37 |
| bakeries | 0.04 |
| tyre retreads | 0.01 |
| sand dryer | 1.08 |
| concrete plant | 0.11 |
| roofing tiles | 0.02 |
| coal-fired boiler | 2.16 |

On the basis of the data shown in Table 13, it was decided to allocate source emission rates as follows (Table 14), using a subjective classification of the different sources.

*Table 14 Particulate matter contribution classification (Graham, 2006b).*

| | |
|---|---|
| **Facilities with the highest potential for PM emissions**: | assigned a rate of 0.1 kg/hr |
| Heavy engineering/maintenance<br>Joinery factories<br>Panel beaters<br>Light metal fabrication<br>Metal finishers – powder coating<br>Bakeries | |
| **Facilities with lower potential for PM emissions**: | assigned a rate of 0.02 kg/hr |
| Light vehicle workshops<br>Tanneries (small specialty products)<br>Paint and other solvents<br>Metal finishers – electroplating<br>Appliance repairs | |
| **Facilities with the potential for 'yard' emissions**: | assigned a rate of 0.1 kg/hr |
| Wreckers<br>Scrap metal dealers<br>Waste management<br>Timber yards | |

The above factors allow for an initial estimate of the controlled and uncontrolled emissions from the different groups of sources. The figures used are totally subjective and should simply be seen as providing ball-park estimates of the possible emissions. The main purpose of the calculations is to determine whether or not the emissions from these small sources are a significant contributor to the WUA inventory. Further work may be required if this is found to be the case.

## 3.3 Uncertainty

Uncertainties are inherent in any emission inventory. Uncertainty arises from:

- The use of average emission figures.
- Applying emission factors from other regions, or countries.
- Activity levels that cannot readily be captured.

The uncertainty in emission factors as a result of averaging is usually reported in the emission factor reference. A WUA specific model containing New Zealand specific factors has been used for transport sources and New Zealand developed factors have been used for domestic heating.

USEPA derived factors have been used for industrial sources, this is typical practice because it is generally the only comprehensive data set, but they may not be entirely relevant to New Zealand operating conditions. For $PM_{10}$ calculations the hours of operation and averaged stack testing results have been used.

The emission factors used in the inventory were the best available at the time. Uncertainty in the activity statistics for each source is summarised in Table 15.

*Table 15 Uncertainties associated with inventory calculations.*

| Source | Comment |
|---|---|
| **Transport** | Good certainty in VKT data given the road length data from RAMM data base. Limitations are in whether measurements have been taken at enough points on a road to be truly representative. Vehicle counts are likely to vary seasonally particularly, due to tourism over summer, but the VKT data is expected to be reasonably representative of an annual average. |
| **Domestic** | All domestic source activity data is reasonably certain because it has been built on the results from the 2006 census data and an adjusted form of the Model of Domestic Burning derived for the Rotorua LAMA. |
| **Light industry/commercial** | Low certainty for the result from this category. Good knowledge of types of activity from the WDC database, but limited knowledge of discharges for these point sources. The methodology acknowledges this screening approach to determine if more detailed investigations are necessary. |
| **Industrial** | There is reasonable certainty in the activity data for industrial sources, the majority of which was obtained by direct contact with industry. For PM, hours of operation are used (for which there is good certainty) in conjunction with consented discharge limits (actual discharge should be lower than this figure). |

Inventories are useful tools for assessing the sources contributing to pollution but the results need to be interpreted and used bearing in mind that the inventory is not the result of an exact science.

Certain policy decisions may require a more refined and/or localised information base and further investigations may be needed in such cases.

# Chapter 4: Data Summary and Analysis

The data summary information is presented in two forms firstly by emission source type in a tabular format and secondly by contaminant type in a spatial format. This approach gives a numerical value for each dominant source and also an indication of distribution of each contaminant.

## 4.1 By emission source

This section presents the estimated emissions for the various sources based on the best information available for activity data and emission factors to represent the 2007 year. The data is presented for two timescales i) annual and ii) 'winter time', which is deemed to be approximately 150 days based on the determined domestic heating season from $PM_{10}$ ambient monitoring data, the Isaacs report, ambient temperature data, and linkages with the domestic heating survey undertaken in Rotorua in 2005.

This wintertime check is important as it is during this time that exceedences of the $PM_{10}$ standard are being recorded both regionally and nationally.

### 4.1.1 Discussion

On an annual basis domestic heating contributes 27% of the estimated anthropogenic derived particulate matter in the WUA (Table 15 & Figure 18). When determined for the 2007 winter heating season this increases to 47% of the estimated particulate matter (Table 16 & Figure 19). Industry is the main annual contributor with 58 and 43% for annual and winter time figures respectively. Calculations for transport and commercial activities show on average a lesser contribution with transport showing 8 and 6% respectively for annual and winter periods.

*Table 15 Annual emission totals (n/d = not determined)*

| | Tonnes/year 2007 | | | | |
|---|---|---|---|---|---|
| | $PM_{10}$ | CO | $NO_x$ | $SO_2$ | VOC |
| Industry | 51 | 41 | 81 | 77 | 1 |
| Transport | 7 | 556 | 84 | - | 72 |
| Domestic | 24 | 228 | <1 | <1 | 6 |
| Domestic heating | 23 | 226 | <1 | <1 | 5 |
| Backyard burning | 1 | 2 | <1 | <1 | <1 |
| Commercial | 6 | n/d | n/d | n/d | n/d |

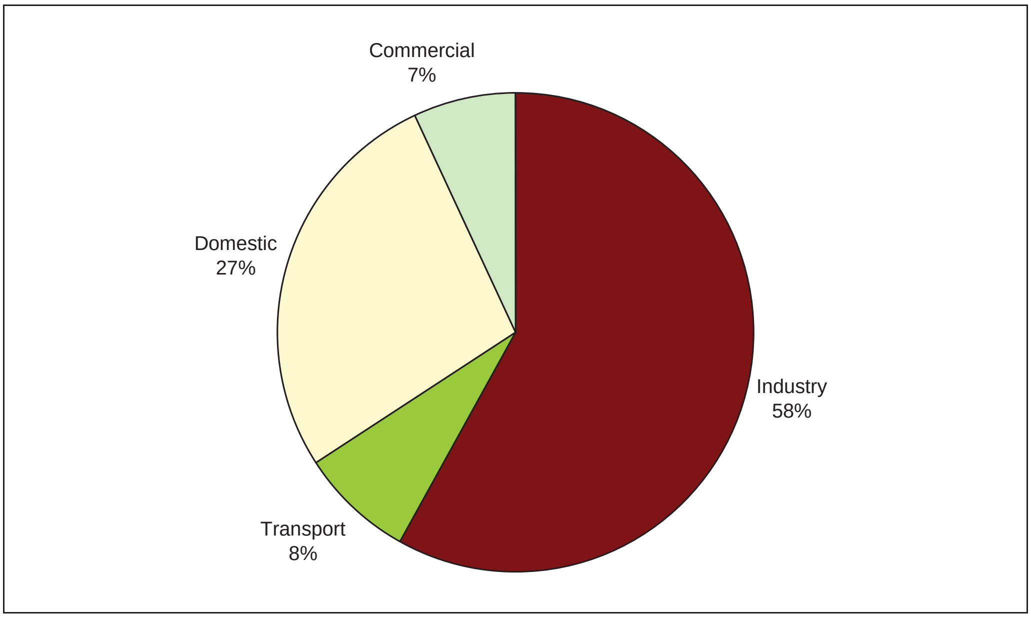



*Figure 18* *$PM_{10}$ percentage by source.*

*Table 16* *Winter time emission totals (n/d = not determined).*

| | Tonnes/winter 2007 | | | | |
|---|---|---|---|---|---|
| | $PM_{10}$ | CO | $NO_x$ | $SO_2$ | VOC |
| Industry | 21 | 17 | 33 | 32 | <1 |
| Transport | 3 | 229 | 35 | n/d | 30 |
| Domestic | 23 | 226 | <1 | <1 | 5 |
| Commercial | 2 | n/d | n/d | n/d | n/d |

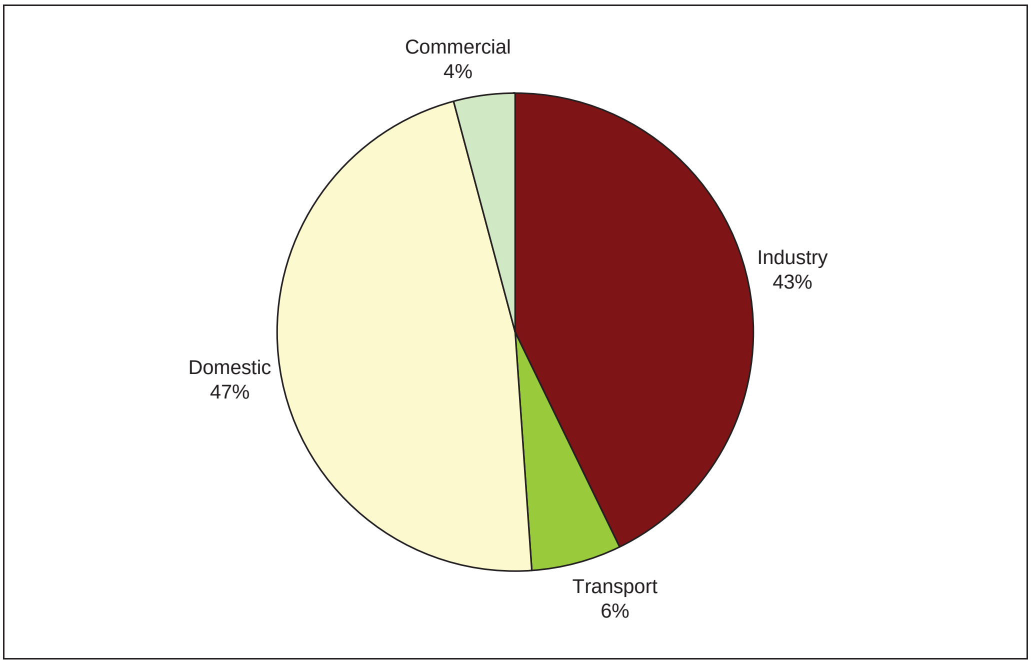



*Figure 19* *$PM_{10}$ wintertime percentage by source.*

## 4.2 By contaminant

The mapping in this section is by 100 x 100m grid. Emissions are calculated from an area basis for the domestic emissions and a line basis for transport emissions for each grid.

### 4.2.1 Discussion

The figures for the previous section are for the WUA as a whole. Contributions from various sources will differ throughout the WUA based on intensity of activity. This section of the inventory will look at this emission distribution within the WUA in more depth. Bearing in mind that how the contaminant behaves once emitted from the sources of interest is beyond the scope of this report and will be addressed in the accompanying airshed modelling investigation.

Several maps (Figures 20 – 23) have been produced to show the distribution of sources for each contaminant and the quantity of each contaminant emitted from these sources on an annual basis.

Figure 20 shows the spatial patterns associated with particulate matter emissions. For domestic emissions higher emissions are estimated in the central and western sections of the WUA, with pockets of elevated values around the James Street – Henderson Street area, the area around central King Street and Bridge Street and parts of the Awatapu subdivision. Significant emissions are also estimated for the topographically confined Mokoroa subdivision.

For transport sources emissions are dominated by the higher volume carriageways, in particular State Highway 30. These elevated emissions are also calculated for the Landing Road/Domain Road carriageways and the lower section of the Gorge Road. Commerce Street traffic volumes also result in elevated emissions.

Light and heavy industry are primarily restricted to two areas within the WUA; the area to the north of the Whakatane River and the within the Valley Road/TeTahi Street area in the south sector of the WUA. The main industrial contributor is the CHH Paperboard Ltd plant were three boilers fired primarily on coal are operated.

The other contaminants investigated mimic the distribution patterns exhibited by the $PM_{10}$ analysis. This is not unexpected due to the activity data being the dominant component in the emission calculation when reviewing the data spatially.

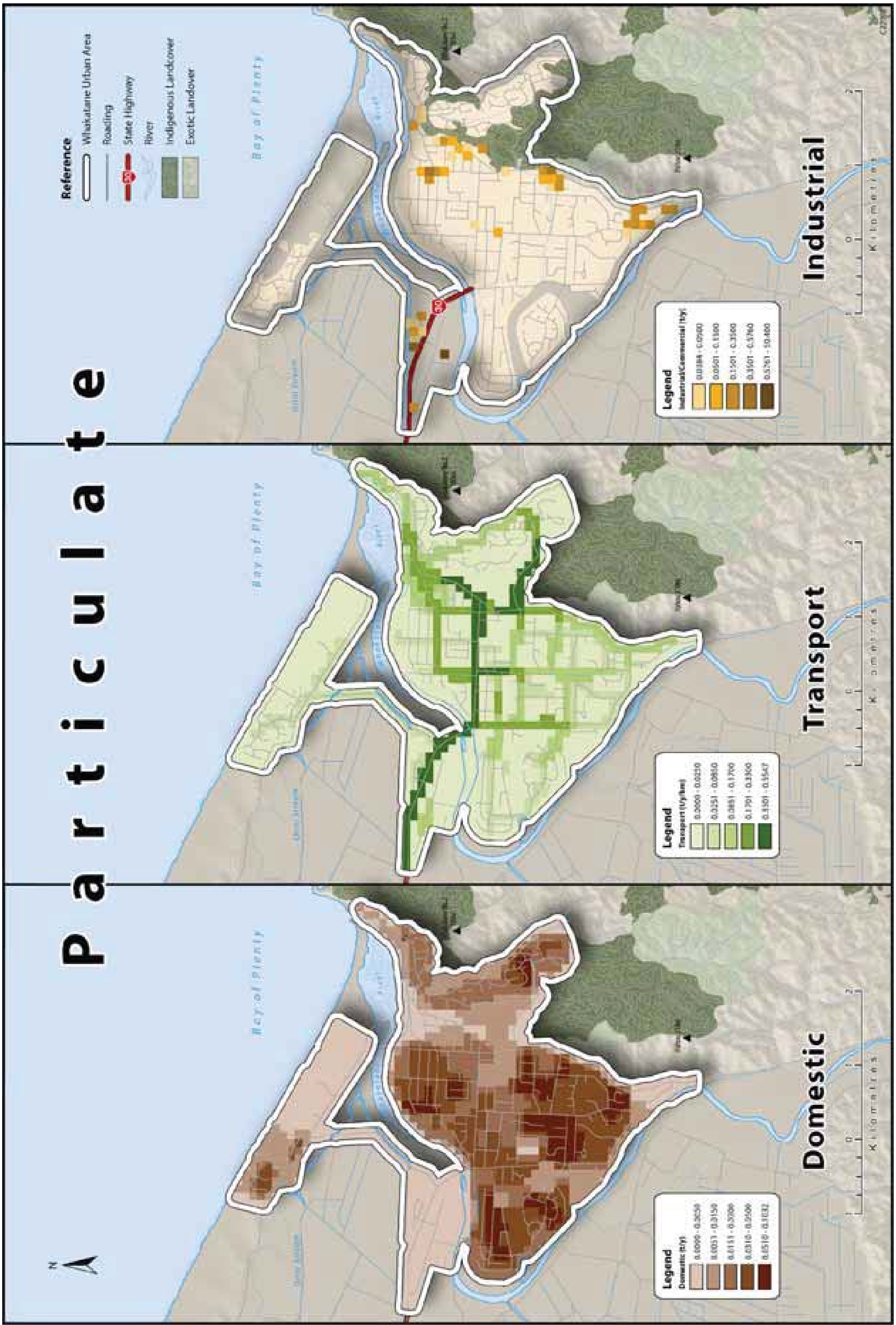



*Figure 20 Annual particulate matter estimated emissions.*

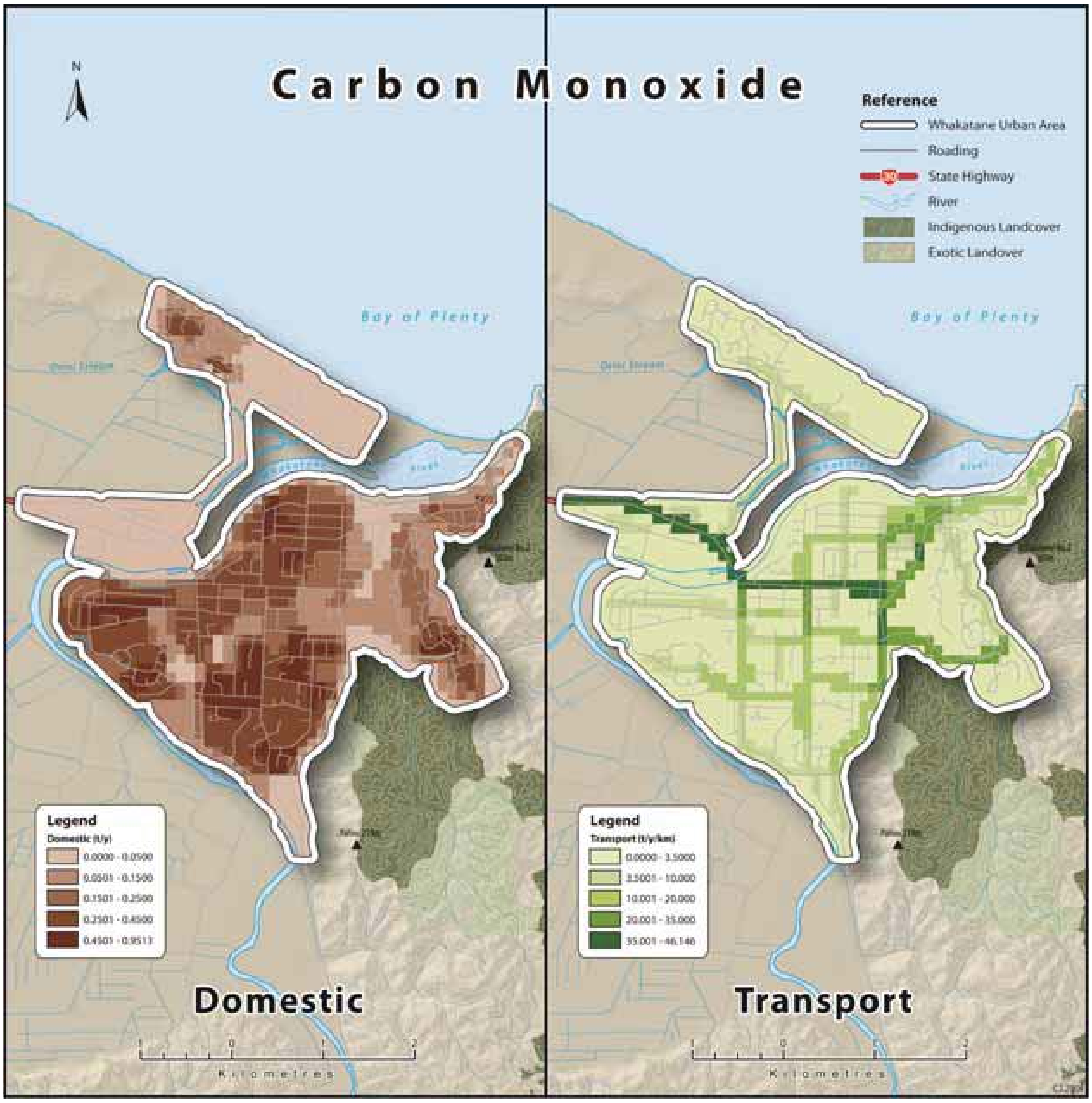



*Figure 21 Annual carbon monoxide emissions.*

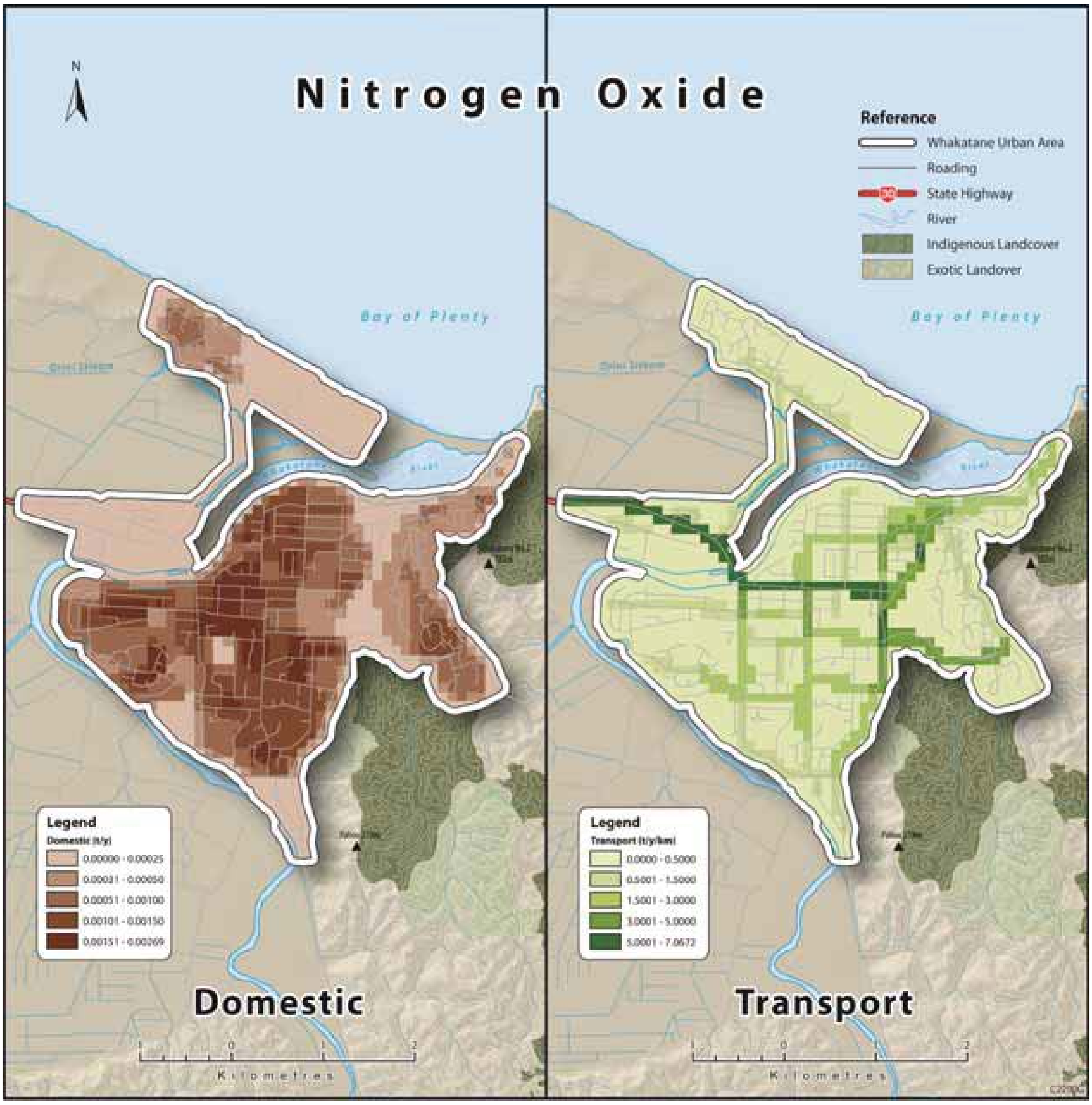



*Figure 22 Annual nitrogen dioxide emissions.*

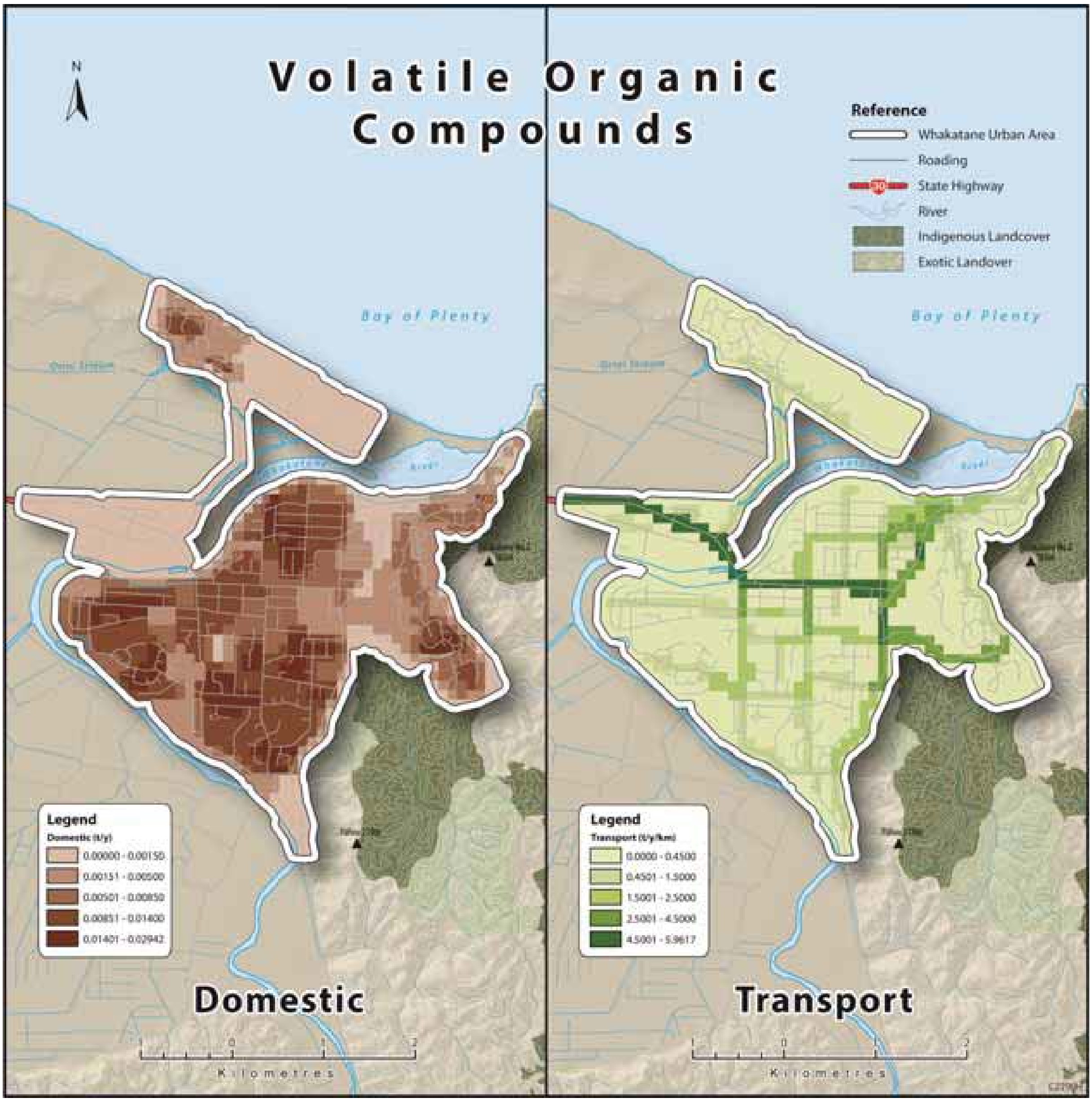



*Figure 23 Annual volatile organic compounds emissions.*

# Chapter 5: Conclusion

To date ambient air quality monitoring within the Whakatane Urban Area shows that during the winter period exceedances of the National environmental Standards have not been recorded. Values recorded for 24 hour $PM_{10}$ concentrations have however on several occasions approached this air quality standard at the King Street monitoring site. The spatial representation of emissions for this contaminant shows that this site is located in an area of moderate emissions. Investigation of ground level concentrations by the use of an dispersion model (with validation from monitoring data ) will provide an overall picture of $PM_{10}$ concentrations with the WUA which one site along can not seek to achieve. Having determined and quantified the emissions within this report this modelling exercise is the next part of this air quality assessment for Whakatane.

The results from the inventory show that during the critical (in relation to elevated levels of $PM_{10}$) time of the year, domestic sources are the leading although not dominant producer of $PM_{10}$ emissions (47%) for the WUA. As expected the major sub category in this section is domestic heating. Backyard burning is only a minor contributor which should not be ignored. The prohibition of back yard burning in the urban area as proposed in the draft Proposed Plan Change No.1 Bay of Plenty Regional Air Plan (Environment Bay of Plenty, 2006) would be beneficial in removing particulate emissions from the WUA.

On an annual basis industry is the major contributor to $PM_{10}$ emissions within the WUA (58% of the estimated emissions). This is a result of the scale of the operation and also a function of the level of activity (24 hour, 7 day process). Regular stack testing and opacity monitoring as required by their air discharge consent means there is a good understanding of the emissions from this site. This regular auditing as required by the relevant consent conditions ensures emissions are maintained below the stipulated discharge limits for particulate matter.

Transport sources are only a moderate contributor to the $PM_{10}$ profile. During winter time their contribution is estimated at 6%. Emissions from these sources are controlled primarily at the central government level through import regulations, WOF requirements, and fuel specifications. However roading network development at the design stage (at the district council level) should be addressing factors which impact on the quantity of emissions to the WUA and ultimately the ambient air quality.

Population growth is a strong driver for emission production. For the WUA a decrease of 1.0% (Section 1.3.3) for the resident population is projected, this will have a potentially positive effect (albeit slight) of decreasing emissions.

Meteorology and to a lesser degree topography are also strong drivers when looking at what happens to the emissions once they enter the WUA. These complex interactions have been flagged in Section 1.3 and will be investigated in more detail in the dispersion modelling component of this project.

# Table of Abbreviations

| | |
|---|---|
| **AADT** | Annual average daily total. |
| **AP42** | Document of emission factors published by the USEPA's Emission Factor and Inventory Group. |
| **CO** | Carbon monoxide. |
| **HCV** | Heavy commercial vehicle. |
| **LAMA** | Local Air Management Area. |
| **LCV** | Light commercial vehicle. |
| **MfE** | Ministry for the Environment. |
| **NERMN** | Natural Environment Regional Monitoring Network. |
| **NIWA** | National Institute of Water and Atmospheric Research, NZ. |
| **$NO_x$** | Oxides of nitrogen. |
| **NZTER** | New Zealand Transport Emission Rate (Ministry of Transport model) |
| **PM** | Particulate matter. |
| **$PM_{10}$** | Particulate matter less than 10 microns. |
| **RAMM** | Road Asset Management Model (Land Transport NZ). |
| **$SO_2$** | Sulphur dioxide. |
| **USEPA** | United States Environmental Protection Agency. |
| **VKT** | Vehicle kilometres travelled. |
| **VOC** | Volatile organic compounds |

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