AIR QUALITY MONITORING

Highlights 2001-2002

- In general, Northland has a high standard of natural air quality.
- In March 2000, a particulate matter (PM_{10}) high volume sampler was installed in Robert St, Whangarei. Sample results reveal that the PM_{10} concentration varies considerably on a daily basis, and according to national air quality guidelines are either good or adequate 80% of the time. The results also indicate that at times the PM_{10} concentration is approaching or exceeding recommended guidelines.
- An investigation using radioisotopes has identified that approximately half of the PM_{10} air pollution in the central city area is sourced from motor vehicles with the rest coming from domestic wood fires. It's a different story in Morningside with around 70% of the PM_{10} air pollution coming from domestic wood fires.
- Northland has completed an emission inventory which reveals that industrial sources discharge most of the sulphur dioxide, nitrous oxides and PM_{10} while motor vehicles are responsible for most of the carbon monoxide and Volatile Organic Compounds (VOC's). Residential home heating also makes modest contributions to PM_{10}, CO and VOC's although these latter emissions vary seasonally.
- Measurements of ambient levels of pesticides are being undertaken during the 2002/03 year. Levels of sulphur dioxide have previously been reported in the State of the Environment Report 2002.

Annual Plan Performance Targets

To continue to develop and implement a prioritised State of the Environment monitoring programme based on the Regional Policy Statement and Regional Plans by:

- **Monitoring ambient air quality; including background levels of dust in the Whangarei urban area, ambient levels of pesticides, and sulphur dioxide at Takahiwai.**

Background

Since the introduction of the Resource Management Act (RMA) 1991, the Northland Regional Council has been the primary agency responsible for air quality management in Northland. In accordance with this responsibility, the Northland Regional Council undertakes:

- State of the Environment monitoring to determine ambient (background) air quality.
- Resource consent compliance monitoring.
- Investigation of and response to air quality related incidents.

Northland's climate is dominated by the region's exposure to the prevailing south-westerly winds which, particularly during the winter and spring, quickly disperse air pollutants. This, along with the relatively dispersed population, low vehicle density and sparce heavy industry, means that Northland enjoys a high standard of natural air quality.

The air, like any other natural resource, can be adversely affected by pollutants. Pollutants are substances that, under certain conditions, can harm human, animal or plant life. Polluted air can also interfere with the use and enjoyment of life and property by affecting visibility, causing odour, dust or smoke problems or corroding and disfiguring materials.

Particulate Matter (PM_{10})

The term 'particulate matter' covers a range of small to medium sized particles which exist in solid or aerosol state under normal conditions. There are a number of different types of particulate matter, PM_{10} is the name given to very small, fine suspended particles that have an aerodynamic diameter of 10 microns or less.

PM_{10} particulates are sourced from a variety of different processes. Some are generated from combustion and industrial processes, others from naturally occurring dusts and salt spray. Because of their small size these particulates can be inhaled into the lungs where they can cause a variety of adverse health effects.

In the early 1950s many residents in London were affected by what became known as the "killer fogs". These fogs were responsible for affecting the health of a large number of residents in the central London area, in part because the concentration of fine particulate (or PM_{10}) from local coal burning exceeded safe guidelines.

Concentrations of PM_{10} are now closely monitored in most major cities around the world to ensure that they stay below concentrations that cause health effects.

PM_{10} in Northland

In March 2000 a PM_{10} high volume sampler was installed in Robert Street, Whangarei to monitor daily PM_{10} concentration. Samples are collected and analysed gravimetrically on a weekly basis in accordance with USEPA methodology. Although the sampler has only been operating since March 2000, some useful information has already been obtained.

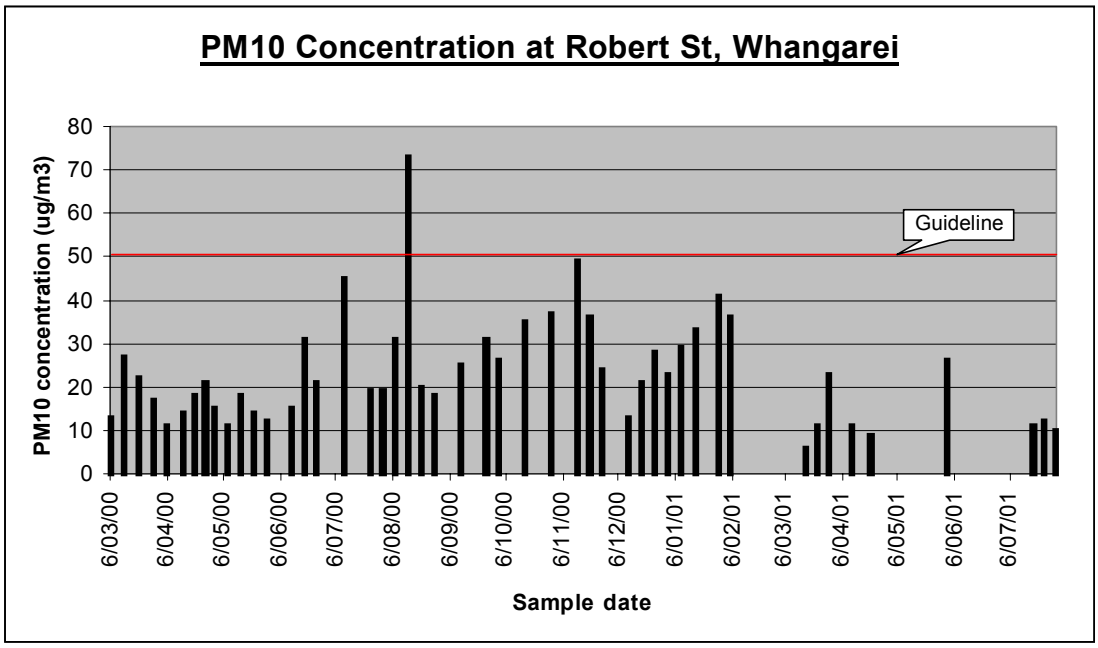

Figure 1.1: PM_{10} concentration measured at Robert Street, Whangarei

The concentration of PM_{10} particulate in air at the Robert St site varied from 5 $\mu g/m^3$, to 73 $\mu g/m^3$ (24hr average), see Appendix 1. These concentrations are the result of the source activity (mostly traffic and domestic home heating), and the influence of meteorological factors, such as wind and rain, and temperature. There is no obvious timing pattern to high vs. lower PM_{10} levels, with regard to day of week, or season. Seventy-two $\mu g/m^3$ was recorded on the 14th of February 2000, which was a Wednesday. It is not expected that there would be significant wood burning occurring at this time of year in Northland, and it may be that this higher level was the result of some local, short-term activity.

On the whole, the levels seem to be equally variable during the working week and on the weekends. Lower levels are recorded in all seasons of the year, and during weekdays as well as weekends. The health-based air quality guideline, proposed by the Ministry for the Environment, recommends the 24-hour averaged level not to be exceeded as 50 µg/m^3.

In addition to the ambient air quality guideline, the Ministry for the Environment also uses air quality categories that are given below:

Category	Percentage of guideline	Colour
Excellent	>5 µg/m^3 (<10%)	
Good	6-16 µg/m^3 (10-33%)	
Acceptable	17-32µg/m^3 (33-66%)	
Alert	33-50µg/m^3 (66-100%)	
Action	>50µg/m^3 (>100%)	

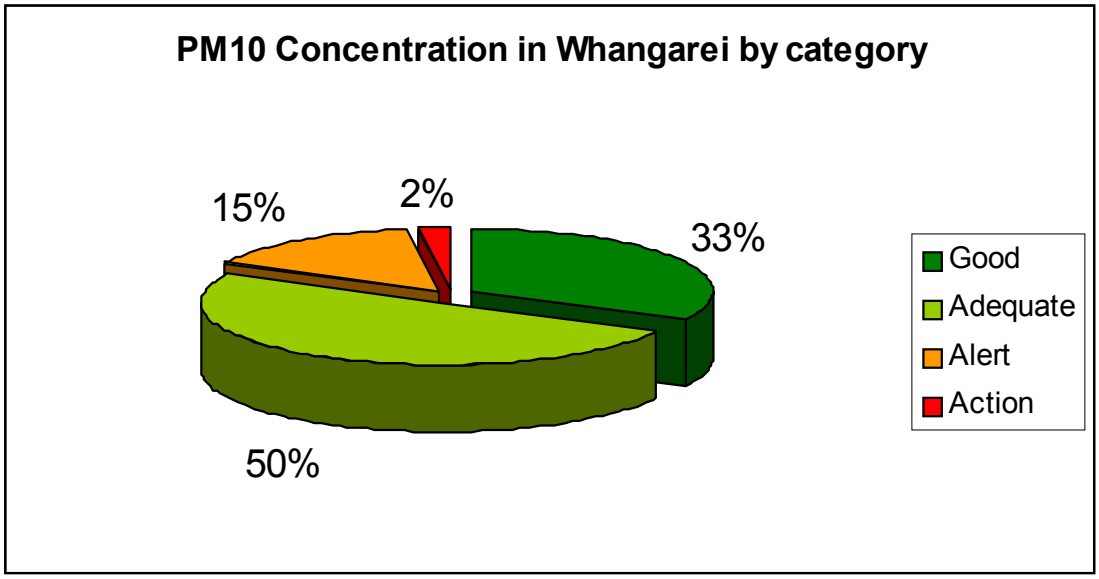

Figure 1.2: Percentage of the time Whangarei PM_{10} concentration was in each category

Figure 1.2 indicates in terms of the air quality categories, the air quality measured is either good or adequate approximately 80% of the time. However, the results also indicate that, at times, the PM_{10} concentration is approaching or even exceeding recommended guidelines. These exceedances are unlikely to manifest themselves as health effects, even for sensitive individuals given that they are relatively infrequent events and that the magnitude of the exceedance is not that great. In addition, the higher PM_{10} concentrations will usually be attained during the early hours of the morning under cool, winter inversion conditions when most residents are resting indoors.

The levels and pattern measured during the period from October 2000 to August 2001 at Robert St are similar to those measured in Auckland. PM_{10} is measured at sites in Penrose, Takapuna, Mt Eden, Khyber Pass, Henderson and Queen Street in Auckland. The location of these sites varies in terms of proximity to roads, and major emission sources, but they consistently measure levels above 33 µg/m^3 (66% of the guideline level of 50 µg/m^3 , 24 hour average) throughout the year, although for the most part, the higher levels (>50 µg/m 3) tend to occur during the colder months. Table 1.1 provides a comparison of the number of days on which the Auckland sites have been in the alert category (equalled or exceeded 66% of the 50 µg/m^3 guideline), with those measured at Robert St.

Table 1.1: Comparison of measurements in the ALERT Category

Site	Number of Measurements in ALERT Category	Maximum Concentration ($\mu g/m^3$)
Robert St	**5**	**73**
Penrose	6	57.4
Takapuna	0	30.5
Mt Eden	5	43.3
Khyber Pass	10	94.6
Henderson	2	37.7
Queen St	7	84.1

The levels of PM_{10} at Robert Street are similar to those at the more polluted sites in Auckland (Penrose, Khyber Pass and Queen St). While these concentrations are not as alarming as those measured in centres like Christchurch and Nelson, where the guideline is exceeded on more than 30 days a year, and maximum concentrations of 183 $\mu g/m^3$ and 165 $\mu g/m^3$, respectively, have been recorded; it is cause for concern, and requires on-going investigation.

Where does our PM_{10} come from?

Until recently, it was assumed that the most significant sources of PM_{10} in the Whangarei urban airshed were sourced from domestic home heating and transport – however there was no quantifiable data to verify this assumption.

Given the elevated levels of some of the PM_{10} results and the possibility that these concentrations may increase over time, the Northland Regional Council decided to determine the source of the PM_{10} within the Whangarei urban airshed.

Source Determination of Particulates in Air in Whangarei, Using ^{14}C

The radioactive isotope ^{14}C occurs naturally in the Earth's atmosphere as a result of the action of cosmic radiation on molecules of carbon dioxide. Since the advent of nuclear bombs, nuclear test explosions have also contributed substantially to atmospheric ^{14}C levels, although this contribution is now declining as atmospheric carbon dioxide enters various exchange processes, particularly with oceanic carbon dioxide and bicarbonate.

Plants take up ^{14}C by photosynthesis in the ratio to total carbon, which exists in the atmosphere during their growth. Animals then reflect the same ratio, because the entire food chain depends on plant photosynthesis. The half-life of ^{14}C is 5770 years. As a result, the ^{14}C content of biological materials gradually decreases over time after death, and this is the basis for radiocarbon dating.

These considerations suggest that identification of the origin of carbon in particulate material will indicate the sources of the components of PM_{10} in Whangarei of most concern from a pollution and health perspective, and also those which are potentially amenable to emission controls.

This project used the natural occurrence of ^{14}C in ambient air to determine the relative contribution to ambient particulate material in air from domestic heating sources and vehicular traffic at two sites in Whangarei. The first site at Robert Street is situated near the centre of Whangarei and is representative of emissions in the central business district (CBD). The second site was situated in Orchard place, Morningside, and was selected as a site which is representative of emissions in suburban Whangarei.

The ^{14}C result for Robert St indicates that about 50% of the carbonaceous particulate material in air at the sampling site originated from domestic wood burning. For the suburban area of Morningside, the ^{14}C result indicates that around 70% of the carbonaceous particulate material at the sampling site originated from burning wood for home heating.

The Robert St site is in the business area of Whangarei, and therefore has a higher vehicular source contribution, but still has domestic sources contributing to the air shed. The Morningside site by comparison, has a much lower vehicular source contribution due to less traffic in the area, and a high domestic heating contribution.

The 50% contribution from domestic heating emissions is higher than would be expected on the basis of emissions in the immediate vicinity of the sampling site at Robert St. However, the Robert St site is located within the CBD at the lowest point of the airshed, largely surrounded by residential areas on higher ground. Under relatively still winter evening conditions, when the highest PM_{10} concentrations are likely, the CBD is likely to receive down-slope katabatic flows that will transport emissions from the residential areas. Accordingly, the ^{14}C source apportionment result is consistent with what would be expected when geographical and meteorological factors are taken into account.

Health effects of particulate materials (and other air pollutants) are most strongly associated with the concentrations in air, and the periods for which those concentrations persist, or in other words, the levels of exposure. Because the source contribution to estimates obtained from techniques such as ^{14}C analysis address concentrations in air and levels of exposure, rather than proportions of emission, they can be considered to correspond more accurately to the potential contribution from the various sources to health risks.

Deposited Particulate Monitoring Programme

On-going deposited particulate (dust) investigations are carried out at two monitoring sites. One site is located at Robert Street, Whangarei and the other site at Whangarei Airport.

Monitoring is carried out using a deposition gauge, which is essentially an elevated 'bucket' with a known surface area. The gauges are installed and a chemical solution added, after which the gauges are left for a 30-day period (± 2 days) during which time they collect particulate material. The gauges are collected and taken to the laboratory for analysis. The final result is a composite of both soluble and insoluble material.

Figures 1.3 and 1.4 illustrate the deposition gauge results from the Whangarei City (Robert Street) and Onerahi Airport sites respectively.

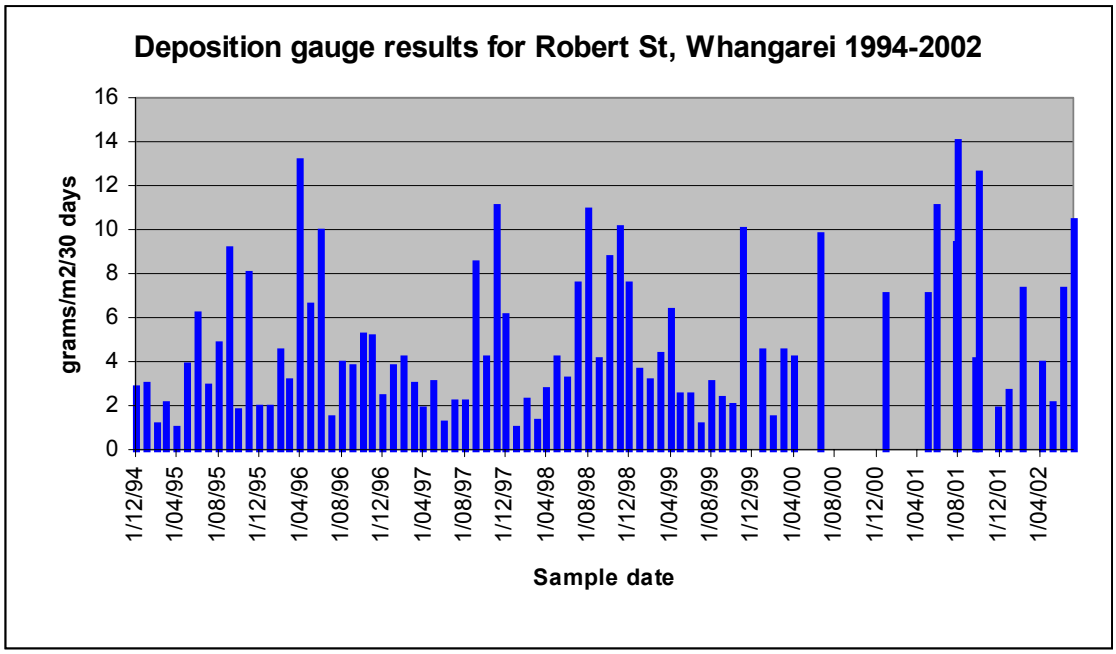

Figure 1.3: Deposition Gauge Results for Whangarei City (Robert Street)

Results

Figures 1.3 and 1.4 show that typical deposited particulate values in Whangarei range between 1 and 12 grams per square metre per 30 days depending upon the time of the year, weather, location, wind speed/direction etc. In general, higher results prevail during the summer and lower results during the winter. This is due to the dust suppression action of the wetter winter weather. Sources of deposited particulate include; bare earth, pollen and grass seed, and industrial processes such as fertiliser silos and abrasive blasting.

While there is no specific limit set for deposited particulates, the Ministry of Health previously specified a 'nuisance' guideline value of an average of 4 grams per square metre per 30 days. Values above this have been known to result in dust nuisance complaints, but they would have to be significantly higher before health effects are observed. If values were found to be significantly higher than the typical normal range of between 1 and 12 grams, then the Council would identify the source(s) and take the necessary action.

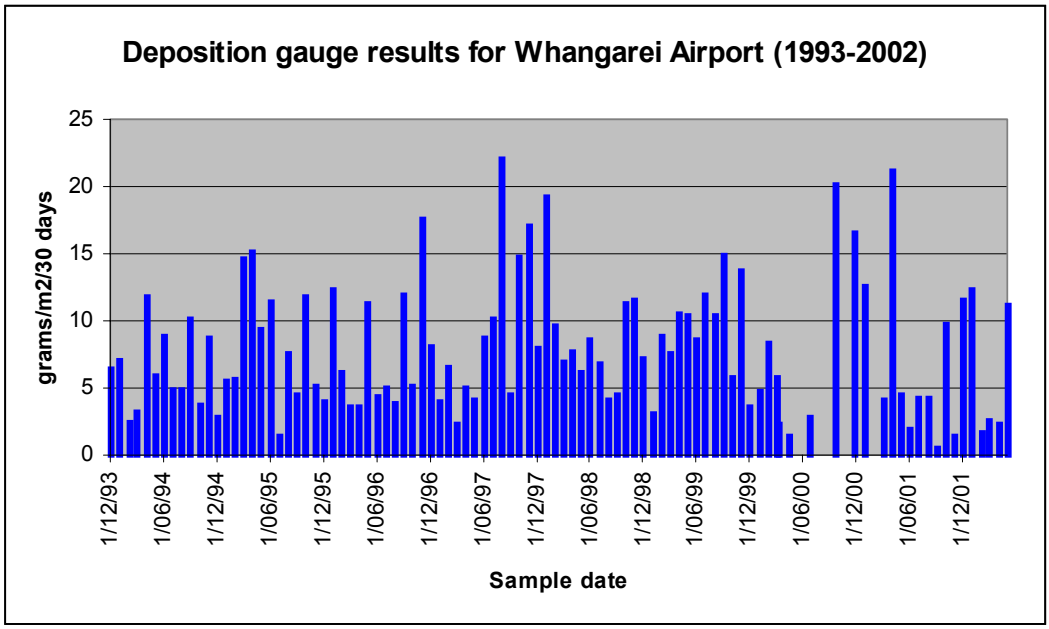

Figure 1.4: Deposition Gauge Results for the Whangarei Airport (Onerahi)

The high result measured at Whangarei airport in August 1997 resulted from foreign material entering the gauge. It is likely that the gauge was tampered with during this period.

In general the deposition gauge results suggest that dust nuisance is not a serious issue in Whangarei. While earthworks, excavation and other dust producing activities generate localised dust nuisance problems, these issues are not widespread and are generally dealt with quickly and efficiently through our hotline service.

Emission Inventory

Air emission inventories provide an estimate of the quantity of air pollutants released from different sources within a defined area. Emission inventories can help in the identification of pressures on the environment and in the development of possible options to manage them.

This inventory is intended to provide a preliminary assessment of the air emissions in the Northland Region area using available data sources. The primary purpose of this study was to identify what emission sources and contaminants are likely to be the most significant in the Northland region and consequently where future air quality resources may best be focused by the council.

A secondary objective of the study was the development of transparent methodologies for calculating the region's air pollutant emission rates and incorporating them into a computerised database that may be rapidly updated or modified.

The inventory considers emissions from large industrial point sources, motor vehicles, domestic (e.g. residential heating) and agricultural sources in the region.

Due to resource constraints, it was decided to limit the scope of the emissions inventory to a selection of key pollutants.

Five 'criteria pollutants' are included in the inventory:

- Non-methane volatile organic compounds (NMVOC)
- Nitrogen oxides (NO_X)
- Sulphur dioxide (SO_2)
- Carbon monoxide (CO)
- Suspended particulate matter less than 10 microns in diameter (PM_{10})

Three greenhouse gases are also quantified in the inventory:

- Carbon dioxide (CO_2)
- Nitrous oxide (N_2O)
- Methane (CH_4)

Criteria pollutants are mainly associated with local and regional scale impacts such as community health impacts and aesthetic effects. The climate impacts associated with greenhouse gases are on a global scale.

Major findings for Criteria Air Pollutants

- Within a typical year an estimated 1,411 tonnes of PM_{10}, 22,083 tonnes of CO, 6,980 tonnes of NO_X, 5,003 tonnes of SO_X, and 4,098 tonnes of VOC are predicted to be emitted from anthropogenic sources within the region.

- Industrial sources are predicted to be the predominant contributors of PM_{10}, NO_X, and SO_2 emissions within the region. Emissions from industrial sources are estimated to account for the 52% of PM_{10}, 63% of NO_X, and 97% of SO_2 annually emitted from inventoried sources. The petroleum processing sector alone is predicted to account for 88% of annual SO_2 emissions in the region.

- Motor vehicle sources are the predominant contributors of CO, and VOC emissions within the region. The predictions indicate that approximately 69% of CO and 60% of VOC will be released by traffic in the region. In addition motor vehicles are estimated to account for 37% of NO_X released from inventoried sources.

- Residential sources, particularly wood burning for home heating purposes, are estimated to make modest contributions to annual PM_{10} CO and VOC emission in the region, approximately 32%, 21% and 26% respectively of total emissions. However, during winter the relative contribution from these sources is significantly higher. For example, approximately 55% of PM_{10}, 40% of CO and 47% of VOC daily emission is associated with residential activities. Residential sources show the only significant variation in seasonal emission rates. Most other sources are relatively constant throughout the year.

- Emissions from agricultural sources make a comparatively small contribution to the total quantities of criteria pollutants emitted during a typical year.

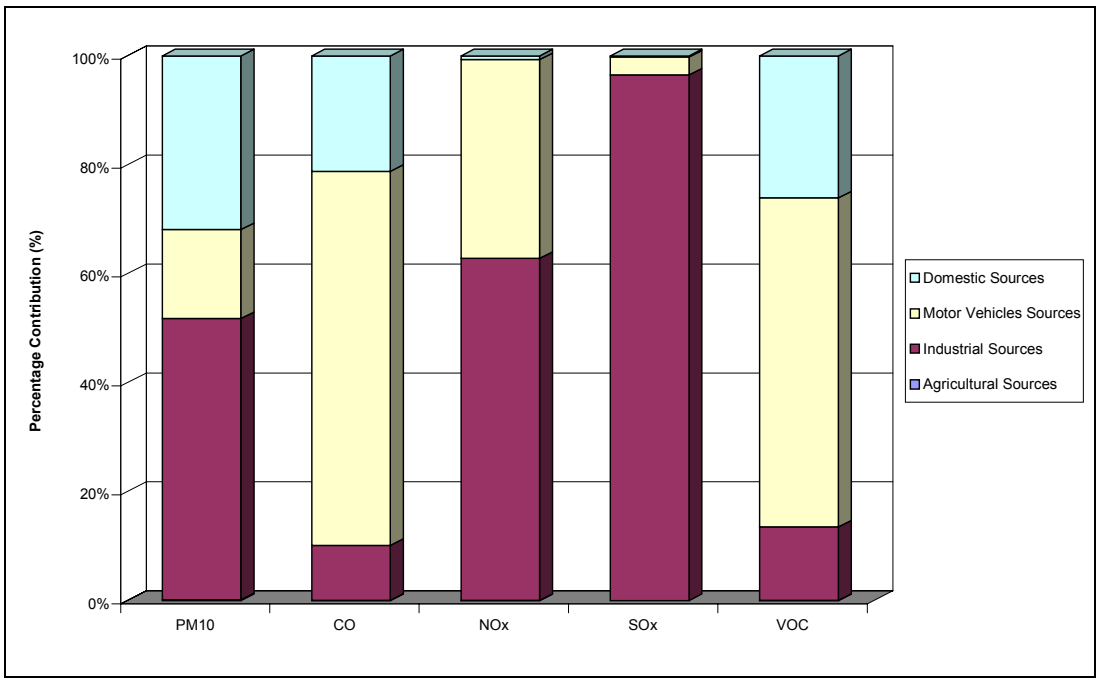

Figure 1.5: Annual anthropogenic emission rates with respect to source

Greenhouse Gas Emissions

- Approximately 2,321,418 tonnes of (non-biogenic) carbon dioxide, 79,534 tonnes of methane, and 2,058 tonnes of nitrous oxide are emitted each year from anthropogenic sources in the Northland region**.**

- Industrial sources are predicted to emit an estimated 79% of the total quantity of carbon dioxide credited towards greenhouse emissions.

- Livestock and agricultural soils are the predominant sources of methane and nitrous oxide emitted in the region. Agricultural sources accounting for 97% of annual methane emissions and 98% of annual nitrous oxide emissions.

- The relative climate change impact of each pollutant can be estimated using a Global Warming Potential (GWP) index. The GWP index varies with pollutant and the reference time frame within which impacts are considered. The chart below shows the relative global warming potential emissions from each source category has using a 20 year, 100 year and 500 year reference time frame index. The variation in accumulative GWP is due to changes in the GWP index of methane and nitrous oxide with each time reference step. The GWP of carbon dioxide is always equal to one.

- The results show that the proportional contribution of agricultural sources to the accumulative region GWP decreases from 67% in a 20-year time frame, to 49% in a 100-year time frame, to 27% in a 500-year time. Conversely the contribution from industrial sources to total GWP increases from 25% in a 20-year time frame, 40% in a 100-year time frame, to 58% in a 500-year time.

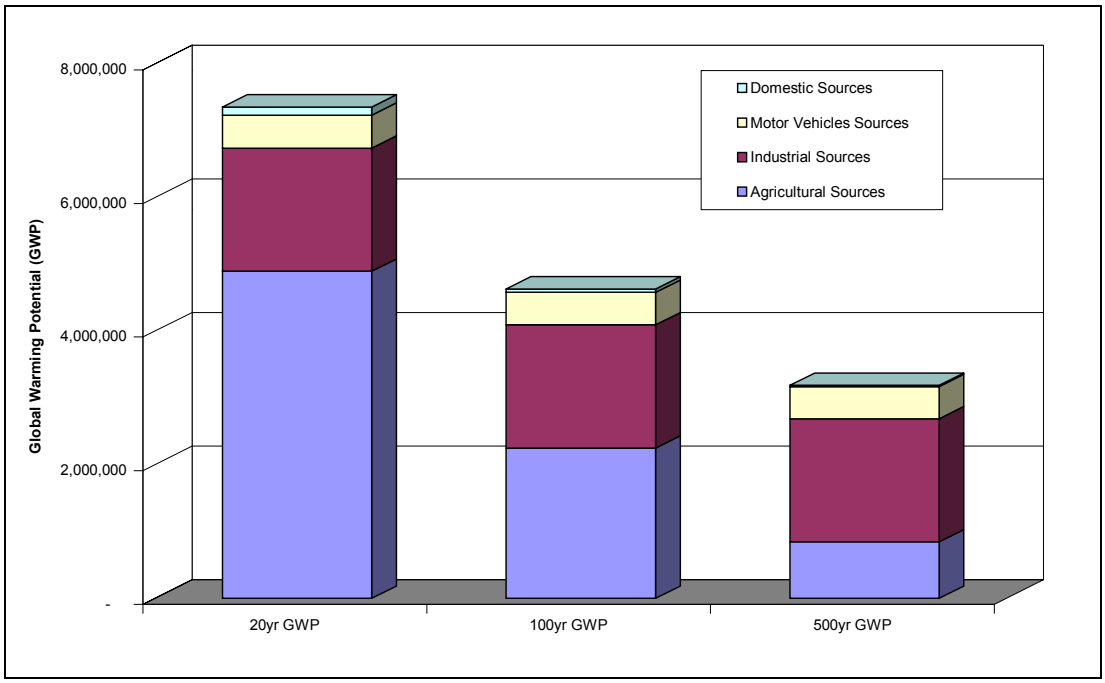

Figure 1.6: Total Global Warming Potential for all inventories sources

Environmental Reporting Programme

To determine the state of our air and the adverse environmental effects of air pollution, we must monitor air quality and track changes in it over time.

It is impossible to monitor all the contaminants in the air. So we must select key or priority pollutants that provide a representative picture of air quality. These pollutants are commonly referred to as "indicators". The Ministry for the Environment has developed a set of key indicators which are provide basic information on the state of air quality.

The key indicators for air quality include:

Indicator	Description	Why is it important
PM_{10}	Particulate matter having an aerodynamic diameter of 10 μm or less	Particles cause adverse effects on human health and degraded visibility such as regional haze
CO	Carbon monoxide	CO causes adverse effects on human health
NO_2	Nitrogen dioxide	NO_2 causes adverse effects on human health and causes the brown colouration of hazes and smogs
SO_2	Sulphur dioxide	SO_2 causes adverse effects on human health and on vegetation
O_3	Ozone	Ground level ozone formed by reactions of other pollutants in the air can adversely affect human health and vegetation

By collating air quality monitoring data and using air indicators, Northland Regional Council aims to collate sufficient, good quality monitoring data to;

- track changes in ambient air pollution concentrations over time
- determine the potential health and environmental effects of air quality in Northland

- assist with the development of regional policies to improve air quality where it is degraded or degrading, and to maintain air quality where it is good
- compare our regional air quality with different regions in New Zealand and evaluate the effectiveness of our regional polices

Air Schedule for Partnership

During the 2001/02 financial year the Northland Regional Council assessed the needs and options for air quality monitoring in conjunction with the Ministry for the Environment. This assessment culminated in the creation of an air partnership agreement.

This agreement sets out the process for the collection, sharing and use of air quality data for the Air Indicators between Northland Regional Council and the Ministry for the Environment.

The Ministry for the Environment have agreed to provide the following:

- Guidance on the collection and use of air quality monitoring data
- Web-based sources of air quality information
- National and regional reporting including issues-based reports
- Regional data comparisons with other regions and other countries
- Collect monitoring data from the GEMS sites in Auckland and Christchurch
- Assist with basic training and capacity building to enable regional councils to carry out monitoring and to manage information
- Tools for calculating summary statistics
- Audits of monitoring programmes and data in regional databases to ensure quality and consistency
- Collaborate with the Council to work out how to fill any gaps in the monitoring

In return, the Northland Regional Council has agreed to:

- Monitor air quality using consistent and agreed methods
- Provide quality assured monitoring data for each indicator as specified in the section entitled 'Regional Contribution' of this agreement
- Provide site and emissions source information
- Carry out appropriate meteorological monitoring
- Input into Air Indicators web pages

In practice, this means that the following sites are to be adopted to monitor key environmental indicators.

Pollutant	Number of permanent, survey and investigation sites	Are we doing it?
Particles (PM10)	Permanent Whangarei (1 urban/residential)	Yes
	Investigation Kaitaia (1 industrial)	No
Carbon Monoxide (CO)	Investigation Whangarei (1 urban)	Yes
	Whangarei (1 residential)	No
Sulphur dioxide (SO_2)	Permanent 1 rural (soon to be relocated to Whangarei - urban)	Yes
	Survey *Marsden Point (3 industrial)*	Yes

Gaps in Current Monitoring

Northland Regional Council's current air quality monitoring largely fulfils the desired national monitoring for stage 1 indicators, however, there are several gaps. These include:

- PM_{10} monitoring at a survey industrial site for at least one year.
- CO monitoring at a survey site for at least one year. This is important to gather meaningful data that can be used to assess CO concentrations in the Northland region. Regular surveys will help to verify predicted reductions in CO concentrations as vehicle emissions policies are implemented.
- SO_2 at a permanent residential site. This is important to understand concentrations of SO_2 in residential areas for assessing the effect of SO_2 on people's health.

Staff at the Ministry and Northland Regional Council have discussed options for filling in the regional monitoring gaps. NRC will investigate the feasibility and justification of purchasing an additional PM_{10} sampler in 2003 for survey monitoring at an industrial site. The permanent rural SO_2 monitoring equipment will be relocated to Whangarei to fill the residential monitoring gap. NRC will also investigate the feasibility and justification of conducting survey monitoring of CO for one year at a roadside location.

The NRC will consult with the Ministry over the findings and recommendations of these investigations before making any decisions.

Information Needs and Monitoring Options

Information needs and monitoring options for the region relate to the following air quality issues:

- Nuisance effects
- Visibility
- Ambient air quality and health effects

Nuisance effects, such as smoke, odour and dust are monitored and managed through the Council's Environmental Incident system and resource consent compliance monitoring.

Visibility is a primary and highly obvious indicator of general air quality which is relatively easily understood by most people. The Ministry for the Environment has recently released a "good practice guide for the monitoring and management of visibility in New Zealand". Northland Regional Council is currently developing a visibility monitoring program for Northland that is based upon the recommendations contained in the good practice guide. Initially the monitoring programme will focus on monitoring visibility in the Whangarei area but is scheduled to expand to other parts of the region including a number of regional tourist destinations.