October 2015

ALLIANCE LORNEVILLE

Background Ambient Air Quality

Submitted to:
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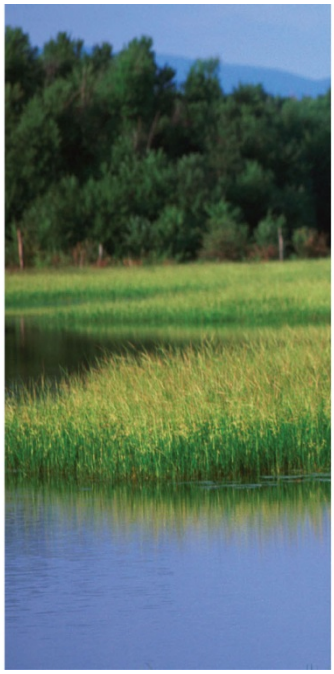


Report Number: 1378104044-012-R-Rev4-040-Baseline

REPORT

Golder Associates

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1.0 INTRODUCTION

1.1 Background

This report presents an assessment of the existing background air quality within the vicinity of the Alliance Group Ltd (Alliance) meat processing and export plant that is situated at Lorneville, near Invercargill. The site is located approximately 3 km north of the Invercargill City residential area and located off the Lorneville-Wallacetown highway. The processing site is one of the largest ovine meat processing sites in the world and has operated at this location since 1960. The location of the site is shown in Figure 1.

Alliance holds an existing resource consent (Environment Southland Consent No. 95077) that authorises air discharges from the site, which expires on 7 August 2016. The preparation of an assessment of effects due to discharges to air from the Alliance Lorneville site is planned. This assessment is pending and when completed, will assist the processing of an application to the Southland Regional Council for renewal of the existing air discharge consent.

To support the pending assessment of air discharges, baseline studies of existing odour exposure levels (including frequency, intensity, duration, and offensiveness) and background air quality are required. The former assessment of baseline odour exposure levels and effects is reported by Golder (2013a).

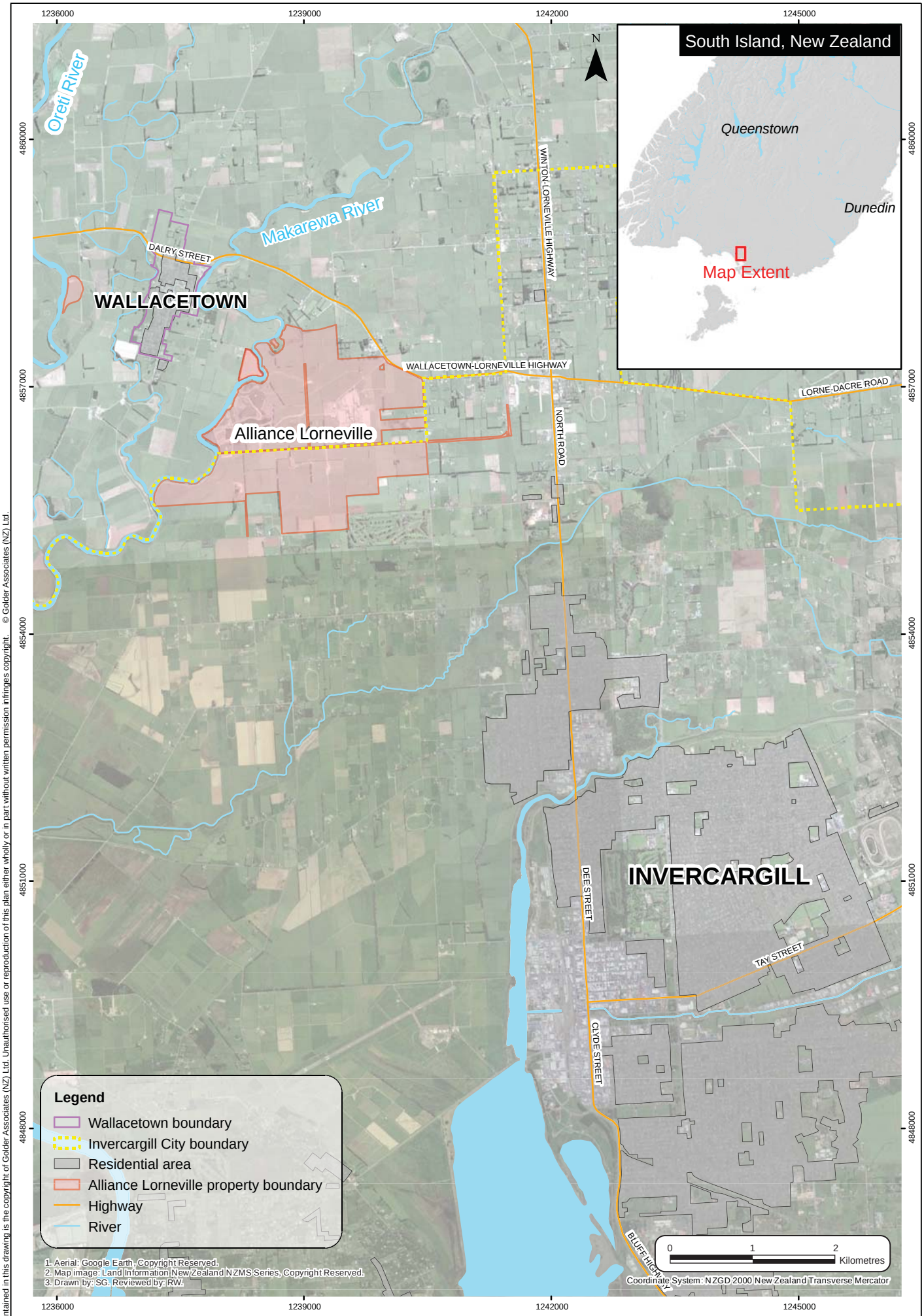
The objective of this report[1] is to provide an assessment of the existing background air quality within the vicinity of the Alliance site at Lorneville. A preliminary assessment of these levels against relevant ambient air quality criteria is also provided.

The main source of air contaminants discharged to air at the Alliance Lorneville site is the lignite-fired steam boiler plant. A modelling based assessment of air contaminants discharged from the Alliance boiler plant prepared by Golder (2014) has utilised the results contained in this report so that a cumulative assessment of air quality effects can be undertaken.

Given that lignite is proposed for the continued firing of the boiler plant, the key contaminants discharged to atmosphere from site would include respirable particulate matter with a diameter of less than 10 micrometres (PM_{10}), sulphur dioxide (SO_2) and nitrogen dioxide (NO_2). Minor and trace contaminant emissions would include various metals and, dioxins and furans from the combustion of lignite.

There are two other industrial sites discharging contaminants to air from coal fired boilers within 5 km of the Alliance Lorneville plant: Prime Range Meats (PRM) and the Alliance Makarewa plant. PRM is 3 km to the south southeast of Alliance and operates a 4.2 MW coal fired boiler. The discharges from the PRM boiler are unlikely to result in significant concentrations more than 1 km from the PRM site. This was taken into account when specifying a location for monitoring that was undertaken to support this study. The Alliance Makarewa plant is located 5 km to the north of the Alliance Lorneville plant. The Alliance Makarewa plant boilers were lignite fired, but the coal-fired boilers were decommissioned in November 2013 and replaced with a 950 kW diesel boiler.

[1] This report is subject to the limitations noted in Section 11 of this report.



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1.2 Study Objectives and Scope

The objective of this project is to quantify typical background (non-plant sourced) concentrations of air pollutants for the area surrounding the Alliance Lorneville plant. This information will be used to assist the pending assessment of cumulative effects from the site boiler plant contaminant emissions. To achieve this objective, the scope of this investigation included the assessment of background air contaminant concentrations for the following pollutants:

- PM_{10}
- NO_2
- SO_2
- Metals
- Dioxins and Furans

1.3 Study Approach

A review of local and nationally available air quality data sources was completed. These included monitoring programmes undertaken by the Southland Regional Council, other regulatory authorities and other studies of ambient air quality.

Due to the proximity to the Invercargill City airshed (listed as polluted by the Ministry for the Environment) and the type of boiler plant used at the Alliance Lorneville site, confirming actual background concentrations for ambient PM_{10} was considered of high importance. This contaminant and its finer $PM_{2.5}$ fraction are likely to be the contaminants of most concern.

Background PM_{10} levels can be estimated from existing information. The limited monitoring data from the immediate local area was considered useful for this purpose. This data was used to confirm the extent of city influences on Lorneville air quality during winter and to establish what sources actually drive normal background levels at the site. To assist with the quantification of typical background concentrations of air pollutants in the area surrounding the Alliance Lorneville plant two programmes of ambient air quality monitoring have been undertaken in 2013 and 2014:

- 2013 Monitoring: PM_{10} ambient air quality monitoring undertaken between 20 May 2013 and 3 September 2013 using a HiVol sampler located at the Alliance Lorneville wastewater treatment plant site, 1.5 kilometres to the west of the boiler plant.
- 2014 Monitoring: PM_{10} and SO_2 ambient air quality monitoring undertaken from 31 January to 22 May 2014 using continuous analysers located about 650 m east of the boiler stacks.

The 2013 monitoring was designed to establish whether there was any significant urban contribution to local PM_{10} levels within the vicinity of Alliance, particularly during winter months when home fires produce significant emissions. It was important to establish this for winter months, as Alliance plans to undertake more material processing during this period in the future. A monitoring site was chosen near the wastewater treatment plant, as this location was expected to have minimal influence from the Alliance coal fired boilers.

Although the main purpose of the 2014 monitoring was to confirm the ambient impacts from the boilers, a combined analysis of measured contaminants concentrations and wind direction also allowed an examination of the background PM_{10}. The combined analysis is described in this report.

The 2014 monitoring not only provided direct information on actual ambient impacts from the boiler stacks, but also it provided information on background PM_{10} and SO_2 levels near to the Alliance site during the peak summer period when boiler emissions to air are at their highest levels and when background air quality is

most degraded by background ambient particles (that includes particulates from long range transport of from sea salt spray, Australian forest fires, windblown dust etc.) in addition to local sources.

1.4 Structure of Report

Section 2.0 summaries air quality standards and guidelines for the pollutants relevant to this project. Sections 3.0, 4.0,5.0, 6.0 and 7.0 respectively present a review of the ambient air quality data used to estimate background concentrations of PM_{10}, NO_2, SO_2, metals, and dioxins and furans. Section 8.0 provides a summary of the background concentrations which will be used in the assessment of cumulative effects. Section 9.0 identifies the gaps in the data available and makes recommendations needed to fill these data gaps.

2.0 AIR QUALITY STANDARDS AND GUIDELINES

2.1 Introduction

Golder has reviewed the Mitchell Partnerships (MP) preliminary statutory assessment (MP 2013). From this the three main regulations that have relevance to this project in terms of defining the relevant air quality assessment criteria are:

- The Resource Management (National Environmental Standards for Air Quality (NES), (MfE, 2004)
- The Ambient Air Quality Guidelines (AAQG) (MfE/MoH, 2002)
- The Regional Ambient Air Quality Targets (RAAQT) for Southland (Environment Southland, 1999)

While the AAQGs are not mandatory, the NES are, and their requirements over-ride those of any regional plan except where such a plan imposes stricter requirements. The requirements of the NES, AAQG and the RAAQT are discussed as follows.

There are a number of criteria available for assessing the impact of discharges to air. The Ministry for the Environment (MfE, 2008) provides recommendations as to which assessment criteria take precedence. Where there are national standards or guidelines, these are given highest priority. After these, any World Health Organisation (WHO) guidelines and California reference levels (OEHAA, 2008) should be used. Where no guideline exists in the above sources, MfE (2008) recommends that the guidelines from the Texas Commission of Environment Quality (TCEQ, 2009) be used.

Sections 2.2 to 2.5 briefly describe the documents which define the ambient air quality standards and guidelines relevant to this project. Section 2.6 details the specific values of the ambient air quality standards and guidelines relevant to this project

2.2 National Environmental Standards

The NES for Air Quality were published in 2004 and amended in April 2011 (with amendments taking effect from 1 June 2011). The regulations are mandatory and include standards related to the ambient concentrations of SO_2, NO_2, CO, PM_{10}, and ozone (O_3). They include concentration limits, maximum numbers of allowable exceedences, and monitoring methods. The NES time-averaging periods are 1-hour for SO_2, NO_2 and O_3, 8-hour for CO, and 24-hour for PM_{10}.

Regulation 14 of the NES sets out the locations that ambient air quality standards apply, as follows:

"14 Application of standards

(1) The ambient air quality standard for a contaminant applies at any place –

(a) that is in an airshed; and

(b) that is in the open air; and

(c) where people are likely to be exposed to the contaminant.

(2) However, if the discharge of a contaminant is permitted by a resource consent, the ambient air quality standard for the contaminant does not apply to area that the resource consent applies to."

"Airsheds" include parts of the region that are specifically gazetted as an airshed where exceedances of the standard/s are known to or are likely to occur. The remaining areas of the region that are not gazetted are also considered an airshed. The gazetted airsheds are subject to specific monitoring and management measures. This means that the standards apply in all areas of New Zealand, in the open air, wherever people may be exposed over the relevant time averaging period. The main exception is that if the discharge is authorised by a resource consent, then the standards do not apply on the site to which that consent applies. Therefore, the key areas for this assessment in terms of NES compliance are the residential and amenity areas around the Alliance Lorneville site. The effect of Alliance's discharges on the Invercargill airshed will need to be considered.

2.3 National Ambient Air Quality Guidelines

The AAQGs applicable to this assessment have very similar limits to the NES, but also include guidelines additional to those in the NES, particularly for 24-hour NO_2 (100 $\mu g/m^3$) and an annual PM_{10} guideline of 20 $\mu g/m^3$. Compliance with the AAQGs is similar in intent to that of NES. However, AAQGs are not linked to specific airsheds, or regulations which could require a regulatory authority to decline a consent application if there is non-compliance.

2.4 The Regional Air Quality Plan for Southland

Policy 4.3.1 of the Regional Air Quality Plan for Southland (Environment Southland (ES) 1999) defines a number of ambient air quality guidelines. The plan notes that these guidelines will be used to promote or maintain good quality ambient air for the Region. The ambient air quality guidelines values adopted by Environment Southland are higher than those given in either the NES or the AAQGs for the respective air contaminants. The Regional Air Quality Plan for Southland is the subject of a discussion paper (ES 2013). In this discussion paper the council note that a plan review is required to address the significant environmental issues in regard to air quality in the region since the document was adopted in 1999, and to meet more recent legal requirements. Therefore we consider it is more appropriate to use the respective NES or AAQG values rather than the ES Air Plan. MP (2013) has not identified any specific criteria by ES that need to be considered further.

2.5 Other Guidelines

The Californian Office of Environmental Health Hazard Assessment (OEHHA) provides a list of a number of chemicals with acute, 8-hour and chronic reference exposure levels (REL). Acute REL are based on a 1-hour average and chronic REL are based on an annual average exposure. These are the limits at which studies have shown adverse health effects in humans and a range of laboratory animals.

The Texas Commission on Environmental Quality (TCEC) has issued effects screening levels (ESLs) to evaluate the potential for effects as a result of exposure for a comprehensive list of contaminants. The ESLs are based on data concerning the potential for adverse health and welfare effects, along with corrosive and odour effects. If the ambient concentrations exceed the ESLs, it does not necessarily indicate that adverse effects to health or welfare will occur, but that a review of the contaminant in more depth is required. Ambient concentrations below the ESLs are not expected to cause any adverse health or welfare effects. Short-term ESLs are based on a 1-hour averaging period, whereas the long-term ESLs are based on an annual averaging period.

2.6 Relevant Air Quality Standard and Guideline Values

Table 1details the specific values of the ambient air quality standards and guidelines relevant to this project.

Table 1: Air quality assessment standards and guidelines.

Contaminant	Guideline/standard (µg/m³)	Averaging period	Allowable exceedances per year	Source
SO_2	350	1-hour	9	NES (MfE 2004)
	570	1-hour	0	NES
	120	24-hour	0	AAQG MfE 2002
NO_2	200	1-hour	9	NES
	100	24-hour	0	AAQG
PM_{10}	50	24-hour	1	NES
	20	Annual	0	AAQG
Lead	0.2	3-month moving average, calculated monthly	N/A	AAQG
Arsenic	0.0055	Annual	N/A	AAQG
Cadmium	0.02	Annual	N/A	(OEHHA 2008)
Chromium VI	0.0011	Annual	N/A	AAQG
Chromium metal and Chromium III	0.11	Annual	N/A	AAQG
Mercury	0.33	Annual	NA	AAQG
Dioxin and Furans	Tolerable daily intake 1 pg TEQ/kg body weight/day*.	Annual	N/A	MfE (2001)

*Acceptable incremental risk of increased cancer rates in the population of <1 in 1,000,000.

3.0 RESPIRABLE PARTICULATE

3.1 Introduction

This section estimates typical background (non-plant sourced) PM_{10} concentrations of air pollutants for the area surrounding the Alliance Lorneville plant. Three sources of information are considered:

- Existing relevant ambient air quality data (Section 3.2).
- A site specific PM_{10} monitoring programme carried out in 2013 (Section 3.3).
- A site specific PM_{10} monitoring programme carried out in 2014 (Section 3.4).

Although the methods of monitoring ambient PM_{10} levels were different in 2013 and in 2014 (see Sections 3.3.1 and 3.4.1), both are certified methods under the National Environmental Standards and Golder considers that any systematic discrepancy between the results of these two methods would be sufficiently minor to enable the data sets to be compared.

3.2 Review of Existing Data

From April 2010 to January 2011 ES monitored PM_{10} in Invercargill and Wallacetown using high-volume samplers. Invercargill is located approximately 3 km to the south of the plant and Wallacetown approximately 2 km to the northwest. The location of ES's monitoring site in Invercargill is Miller Street, approximately 9 km to the south east of the Alliance Lorneville plant. The details of the monitoring programmes can be found in the Environment Southland Air Quality Annual Monitoring Summary Winter 2010 (ES, 2010). Figure 2 displays the data collected at these two locations. It is important to note that these data were collected in urban areas where people heat their houses with solid fuel burners during winter. This means that while the data was collected in close proximity to the Alliance Lorneville plant the concentrations at these locations are likely to be considerably higher than those experienced in the area immediately around the plant.

Figure 2 shows that during the cooler months of the 2010 air quality monitoring programme (April to September) concentrations of PM_{10} tend to be higher than in the warmer months (October to February). During the cooler months, concentrations in Invercargill tend to be higher than in Wallacetown. Figure 2 shows that during the winter of 2010 Invercargill experienced a number of exceedences of the NES for PM_{10} (50 µg/m³, 24-hour average), while Wallacetown had none. Figure 2 shows that during the warmer months of the 2010 air quality monitoring programme, measurements of 24-hour average PM_{10} concentrations in Invercargill and Wallacetown were similar and generally ranged between 5 and 15 µg/m³.

The MfE provides some guidance on estimating background PM_{10} concentrations in the Good Practice Guide to Assessing Discharges to Air from Industry (MfE 2008). MfE (2008) notes that in rural areas the typical maximum 24-hour average PM_{10} concentration that occurs when there are no obvious sources upwind is expected to be 15 µg/m³.

3.3 Site-Specific Monitoring - 2013

3.3.1 Monitoring method

There are a number of methods available to monitor PM_{10}. In Alliance Lorneville's 2013 monitoring programme, PM_{10} was monitored with a method aligning with the Australian/New Zealand Standard ANZS 3580.9.6-1990 Particulate matter – PM_{10} – high volume sampler with size-selective inlet. In this method, ambient air is drawn at a known and constant flow rate (between 1 and 1.6 m^3 per minute) through a pre-weighed filter and the PM_{10} collected on that filter. The air is drawn through the filter for a period of 24 hours starting at midnight of the day being sampled. The sampling stops at 23:59 of that day. During the 24-hour period a total volume of approximately 1550 m^3 of air is drawn through the filter. At the end of the sampling period the filter is collected and the accumulated PM_{10} is weighed. The concentration of the PM_{10} is calculated by dividing the total weight of the particulate by the volume of air drawn through the filter. Figure 3 shows the high volume sampler installed at the Lorneville Alliance site.

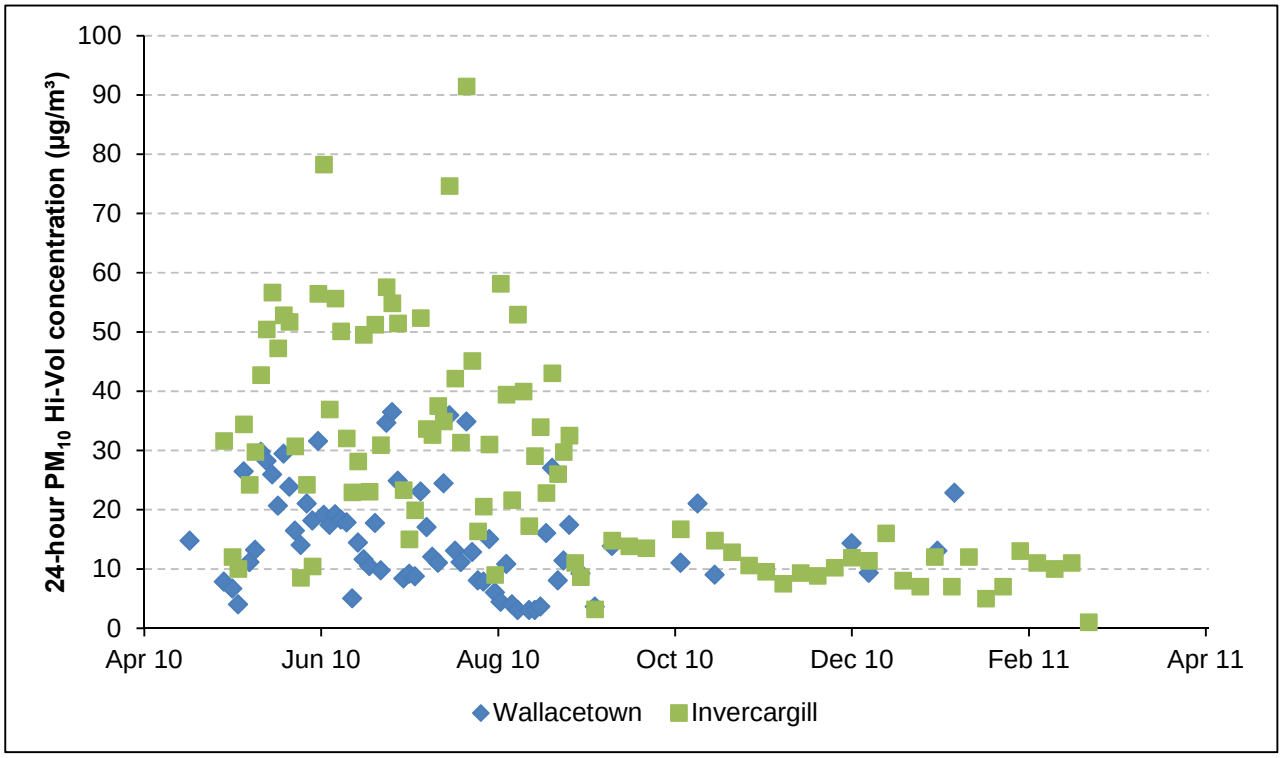

Figure 2: 24-hour average PM10 concentrations for Hi-Vol ambient monitors in Wallacetown and Invercargill.

Figure 3: Photograph of the high volume sampler installed at the Alliance Lorneville 2013 monitoring site.

The high-volume sampling undertaken for this project was not fully compliant with ANZS 3580.9.6-1990. Each sample filtered the correct volume of air over a period of 24 hours, but the start time was not midnight. The start times of each sample varied between 9:00 am and 2:30 pm each day and are given in APPENDIX B. While these start times mean the sampling method were not fully compliant ANZS 3580.9.6-1990, it does not lower the value of this data providing a representative profile of the background concentrations of PM_{10} experienced around the Alliance Lorneville plant site.

K2 Environmental Ltd (K2) was engaged as a suitably qualified and experienced company to calibrate and commission the equipment. K2 calibrated the high-volume sampler's flow rate before it was installed and then commissioned the equipment on site. K2 trained Alliance Lorneville staff in the operation of the equipment and they were responsible for the changing the filters each sampling day. K2 provided the pre-weighed filters, undertook the gravimetric analysis of the exposed filters and provided technical support to Alliance staff during the monitoring campaign.

Because the filters must be changed manually, with only one high volume monitor, it is not possible to sample every day. The monitoring programme began on 20 May 2013 and ran until 03 September 2013. During that period a total of 32 samples were collected, 28 of which provided valid data. The last four samples collected were invalid due to a drop in the sampler flow rate of 30 %.

3.3.2 Monitoring site location

The location for the 2013 monitoring programme was selected to meet a number of criteria:

- Australia/New Zealand Standard AS2922 1987 – Guide for the siting of sampling units
- Electricity power supply available
- Security of equipment
- Outside the immediate influence of the Alliance Lorneville energy plant emissions

To meet all these criteria, a site within Alliance Lorneville's waste water treatment plant (WWTP) was selected. The location of the 2013 and 2014 monitoring site are shown in Figure 4.

Figure 4: Background air quality monitoring sites for 2013 and 2014 programmes.

3.3.3 Results

The results of the 2013 monitoring programme as reported by K2 (2013) are provided in APPENDIX A. A summary of the results from the Alliance Lorneville PM_{10} 2013 monitoring programme are presented in Figure 5 and APPENDIX B.

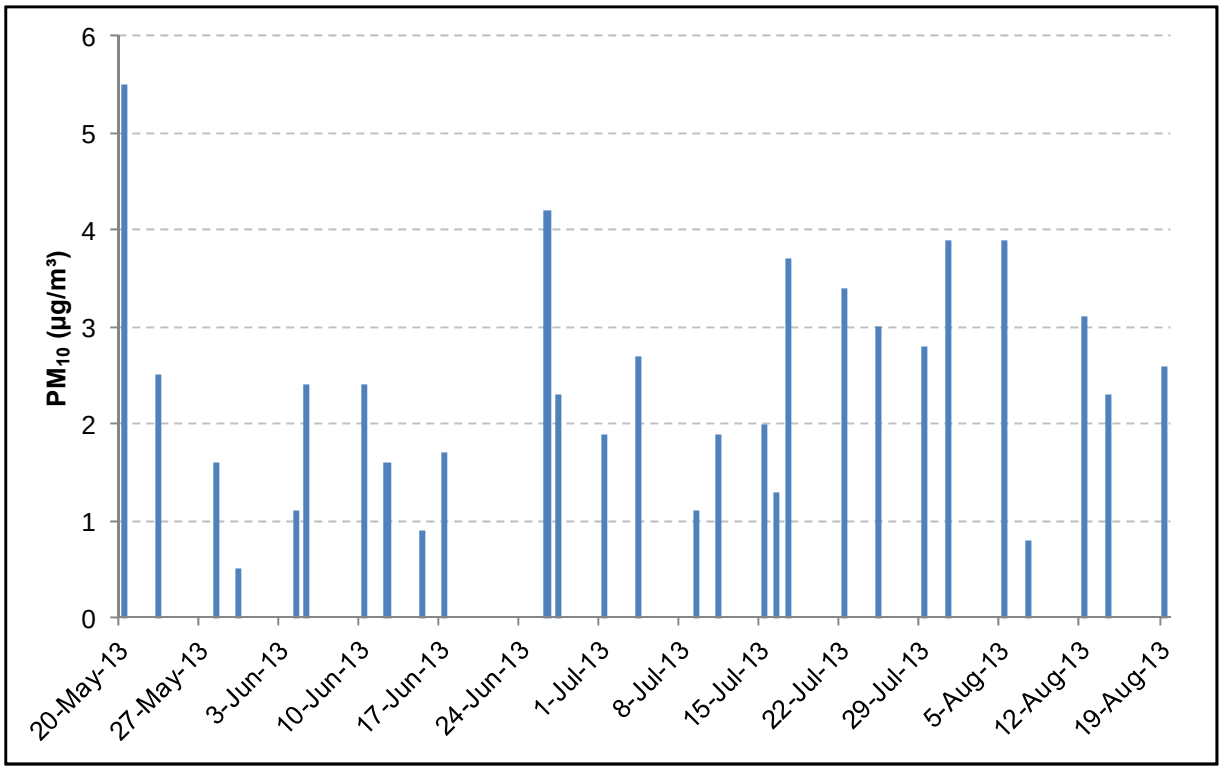

Figure 5: 24-hour average PM_{10} concentrations monitored at the Alliance Lorneville WWTP

The 24-hour average PM_{10} concentrations monitored during this programme range between 0.5 and 5.5 µg/m³. The mean value of the 24-hour average PM_{10} concentrations monitored during this programme was 2.3 µg/m³. The National Environmental Standard concentration for PM_{10} is 50 µg/m³ (24-hour average). All site-specific PM_{10} concentrations are all well below the NES value, with the maximum recorded value being 11 % of the standard and the mean value being 5 % of the standard. The on-site concentrations are all within the lower range of those monitored during the warmer months of Environment Southland's PM_{10} 2010 monitoring campaign.

It is important to consider the PM_{10} results in context of the predominant meteorological conditions occurring on the sampling day. Wind direction determines the most likely source of particulate being sampled. Wind speed influences how much dilution that will occur between the particulate source and the monitoring site. Low wind speeds provide low dilution and high wind speeds provide high dilution. Rainfall will remove some of the particulate from the air, therefore reducing concentrations. A summary of the dominant weather conditions for each of the monitoring days is shown in APPENDIX B.

In summary, while the 2013 monitoring program has covered a range of weather conditions that occur in the Southland winter, there is not a strong correlation between daily PM_{10} concentrations and any specific meteorological conditions that occurred that day. This is probably to be expected given that the concentrations monitored are very low. However, the data indicates (although not strongly) that there are higher PM_{10} concentrations when there are lower wind speed and rainfall. Further it is noted that the predominant wind direction on the day that the maximum PM_{10} concentration (5.5 µg/m³) was recorded was SE (from Invercargill).

It is also noted that the influence of boiler emissions during the 2013 monitoring program is considered to be minor as the monitoring was largely undertaken during the winter shut down period. Additionally, winds from east-northeast (which places the boiler stacks upwind of the monitoring site) was a small fraction of the total monitoring period (the order of 5% or less).

3.4 Site-Specific Monitoring - 2014

3.4.1 Monitoring method

The 2014 monitoring programme measured continuous concentrations of PM_{10} and SO_2 and was carried out from 31 January to 22 May 2014. The equipment was installed and operated by Watercare Services Limited (Watercare). The SO_2 and PM_{10} analysers were housed in an air-conditioned portacom (Figure 6). The sampling height of pollutant was 3 m above ground and ambient PM_{10} was measured in accordance with AS/NZ 3580.9.11:2008 'Determination of suspended particulate matter - PM_{10} beta attenuation monitors' using a Thermo Series FH62-C14 Beta Attenuation Monitor (BAM). Details regarding the monitoring of ambient SO_2 are presented in section 5.2. The 2014 monitoring also included the meteorological parameters of wind speed and direction (6 m above ground level), temperature and relative humidity.

A detailed description of the 2014 monitoring programme is provided in Appendix C.

Figure 6: Photograph of the 2014 ambient monitoring station.

3.4.2 Monitoring site location

The 2014 monitoring programme was carried out at the location shown in both Figure 4 and Figure 7. The monitoring site (orange cross) was located on the property of a private householder at 237 Steel Road, Lorneville, approximately 650 metres east of the Alliance boiler stacks (the house is marked by a blue cross). This location was chosen as it was predicted by the dispersion model (Golder 2013b) to be the highest impacted dwelling with respect to PM_{10} and SO_2 concentrations.

Figure 7: Location of the ambient monitoring site (orange cross), at 237 Steel Road (dwelling marked by a blue cross). The boiler stack locations are indicated by black crosses.

3.4.3 Correction of wind direction observations

The analysis carried out in Sections 3.4.4 and 5.2 makes use of monitored SO_2, PM_{10} concentrations and wind direction. The SO_2 and PM_{10} concentrations used correspond to the values that were quality assured by Watercare, while the wind direction corresponds to raw data that was adjusted by Golder. Most of the wind speed data from the monitoring station was discarded by Watercare's quality assurance process and replaced with wind speed data from MetService's Wallacetown station.

Due to the vector relationship between wind speed and direction, Watercare retrieved the 1-minute wind direction data from the monitoring station data logger and used it with the Wallacetown wind speed to recalculate the vector averaged wind directions. Details of Watercare's validation history for the wind speed and wind direction data are provided in Appendix D.

However the wind direction data that had been adjusted by Golder was similar to the wind direction data recalculated by Watercare's quality assurance process. Consequently, it was retained for referred analysis (those carried out in Sections 3.4.4 and 5.2).

The adjustment done by Golder consisted of applying an offset to reported values of wind direction so that the spike in measured SO_2 concentrations occurred for wind directions that placed the ambient monitoring site downwind of the boiler stacks. A plot of concentration against wind direction is shown in Figure 8, after the offset has been applied, which correlates with the well-defined spike in concentrations under westerly winds.

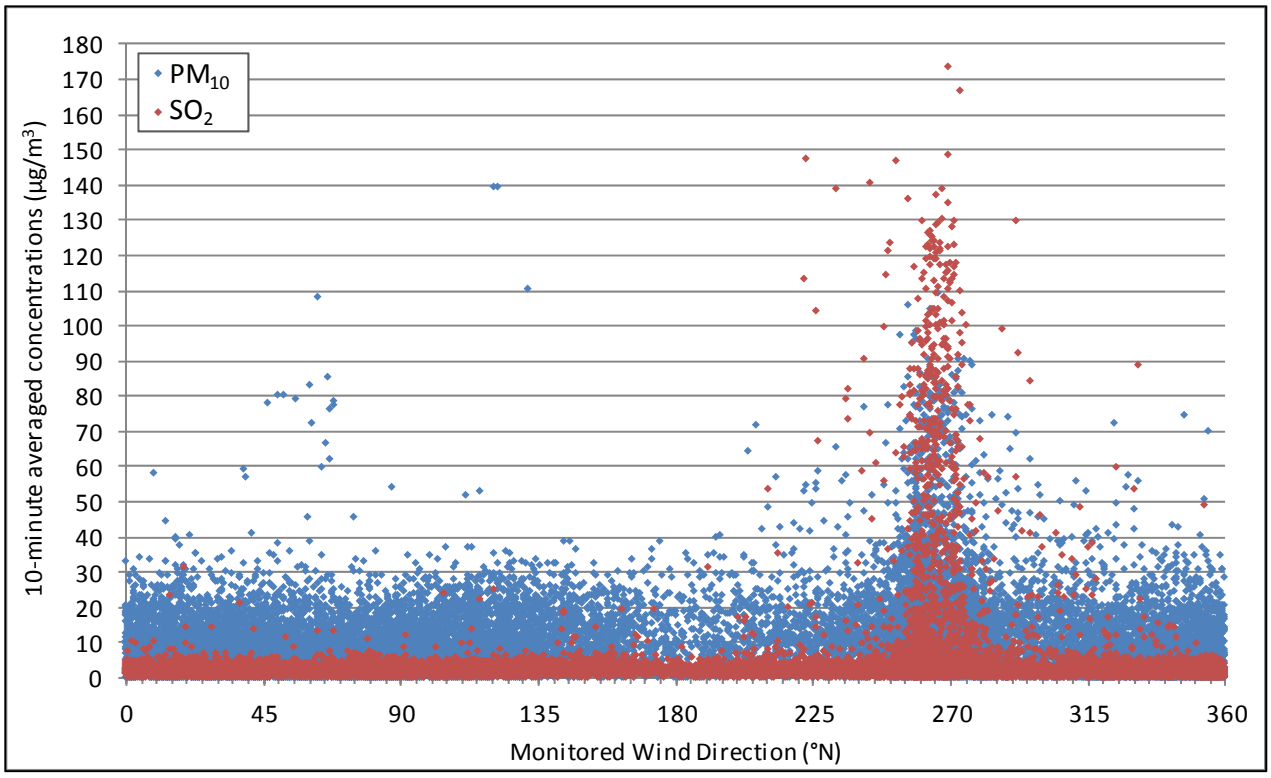

Figure 8: Monitored 10-minute averaged ambient concentrations versus adjusted wind direction, from 31 January to 21 May 2014.

3.4.4 Results

The data provided by the 2014 monitoring programme was used for two main purposes: (i) estimate the background air quality; and (ii) assess the impacts of air discharges from the Alliance coal-fired boilers. The approach used for these distinctive objectives included the generation of separate data sets filtered for when the wind direction measured at the monitoring station was within (boiler impacts) or outside (background) the downwind direction from the boilers. In this report, only the background data set will be discussed, which was generated through the following steps:

1) **Definition of non-downwind direction range:** Scatter plots of 10-minute average PM_{10} and SO_2 concentrations versus wind direction were constructed (such as that shown in Figure 8). The scatter plots displayed well-defined concentration "spikes" at a specific wind direction range, which is the downwind direction from the boilers. The exclusion of the wind direction range that covers the width of these concentration spikes gives the non-downwind direction range of 0 ^{o}N – 254 ^{o}N and 278 ^{o}N –360 ^{o}N.

2) **Construction of 1-hour averaged background time series data set:** The background time series data set was then created by filtering the concentrations for when the wind direction was within the non-downwind range of the monitored data set. The complete 1-hour averaged data set had a total of 2,434 valid data, of which 2,024 (83 %) were filtered to integrate the background (non-downwind) data

set. For the purpose of a cross-check, a second "background" time series data set was created by filtering the monitored data set for wind within the downwind range, but at times when there was no steam production from the boilers (based on measured steam production from the same period). The statistics of this data set (the concentrations at a range of percentile levels) were similar to the first background time series based on non-downwind direction, which is the one that was used in this analysis and on the generation of the results presented henceforth.

3) **Construction of 24-hour averaged background time series data set:** The criterion used for the construction of the 24-hour averaged data set was based on the Ministry for the Environment Good Practice Guide for Air Quality Monitoring and Data Management (MfE, 2009). This guide recommends that the percentage of valid monitored data used for averaging must be at least 75 %. Therefore, the 24-hour averaged background data set was created using only those days from the 1-hour averaged data set that had at least 18 valid hourly data. There was a total of 2,024 valid background 1-hour averages distributed in 111 monitoring days. Of these, 1,643 1-hour averages (81 %) distributed in 72 monitoring days were used for the construction of the 24-hour background data set.

After the steps detailed above, the statistical values of the PM_{10} background time series data set was calculated as shown on Table 2. Graphs of the background time series data set and a cumulative frequency curve of 24-hour averaged PM_{10} concentrations are presented on Figure 9 and Figure 10 respectively.

Table 2: Statistical summary of background PM_{10} from 2014 ambient monitoring programme.

Parameter	Values of 24-hour averaged data set
Number of values in data set	72
Minimum (µg/m^3)	4.2
25th percentile (µg/m^3)	8.2
Average (µg/m^3)	10.9
75th percentile (µg/m^3)	13.2
85th percentile (µg/m^3)	15.1
95th percentile (µg/m^3)	18.1
Maximum (µg/m^3)	22.4

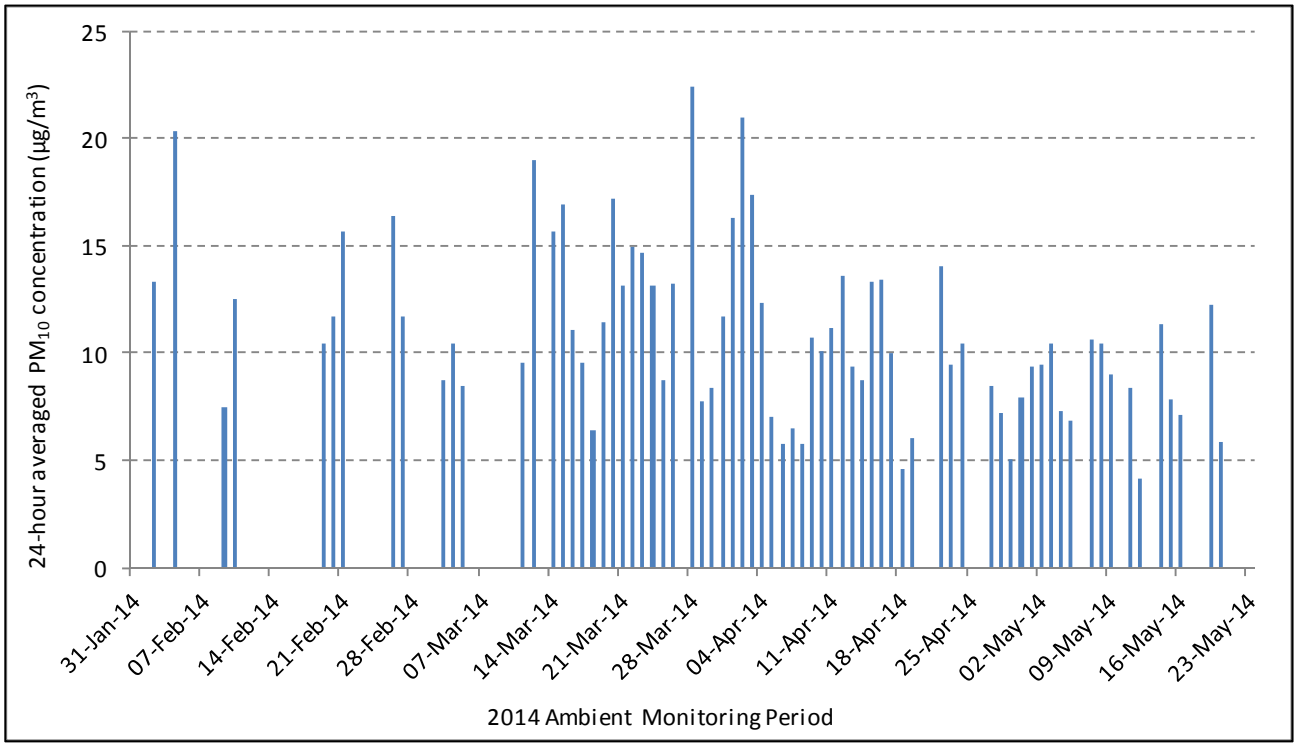

Figure 9: Time series of background PM_{10} ($\mu g/m^3$) from 2014 ambient monitoring programme.

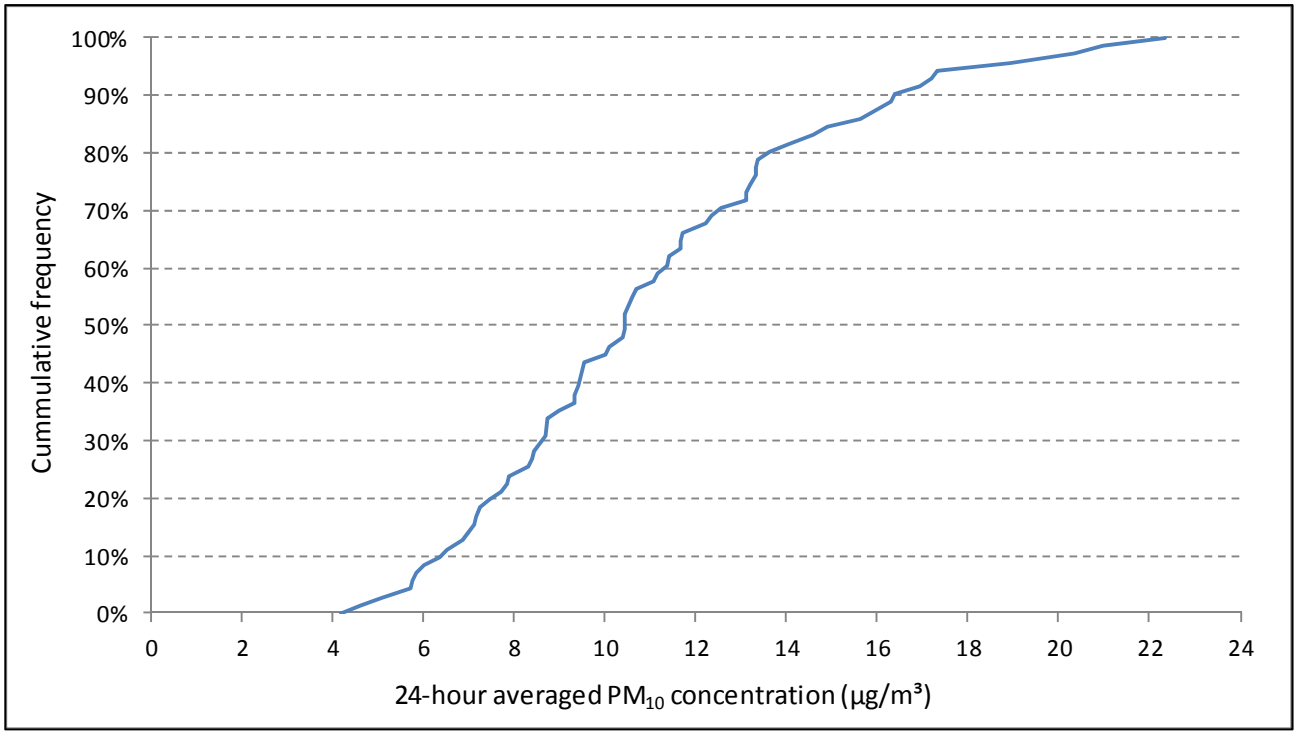

Figure 10: Cumulative frequency curve of background PM_{10} ($\mu g/m^3$) from 2014 ambient monitoring programme.

3.5 Background Concentration

Considering the information presented in Sections 3.2, 3.3 and 3.4, it is concluded that an appropriate background PM_{10} 24-hour value to add to dispersion modelling predictions of boiler stack PM impacts within the area surrounding the Alliance Lorneville plant is 15 µg/m³. This equates to the 85% percentile background PM_{10} 24-hour concentration (see Table 2) cumulative frequency curve of the Alliance Lorneville on-site 2014 monitoring programme). Assuming a higher background concentration to add to modelled predictions, such as 18 µg/m³ (95th percentile, see Table 2), is expected to overstate the actual frequency of cumulative impacts that approach or exceed the NES threshold value of 50 µg/m³ for 24-hour PM_{10}.

The MfE recommendation of 15 µg/m³ (24-hour average) for a summertime background level in a rural site is consistent with the background value established from the 2014 monitoring programme of PM_{10}.

The 2013 monitoring indicated that 5 µg/m³ may be an appropriate background PM_{10} 24-hour concentration to add to predicted boiler emission impacts that are established for mid-winter months. However, this lower concentration has only been confirmed for the more remote WWTP site. Furthermore, the main value of this monitoring was to demonstrate the significance of any contribution of ambient PM_{10} from either Wallacetown or Invercargill – both of which were found to have no measureable impact during winter. The primary reason for this conclusion is that the 2013 monitored values were typical of rural environments and so any contribution from Wallacetown or Invercargill City airsheds must have been minor.

The on-site 2013 monitoring was undertaken during a relatively wet winter so background particulate sources were likely to be suppressed, and it was also located much further away from rural residences and lifestyle blocks compared to the 2014 monitoring location. This latter location, on the other hand, was undertaken during summer/autumn and very close to the rural residences east of the site, and therefore it is likely to have increased background dust levels due to the proximity to agricultural and rural residential activity, lower rainfall and higher wind speeds.

Further to the above, the background annual averaged PM_{10} concentration of 10 µg/m³ is considered to be an appropriate to add to model predictions of the boiler impacts based on the 2014 background data set (see Table 2). Although the monitored background average was about 11 µg/m³, the monitoring programme was carried out for less than 4 months during summer/autumn and therefore lower concentrations are expected to occur throughout the year.

Wintertime concentrations of PM_{10} in the Invercargill and Wallace Town airsheds are expected to be greater than those experienced immediately around the site during winter. Invercargill concentrations are frequently greater than 50 µg/m³ (NES standard), however the monitoring in the winter of 2013 indicated no significant contribution to the Alliance WWTP site from these urban areas.

4.0 NITROGEN DIOXIDE

As far as Golder is aware there has been only limited NO_2 monitoring undertaken in areas close to Alliance Lorneville, or within other parts of the Southland Region. No real-time NO_2 data has been identified for use in this report.

4.1 Review of Existing Data

The New Zealand Transport Agency (NZTA) operates passive NO_2 monitors at two locations in Invercargill (NZTA 2012). The major limitation of passive monitors is that they can only provide monthly average NO_2 concentrations. However studies have shown that passive monitors do correlate reasonably well to real-time NO_2 monitoring data (NZTA 2012). For this reason it considered that the NZTA passive monitoring data is the best regionally specific data available for estimating both 1-hour and 24-hour average background NO_2

concentrations in areas close to Alliance Lorneville. The location and description of each of these sites is given in Table 3. The data from these two stations for the last three years is presented in Figure 11 (monthly concentrations) and Figure 12 (annual variation of concentrations).

Table 3: Location and description of Invercargill passive NO_2 monitors (operated by NZTA).

Station ID	Station location	Station Description	Commencement date	Data coverage for 2010-2012
DUN005	50 Dee St (1242.407 4849.734 km NZTM)	State highway site	January 2007	67 %
DUN010	33 Terrace St (1243.428 4852.255 km NZTM)	Background site	May 2010	78 %

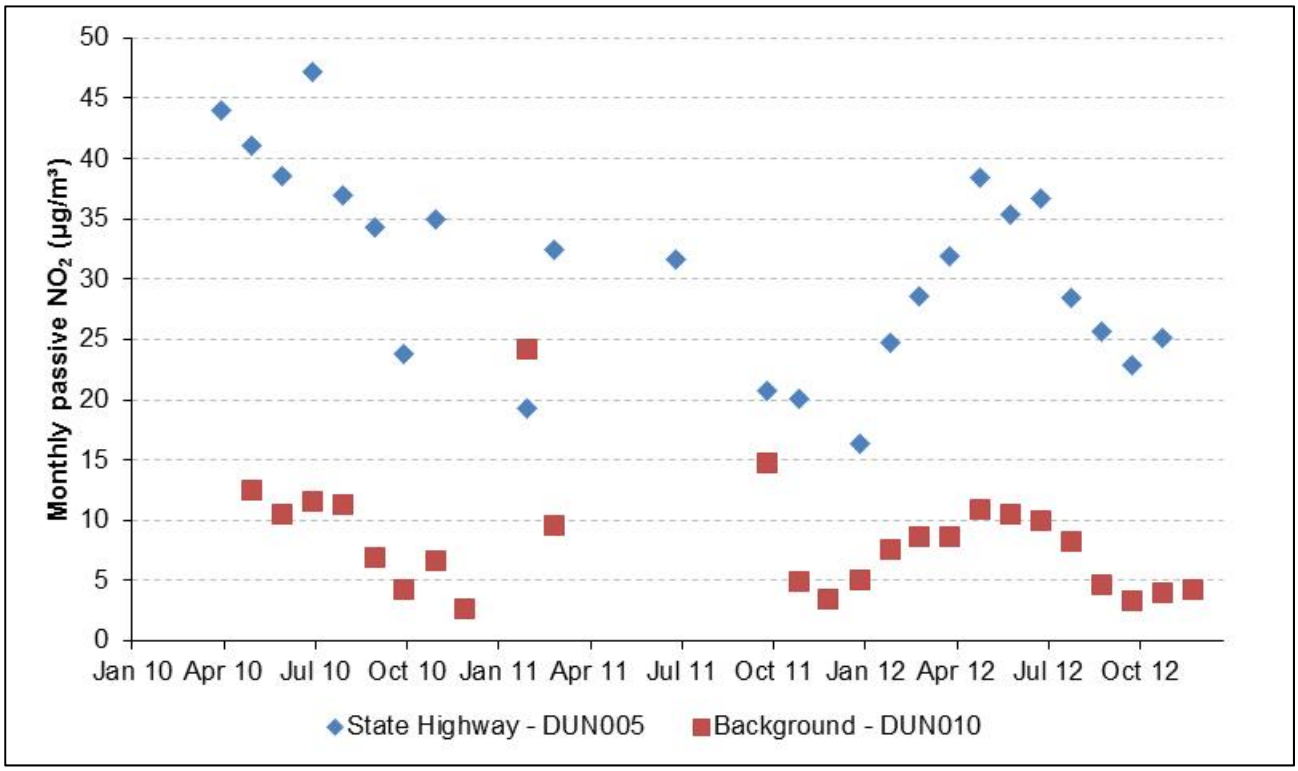

Figure 11: Monthly passive NO_2 concentrations measured at two Invercargill stations.

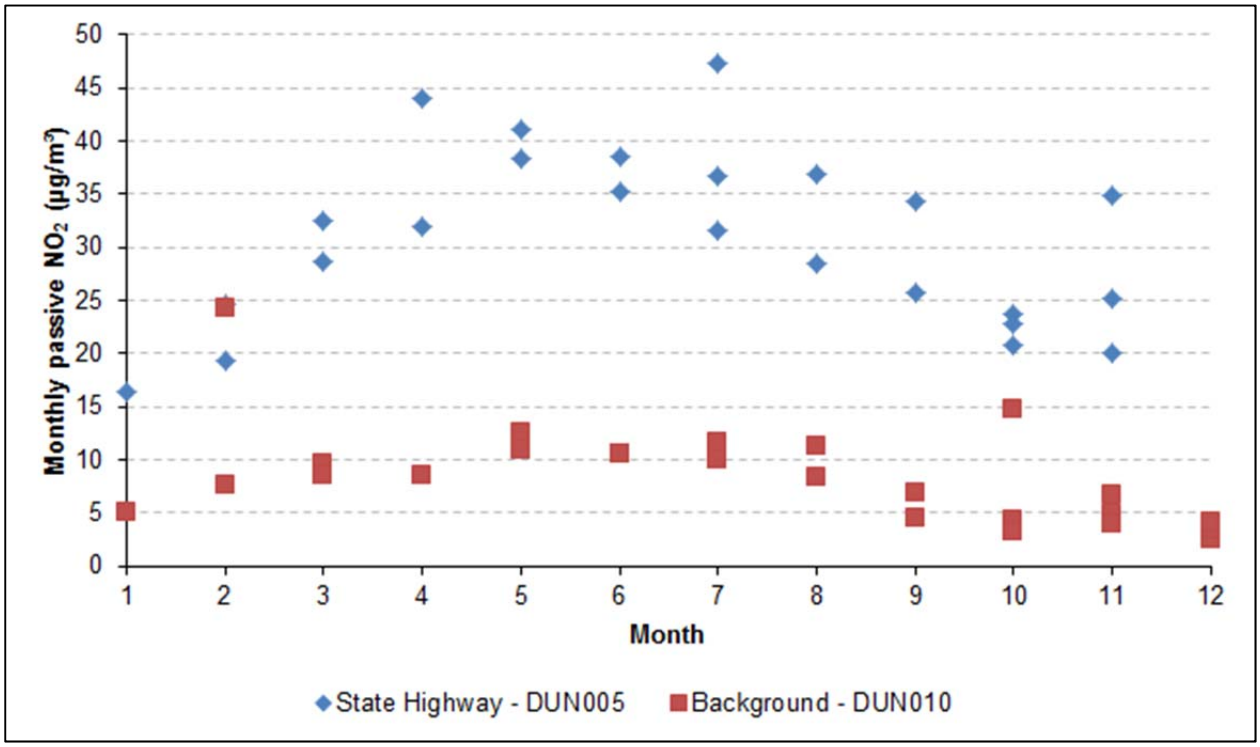

Figure 12: Annual pattern in monthly passive NO_2 concentrations for the Invercargill stations.

As expected, the measured passive NO_2 concentrations are higher for the state highway site than for the background site. The background site is considered more representative than the state highway site for background values of NO_2 expected to occur in the vicinity of the Alliance Lorneville plant. Figure 11 shows the background site has a maximum monthly average value of approximately 25 µg/m³, but more typically shows average values of around 10 µg/m³. Figure 12 shows that monthly average NO_2 concentrations tend to be higher during winter months for both the state highway and background sites.

MfE provide some guidance on estimating background NO_2 concentrations in the Good Practice Guide to Assessing Discharges to Air from Industry (MfE 2008). MfE (2008) notes that in rural areas the typical maximum 1-hour average NO_2 concentration that occurs when there are no obvious sources upwind is 15 µg/m³.

4.2 Background Concentrations

Considering the information presented in Section 4.1 it is concluded that a robust estimate of typical background NO_2 concentrations for the area surrounding the Alliance Lorneville plant is 15 µg/m³ for both the 1-hour and 24-hour average time periods. This conclusion is based on both the results from the NZTA passive monitoring and the guidance provided by MfE on background NO_2 concentrations.

When considering seasonal variation the NZTA monitoring shows that background concentrations tend to be slightly higher during winter months. This is likely to be a contribution from domestic heating and therefore unlikely to be experienced in the immediately vicinity of Alliance. Further, as this NO_2 monitoring data is from sites within the Invercargill urban area (where NO_2 levels would be higher) , using these background levels for the area surrounding the Alliance site is conservative and therefore lead to a conservative assessment of cumulative ambient air quality effects in this instance.

5.0 SULPHUR DIOXIDE

This section estimates typical background (non-plant sourced) SO_2 concentrations of air pollutants for the area surrounding the Alliance Lorneville plant. Two sources of information are considered:

- Existing relevant ambient air quality data (Section 5.1).
- A site specific SO_2 monitoring programme carried out in 2014 (Section 5.2).

Regarding the review of existing data done Golder identified one SO_2 monitoring programme that has been undertaken in the Southland Region. This monitoring was undertaken for the Fonterra Edendale plant as a requirement of its resource consent. Because of the limited Southland specific SO_2 data, information from other areas has been used in this review of existing relevant ambient air quality, presented in Section 5.1. Golder identified two additional sites where SO_2 data has been monitored and which were informative in the estimative of likely background concentrations in areas close to the Alliance Lorneville plant. The two sites considered are in Hamilton and Clandeboye, South Canterbury.

As previously discussed, after the preliminary results from the modelling assessment undertaken by Golder (2013b), an ambient monitoring programme was carried in 2014 to provide site specific PM_{10} and SO_2 data sets. This site-specific data has been used to enhance the estimative of background SO_2 concentrations, as detailed in Section 5.2.

5.1 Review of Existing Data

Fonterra Co-operative Group (Fonterra) commissioned Watercare Services Ltd Laboratory Services to undertake continuous ambient SO_2 monitoring within the vicinity of the milk processing factory at Edendale, Southland, over the months of September to December in 2002 and 2003. The details of the monitoring programme and the 2003 monitoring results are contained in the report 'Fonterra Edendale, Ambient Air Quality Report, Edendale, Southland' (Watercare 2003), which is available from Environment Southland. A summary of the results from these two SO_2 monitoring programmes is presented in Table 4. The results showed that SO_2 concentrations monitored were consistently well below both the 1-hour and 24-hour NES values for this air pollutant.

Table 4: Summary of the Fonterra Edendale SO_2 monitoring results.

Processing season	Max. 1-hour SO_2 conc. (µg/m³)	Max. 24-hour SO_2 conc. (µg/m³)	annual average SO_2 conc. (µg/m³)
2002	45.5	9.7	2.6
2003	34.7	10.3	1.7

Environment Waikato undertook SO_2 monitoring in Hamilton at the Waikato Regional Council's Ohaupo Road monitoring site (Waikato Hospital site) from 1 March 2012 to 31 August 2012 (EW, 2012). This area is classified as a combined Traffic/ Industrial monitoring site. This monitoring showed that the maximum SO_2 concentrations monitored at this site were 21 µg/m³ and 8.7 µg/m³ for the 1- and 24-hour averaging periods respectively. All concentrations monitored over this six month winter period were below 10 % of the respective 1-hour (350 µg/m³) and 24-hour (120 µg/m³) SO_2 NES or regional ambient air quality guidelines.

Fonterra operates a milk processing plant in Clandeboye, South Canterbury under Canterbury Regional Council air discharge consent (CRC040829). Condition 34 of that consent required real-time ambient monitoring of SO_2 over the processing seasons of 2004-5 and 2005-6. The results of these two SO_2 monitoring programmes are presented in Fonterra Clandeboye Annual Air Quality Monitoring report 2004-2005 (Golder 2005) and 2005-2006 (Golder 2006). A summary of the results of these SO_2 monitoring programmes is presented in Table 5.

Table 5: Summary of the Fonterra Clandeboye SO_2 monitoring results.

Processing season	Max. 1-hour SO_2 conc. (µg/m³)	Max. 24-hour SO_2 conc. (µg/m³)	Annual average SO_2 conc. (µg/m³)
2004-05	27	9.6	1.9
2005-06	87	8.0	2.2

All three SO_2 monitoring programmes reviewed as part of this report, show the majority (> 90 %) of 1-hour and 24-hour average concentrations are less than 10 % of the respective 1-hour (350 µg/m³) and 24-hour (120 µg/m³) NES or AAQG. Given the urban settings of the Hamilton location and the influence of the nearby industrial plants on this monitoring site, it is considered less relevant for estimating the background SO_2 concentrations likely to occur at the Alliance Lorneville plant. Because the Fonterra Edendale and Clandeboye data sets were monitored in a rural setting, these are given more weight in the assessment of the background SO_2 concentrations likely to occur in the area around the Alliance Lorneville plant.

The MfE provides no guidance on estimating background SO_2 concentrations in the Good Practice Guide to Assessing Discharges to Air from Industry (MfE 2008).

It is noted that the Ohaupo monitoring data would not be representative of rural SO_2 concentrations within an urban area. However, for the initial assessment (prior to site monitoring in 2014) these data provided useful upper limits of the background SO_2 as the urban area and motorway in question have a small impact on ambient SO_2 levels. Similarly, the ambient SO_2 data from Edendale and Clandeboye would have been influenced by the Fonterra boilers, and therefore the subsequent ambient monitoring in 2014 allowed Golder to establish more accurate information on the actual background SO_2 concentrations within the area of Lorneville.

5.2 Site-Specific Monitoring - 2014

An overview of the 2014 ambient air quality monitoring programme is presented in Sections 3.4.1 and 3.4.2. Ambient SO_2 concentrations were measured in accordance with AS 3580.4.1:2008 'Determination of sulfur dioxide - Direct reading instrumental method', using an Ecotech EC 9850 monitor.

The process used to generate the background time series of SO_2 concentrations is the same as that used for PM_{10}, and therefore the reader is referred to Sections 3.4.3 and 3.4.4 for details. After the steps detailed in those sections, the statistical values of the SO_2 background time series was calculated as shown on Table 6. In the case of SO_2 concentrations, the complete 1-hour averaged data set had a total of 2,380 valid values, of which 1,974 values (83 %) were filtered to incorporate the background (non-downwind) data set. Of those, 1,571 1-hour averages (considering days that had at least 75 % of hourly data available) were used in the construction of 70 background 24-hour averages.

Graphs of the background time series and cumulative frequency of 1-hour and 24-hour averaged SO_2 concentrations are presented on Figure 13, Figure 14, Figure 15 and Figure 16.

Table 6: Statistical summary of background SO_2 from 2014 ambient monitoring programme.

Parameter	Values of 1-hour averaged data set	Values of 24-hour averaged data set
Number of values in data set	1,974	70
Minimum (µg/m^3)	0.02	1.1
25th percentile (µg/m^3)	1.3	1.7
Average (µg/m^3)	2.6	2.4

Parameter	Values of 1-hour averaged data set	Values of 24-hour averaged data set
75th percentile (µg/m3)	2.9	2.9
85th percentile (µg/m3)	3.4	3.2
95th percentile (µg/m3)	4.7	4.3
Maximum (µg/m3)	89	5.9

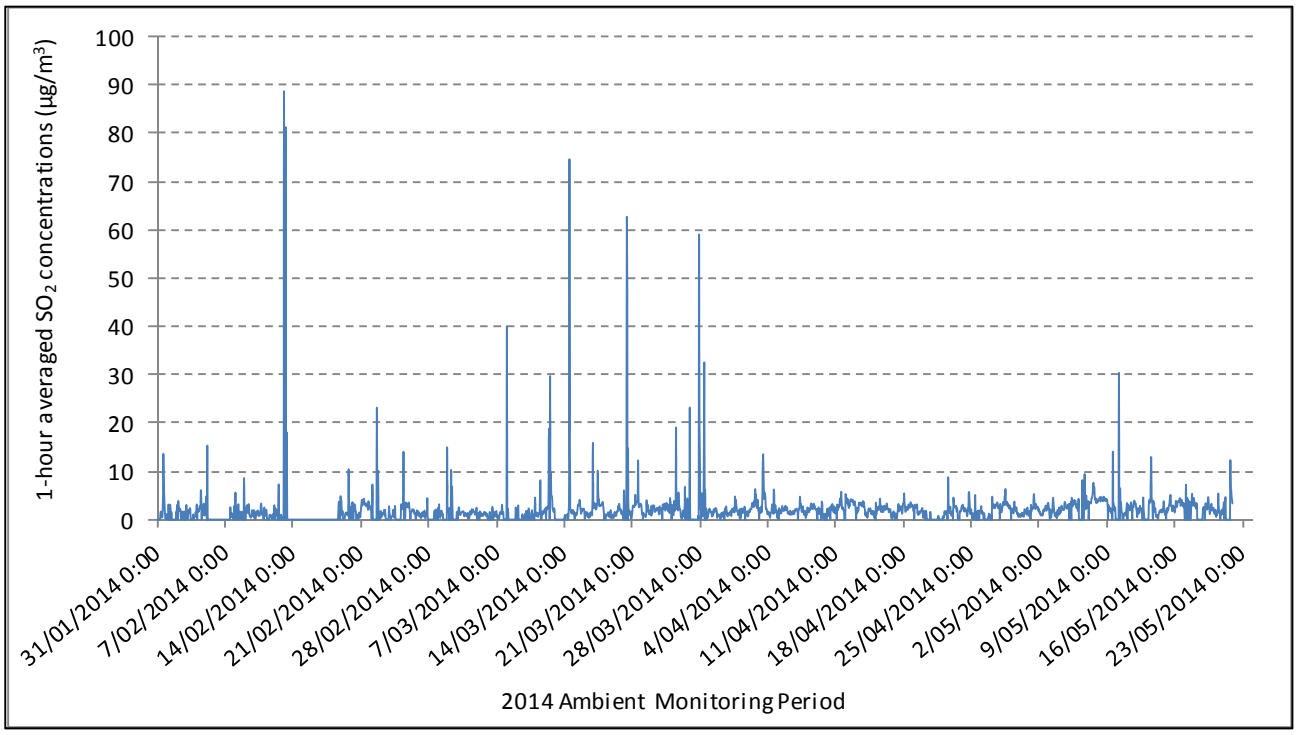

Figure 13: Time series of background 1-hour averaged SO_2 (µg/m3) from 2014 ambient monitoring programme.

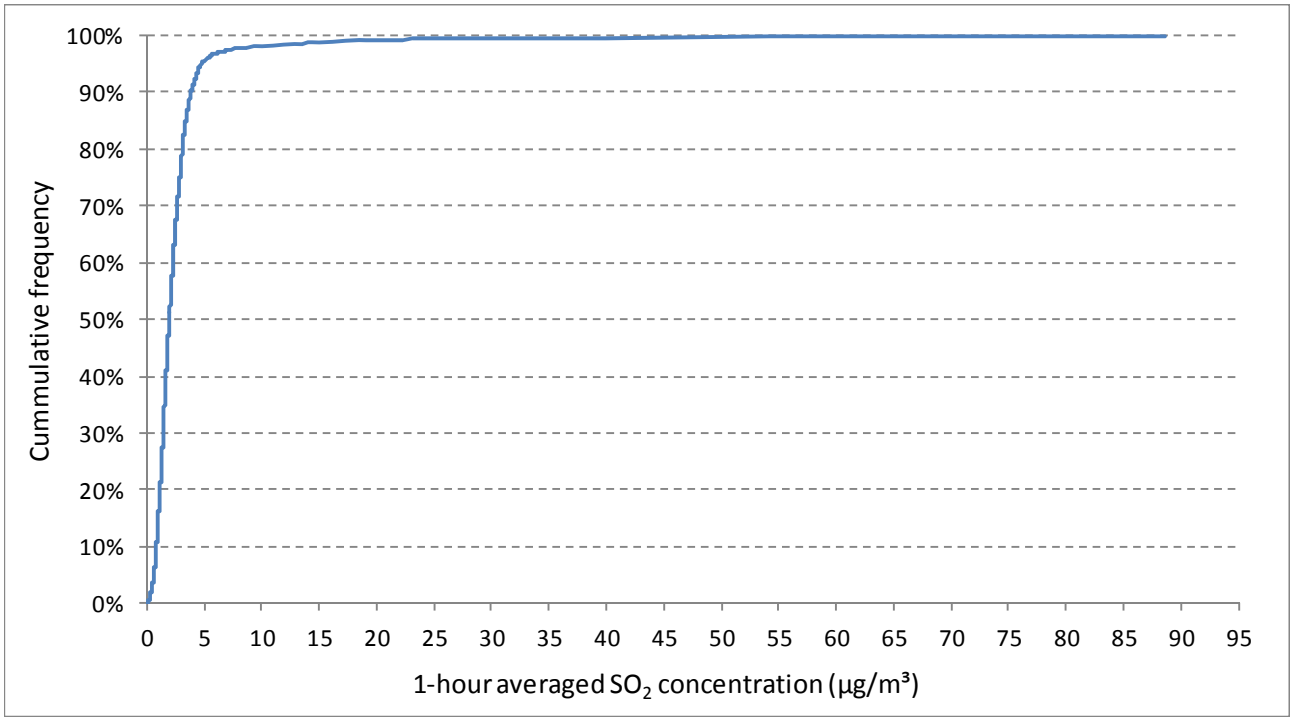

Figure 14: Cumulative frequency curve of background 1-hour averaged SO_2 ($\mu g/m^3$) from 2014 ambient monitoring programme.

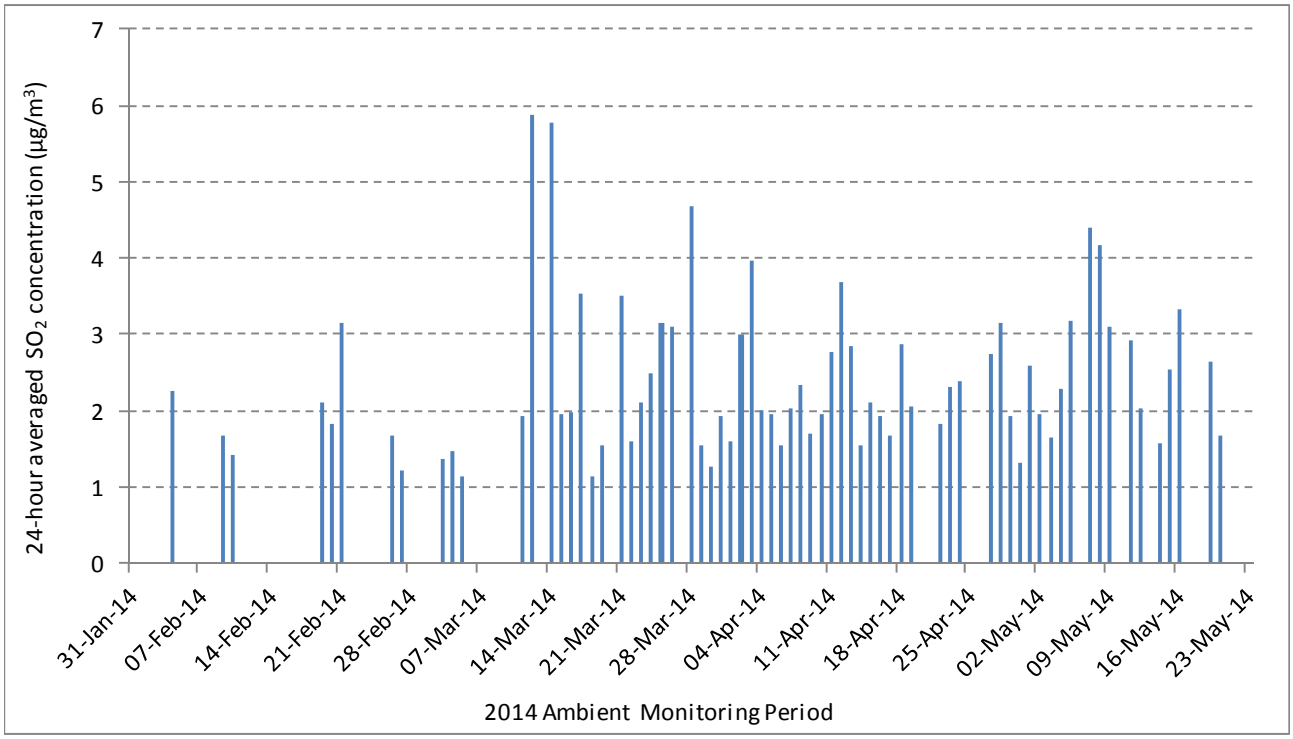

Figure 15: Time series of background 24-hour averaged SO_2 ($\mu g/m^3$) from 2014 ambient monitoring programme.

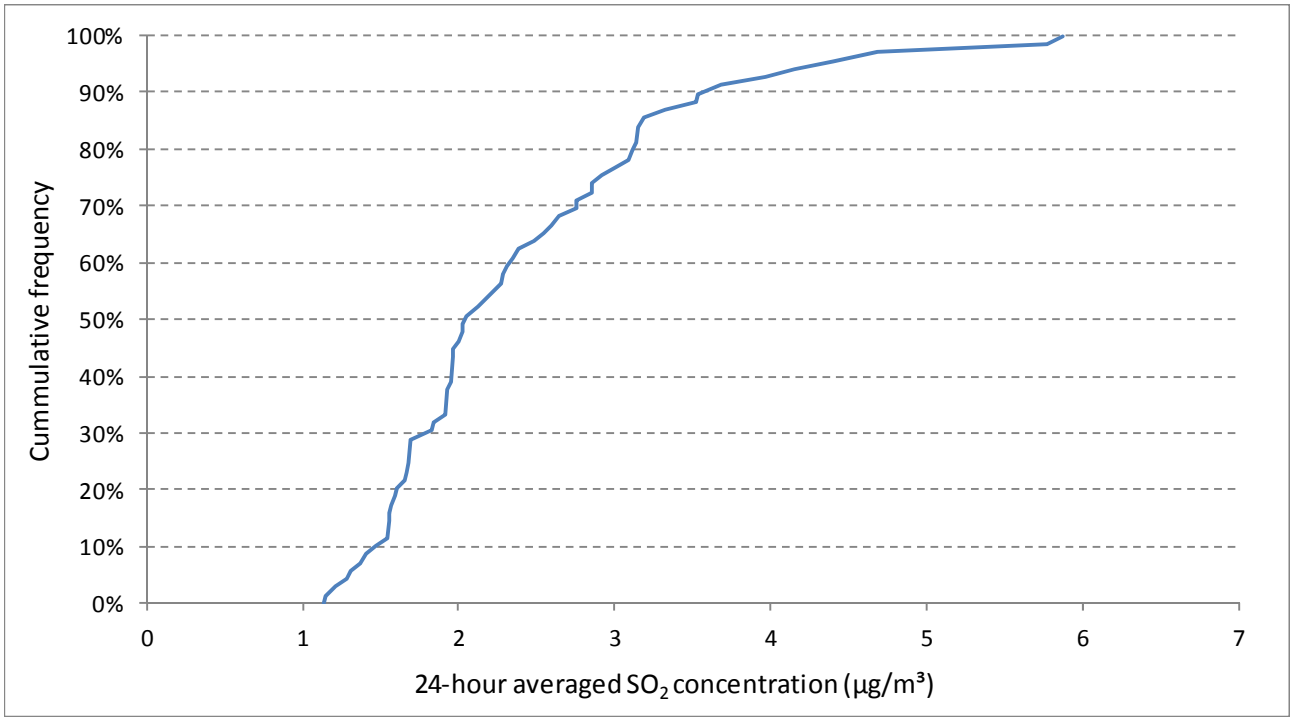

Figure 16: Cumulative frequency curve of background 24-hour averaged SO_2 ($\mu g/m^3$) from 2014 ambient monitoring programme.

5.3 Background Concentrations

Considering the information presented in Sections 5.1 and 5.2, it is concluded that a conservative estimate of typical background SO_2 concentration for the area surrounding the Alliance Lorneville plant is 5 µg/m³ for both the 1-hour and 24-hour averaged concentrations. This conclusion is based mainly on the cumulative frequency curves (see Figure 14 and Figure 16) of the Alliance Lorneville on-site 2014 monitoring programme, which provide a robust site specific estimate of background concentrations. The background value of 5 µg/m³ is where the cumulative frequency curves slopes start to flatten out, indicating that values above it are likely to represent more infrequent occasions in which emission events and meteorological conditions combine to result in peak background values.

No information is available on seasonal variation of background SO_2 concentrations, but given the low monitored background values, these are not expected to be significant. The 75 % percentile 24-hour is approximately 3 µg/m³ and this is expected to provide a realistic estimate of the annual average SO_2 concentration.

6.0 METALS

Coal can contain many metal contaminants including: arsenic, beryllium, boron, cadmium, chromium, hexavalent chromium, cobalt, lead, manganese, mercury, molybdenum, selenium, strontium, thallium, and vanadium. The metals, which are discharged from the combustion of New Zealand coal, that have the highest potential to cause adverse effects include; arsenic, cadmium, chromium, lead, and mercury.

6.1 Review of Existing Data

There is very little information available on ambient concentrations of metals in rural New Zealand. However, Golder's knowledge of the sources of metal contaminants suggests that the concentration of metals in background ambient air is generally negligible. The exception is when there is a nearby source of metal contaminants to air. Sources of metal contaminants to air include mining metal ores, smelting metals, metal recycling or very large combustion sources. The Tiwai Point aluminium smelter is the only close by source of metal contaminants to air that has been identified. However, the emissions of aluminium due to the combustion of coal are expected to be negligible and will not be considered in the Alliance Lorneville air quality impact and mitigation assessment.

The MfE provides no guidance on estimating background metal concentrations in the Good Practice Guide to Assessing Discharges to Air from Industry (MfE 2008).

6.2 Background Concentrations

Considering the information presented in Section 0, the absence of any of any significant sources of arsenic, chromium, cadmium lead, of mercury to air in the area surrounding the Alliance Lorneville plant, it is assumed that the background concentrations of these metals will be negligible.

7.0 DIOXINS AND FURANS

The terms 'dioxins' and 'furans' are used here to refer to the two classes of chemicals known as polychlorinated dibenzo-p-dioxins, (dioxins) and polychlorinated dibenzofurans (furans). These complex chemicals are formed at trace levels during most combustion processes, and are only likely to be present at trace levels in the discharges from the Alliance Lorneville energy plant. Some of the dioxins are toxic to humans, and they do not break down readily in the environment and can bio-accumulate in human and animal tissues. Dioxins in New Zealand are mostly produced from the combustion of domestic rubbish and uncontrolled vegetation burning. The trace level of dioxin discharge that is typically discharged from industrial coal-fired boilers in New Zealand is not usually assessed as part of resource consenting processes. Furthermore, the discharge of dioxin like compounds from the Alliance boiler plant are expected to be very minor. However, given that a long term consent is sought, it is recommended that background ambient levels are assessed and are available for use within the pending assessment of air discharge effects that will be prepared to assist the consent application process.

7.1 Review of Existing Data

MfE has undertaken a nation-wide environmental survey to determine the background levels of organochlorines in ambient air (MfE, 1999). A total of 52 air samples were collected from reference, rural, urban and industrial sites. The rural sites monitored were at Te Wera (Taranaki), and Culverden (Canterbury). Four to six samples were collected from each site during 1996-97. Typically each sample was collected over a continuous 20 day period. The results of the MfE monitoring programme for polychlorinated dibenzodioxins (PCDDs) and polychlorinated dibenzofurans (PCDFs) monitored at rural sites are presented in Table 7.

Table 7: PCDD and PCDF I-TEQ concentrations in New Zealand air (fg I-TEQ* m^{-3}) (MfE, 1999).

	Min.	Max.	Median	Mean
Te Wera	1.66	31.7	18.0	16.0
Culverden	0.94	9.9	2.8	3.8

* femto-grams ($1x10^{-15}$ g) International Toxic Equivalents

Table 7 shows that concentrations of PCDD and PCDF were higher in Te Wera than in Culverden. The results presented by MfE (2008) show that the rural site results were significantly lower than the urban and industrial sites monitored and were similar to the reference site (Baring Head, Wellington).

It is important to note that the ambient air background concentrations displayed in Table 7 are not directly comparable to the MfE dioxin and furan guideline reported in Section 2.6 which refer to a tolerable daily intake. The tolerable daily intake requires the calculation of the total annual exposure concentration which is the sum of dioxins entering a body via three routes; inhalation, dermal exposure and ingestion. The background PCDD and PCDF concentration displayed in Table 7 will contribute to the assessment of the inhalation health risk which will be calculated by the sum of the background concentrations and the concentrations generated by the direct dioxin emissions from the Alliance energy plant.

7.2 Background Concentrations

Considering the information presented in Section 7.1, it is concluded that a robust estimate of typical background dioxins and furan concentrations for the area surrounding the Alliance Lorneville plant is 16 fg I-TEQ /m³ as an annual average. Given the limited data available it is considered the mean values monitored in Te Wera are the best available estimate of background concentrations.

In regard to seasonal variation, MfE (1999) note that the highest background concentrations tend to occur in the colder winter months

8.0 SUMMARY OF BACKGROUND AIR QUALITY

The objective of this report is to quantify typical background (non-plant sourced) concentrations of air pollutants for the area surrounding the Alliance Lorneville plant.

Table 8 presents a summary of the estimates of background pollutant concentrations which are based on the data presented, reviewed, and analysed in this report. The background concentrations presented in Table 8 will be used for the cumulative assessment of the effects of contaminants discharged from the Alliance Lorneville energy plant.

Table 8: Background pollutant concentrations to be used in the Alliance Lorneville air quality modelling based assessment.

Pollutant	Source of data reviewed	Averaging period	Estimated background concentration
PM_{10}	Environment Southland, MfE, Alliance Lorneville	24-hour	15 µg/m³
		Annual	10 µg/m³
NO_2	NZTA, MfE	1-hour	15 µg/m³
		24-hour	15 µg/m³
SO_2	Environment Waikato, Fonterra and Alliance Lorneville	1-hour	5 µg/m³
		24-hour	5 µg/m³
		Annual	3 µg/m³
Metals: arsenic, cadmium lead, and mercury	N/A	3-month and Annual	0 µg/m³
Dioxins and Furans	MfE	Annual	16.0 fg I-TEQ /m³

9.0 RECOMMENDATIONS

The objectives of this report included identifying any gaps in the data available and to make any recommendations needed:

- to fill any data gaps that were identified.
- on further monitoring and analysis of data to account for seasonal variations.

Following the completion of the site specific PM_{10} monitoring programme carried out in winter of 2013, the relatively low background concentrations indicated that seasonal variation of background PM_{10} concentrations may be significant. In part, to address this issue, a summer time, site specific PM_{10} monitoring programme was carried out in 2014.

The seasonal variations of background concentrations are reasonably well understood and values have been chosen which incorporate the effect of the seasonal highs that do occur.

The review of data available including the 2014 monitoring campaign did not identify any significant gaps which need to be filled before robust estimates of the background concentrations of pollutants could be made. The data showed that typical background concentrations for the area immediately surrounding Alliance are well within ambient criteria.

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APPENDIX A

K2 Ambient Air Quality Monitoring Report 2013

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Golders
Hi Vol Filter Weights
Alliance, Lorneville Plant
20th May - 3rd September 2013

Stuart Keer-Keer

Job Number O168 September 2013

1 INTRODUCTION

1.1 Analysis of Filters

The filters were analysed by K2 Environmental Ltd.
K2 Environmental is accredited to ISO 17025 for the analysis of the high volume filters.

1.2 Filter Weights

Table 1 Alliance Lorneville Site

Sample Date	Total Volume (m^3)	Weight			Concentration
		Initial	Final	Gain	
		(g)			(µg/m^3, 0°C, 1atm)
20 May 2013	1548	4.43168	4.44013	0.0084	5.5
23 May 2013	1548	4.44041	4.44424	0.0038	2.5
28 May 2013	1558	4.41333	4.41578	0.0024	1.6
30 May 2013	1548	4.45102	4.4511	<0.0001	<0.5
4 June 2013	1548	4.44626	4.44791	0.0017	1.1
5 June 2013	1548	4.52528	4.52901	0.0037	2.4
10 June 2013	1548	4.54151	4.5452	0.0037	2.4
12 June 2013	1548	4.5157	4.5182	0.0025	1.6
15 June 2013	1549	4.53118	4.53256	0.0014	0.9
17-June-13	1548	4.54373	4.5464	0.0027	1.7
26-June-13	1548	4.5153	4.5218	0.0065	4.2
27-June-13	1548	4.51243	4.51603	0.0036	2.3
1-July-13	1548	4.54265	4.54566	0.0030	1.9
4-July-13	1548	4.51865	4.52278	0.0041	2.7
9-July-13	1547	4.50433	4.506	0.0017	1.1
11-July-13	1548	4.53441	4.53734	0.0029	1.9
15-July-13	1548	4.54277	4.54584	0.0031	2.0
16-Jul-13	1548	4.49217	4.49424	0.0021	1.3

17-Jul-13	1548	4.52468	4.53043	0.0057	3.7
22-Jul-13	1552	4.53196	4.53729	0.0053	3.4
25-Jul-13	1548	4.53295	4.53763	0.0047	3.0
29-Jul-13	1548	4.49396	4.4983	0.0043	2.8
31-Jul-13	1548	4.5449	4.55096	0.0061	3.9
5-Aug-13	1548	4.54653	4.55254	0.0060	3.9
7-Aug-13	1548	4.51031	4.51154	0.0012	0.8
12-Aug-13	1548	4.4968	4.50167	0.0049	3.1
14-Aug-13	1547	4.54128	4.54481	0.0035	2.3
19-Aug-13	1548	4.52888	4.53286	0.0040	2.6
20-Aug-13	1547	4.50861	4.52408	0.0155	10.0
26-Aug-13	1547	4.50023	4.50941	0.0092	5.9
2-Sep-13	1548	4.55214	4.56728	0.0151	9.8
3-Sep-13	1554	4.53333	4.54678	0.0134	8.7

For shaded results refer to section 1.3 – Results Discussion.

K2 Environmental has an air conditioning system installed in its Balance Room capable of maintaining a stable temperature +/-3ºC of set point and relative humidity stable within +/-5% of the set point. This is a requirement of the recently updated standard.

Table 2 Alliance Lorneville Site – Weather

Date	Weather conditions
20 May 2013	Fine/calm
23 May 2013	Fine
28 May 2013	Rain, moderate winds
30 May 2013	Plant operating, overcast/drizzle
4 June 2013	Plant operating, drizzle – fine
5 June 2013	Plant operating, overcast/drizzle, heavy fog
10 June 2013	Plant operating, fine
12 June 2013	Plant operating, overcast/fine
15 June 2013	Overcast/fine
17 June 2013	Plant operating, rain/drizzle
21 June 2013	Plant operating, overcast
26 June 2013	Plant operating, overcast
1 July 2013	Plant operating, fine
4 July 2013	Plant operating, fine
9 July 2013	Plant operating, fine

11 July 2013	Plant operating, fine
15 July 2013	Plant operating, overcast
16 July 2013	Overcast
17 July 2013	Fine
22 July 2013	Overcast/fine
25 July 2013	Rain/strong winds
29 July 2013	Overcast
31 July 2013	Overcast
5 August 2013	Plant not operating, fine sunshine
7 August 2013	Plant not operating, fine
12 August 2013	Plant not operating, overcast/drizzle
14 August 2013	Plant not operating, rain/overcast
19 August 2013	Plant not operating, fine, light northerly winds
20 August 2013	Plant not operating, fine, light northerly winds
26 August 2013	Plant not operating, fine, moderate westerly winds
2 September 2013	Plant not operating, fine, light winds
3 September 2013	Plant not operating, overcast, light westerly winds

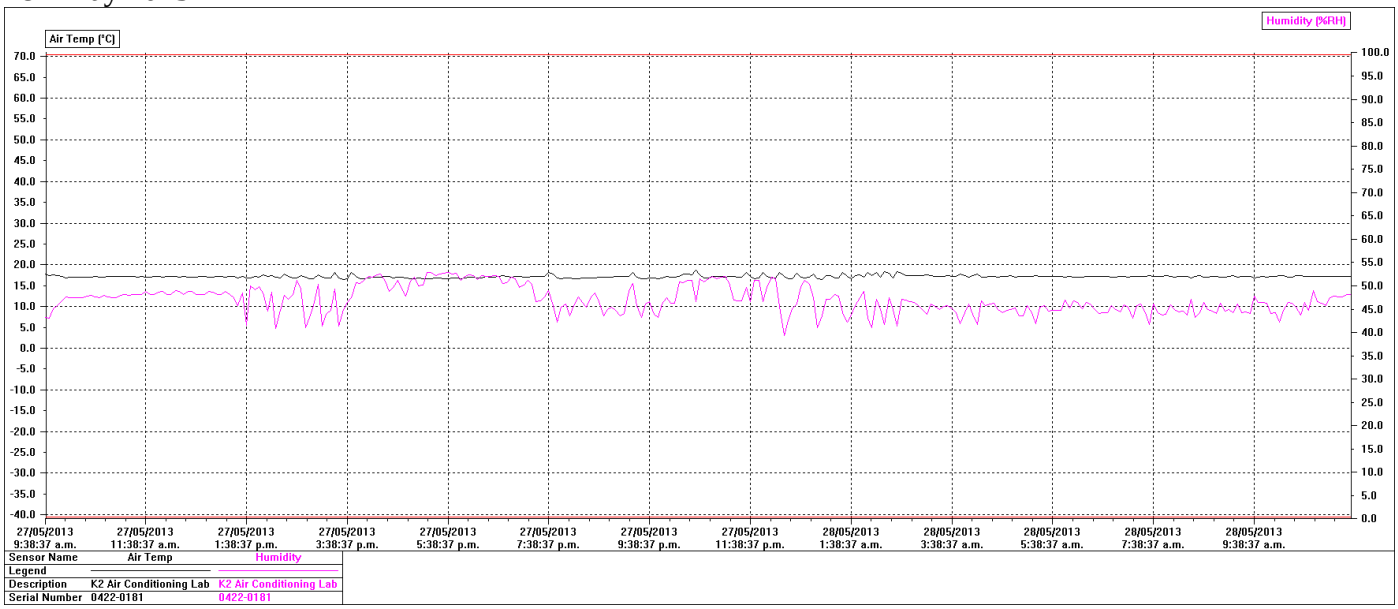
1.3 Results Discussion

The meter readings are recorded after each test and from these a flow rate is determined.

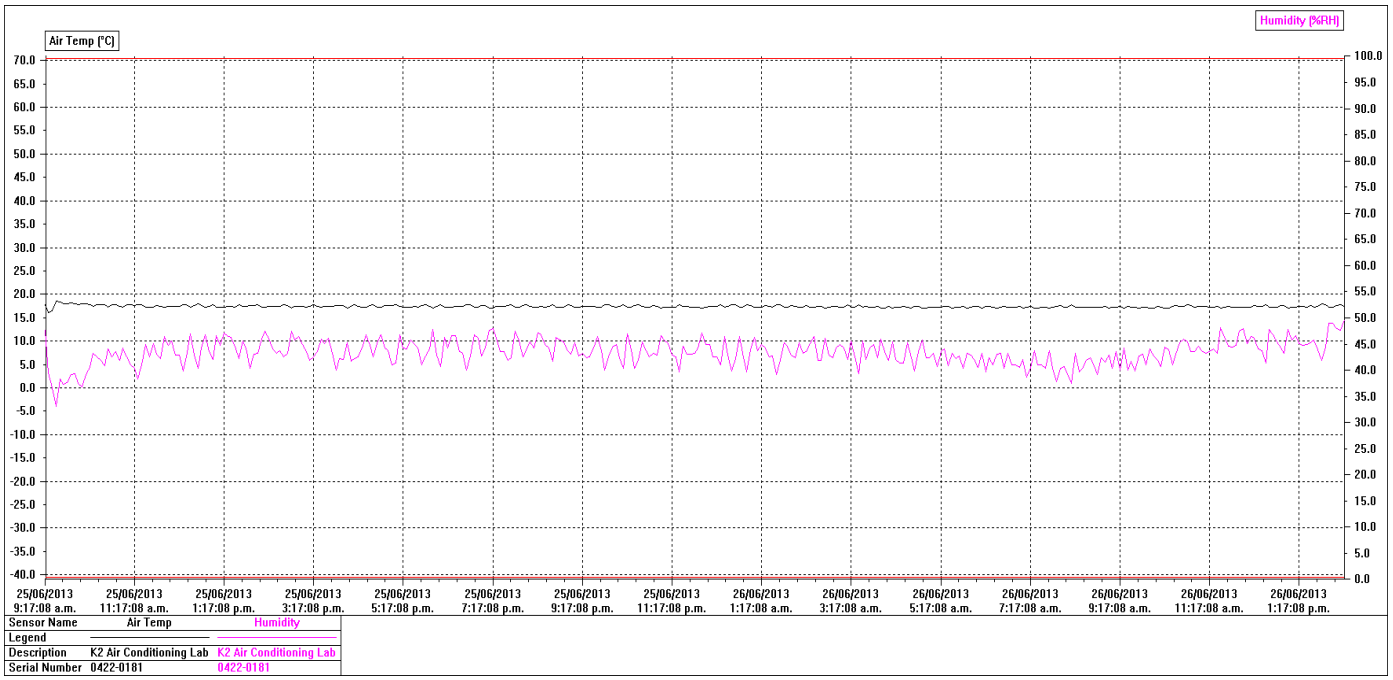
- The last four samples there was a drop in the flow rate by 30%.
- The colour in the last four filters shows a change – a comparative photo is provided.
- All previous samples the flow rate was consistent.
- Does the lower flow rate affect the cut size on the cyclone, is the particulate captured going to be true PM_{10} or contain higher sized particles?
- A post-test calibration check was carried out; however, when the calibration head was applied to the high volume sampler the readings were unstable.
- Confidence in the last four samples is low.

1.4 Temperature/Humidity Graphs

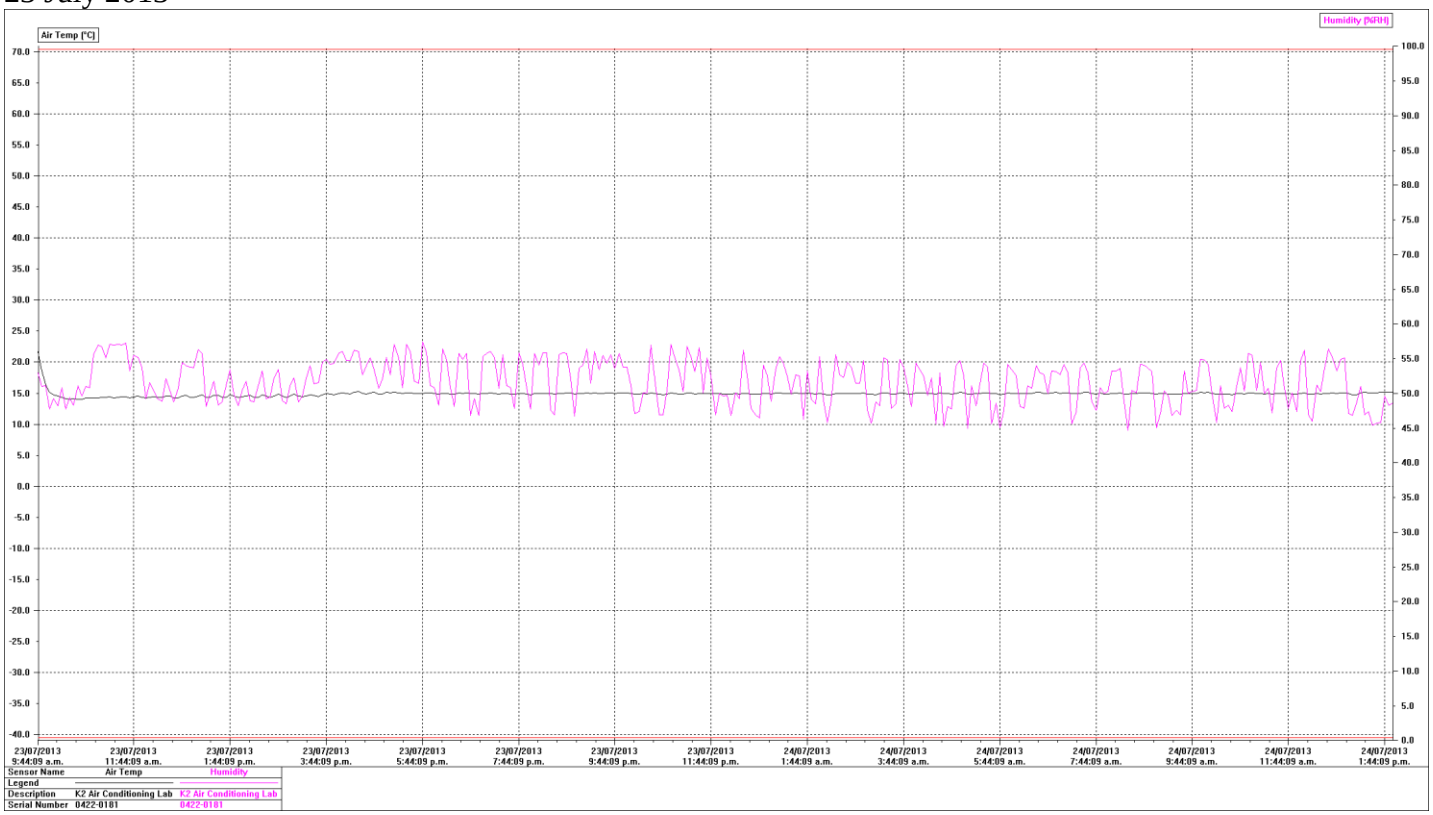
28th May 2013



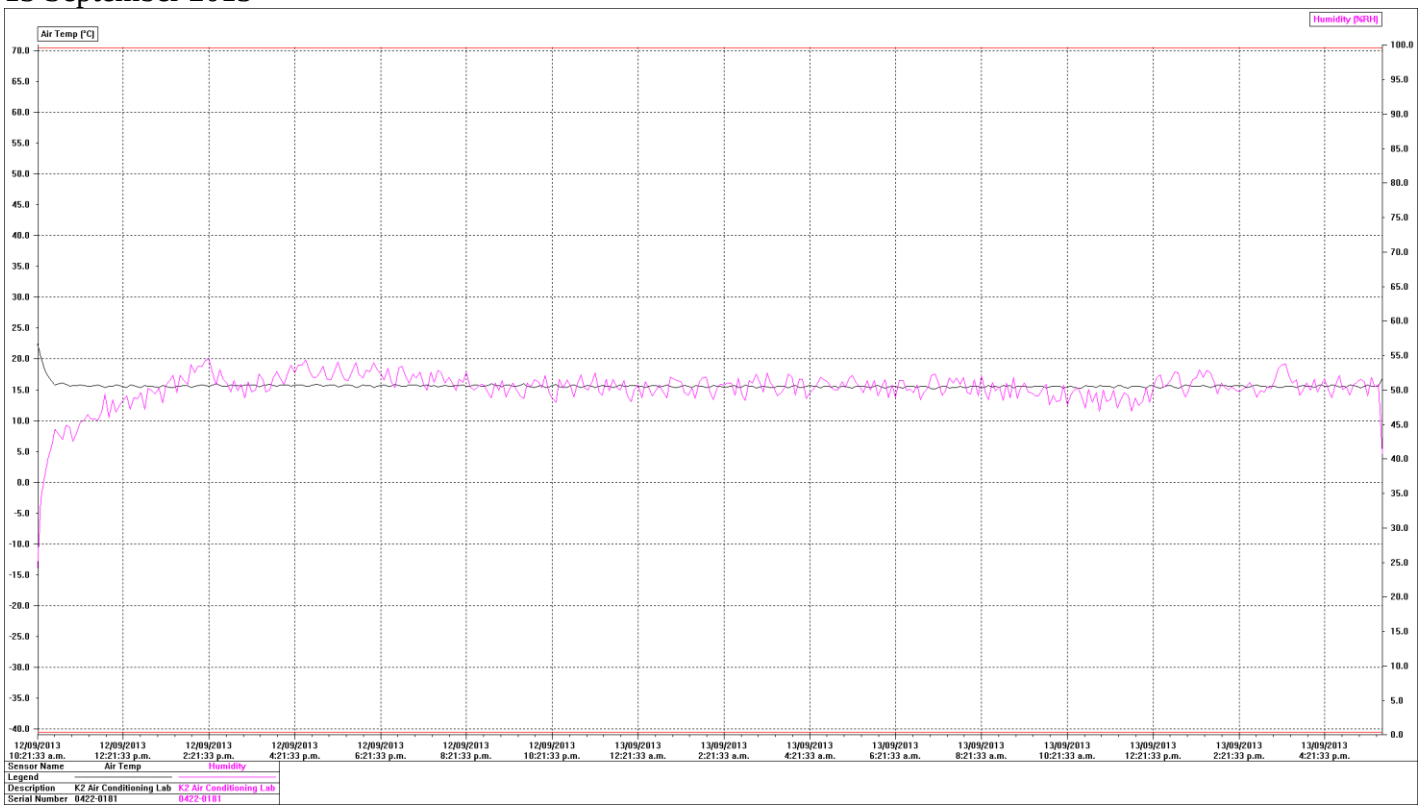
26th June 2013



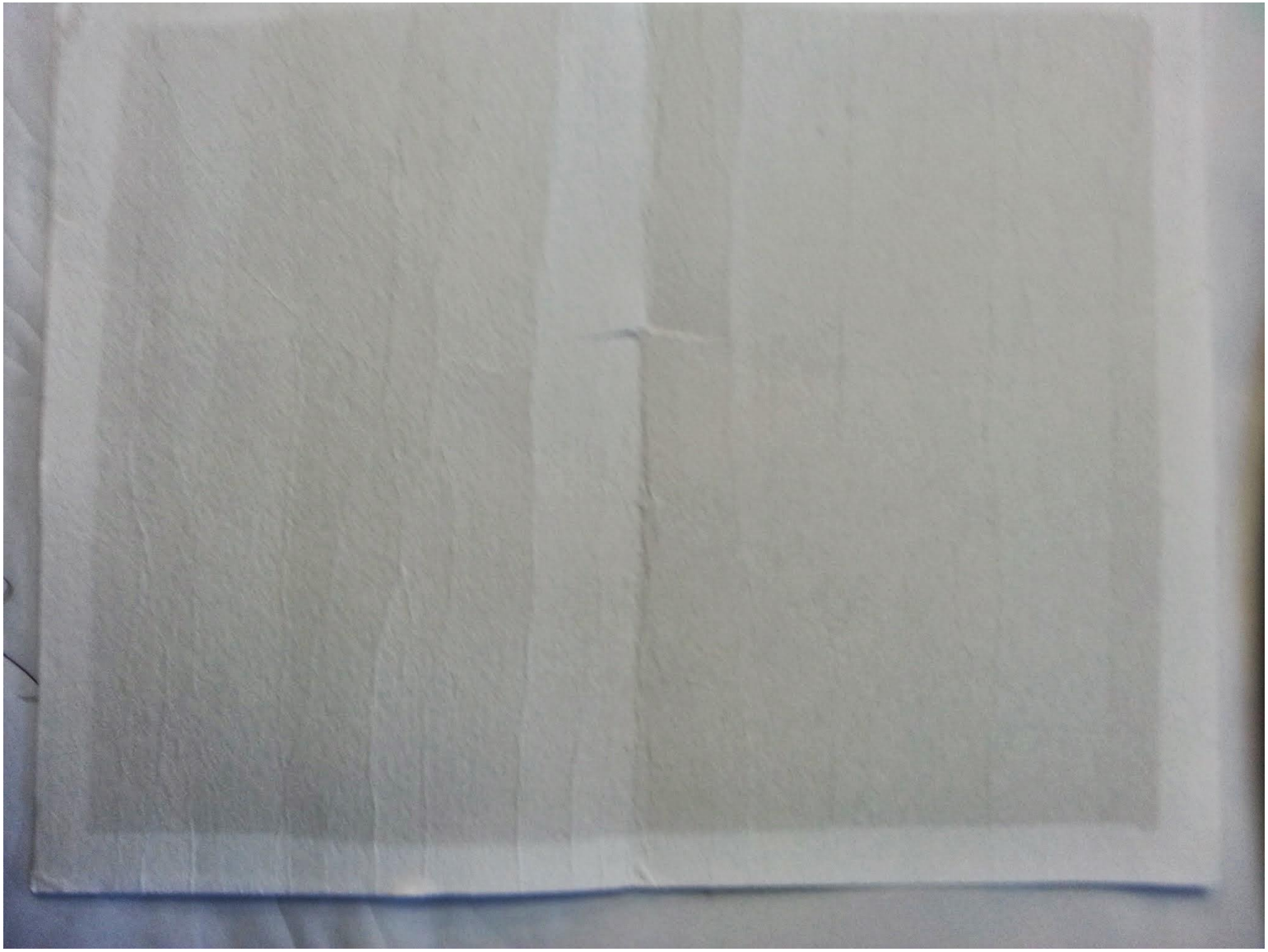
23 July 2013



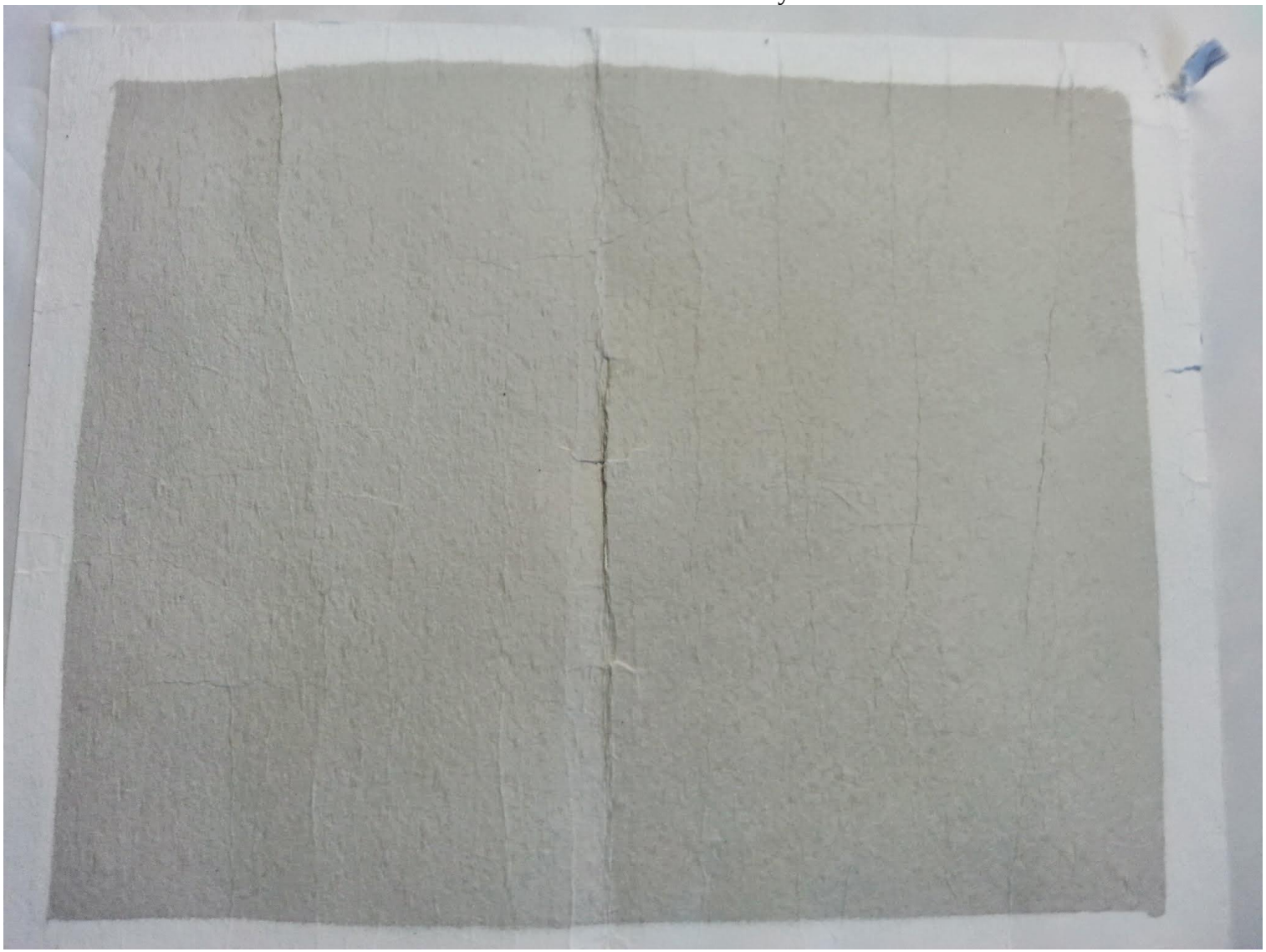
13 September 2013



5 June 2013 Filter

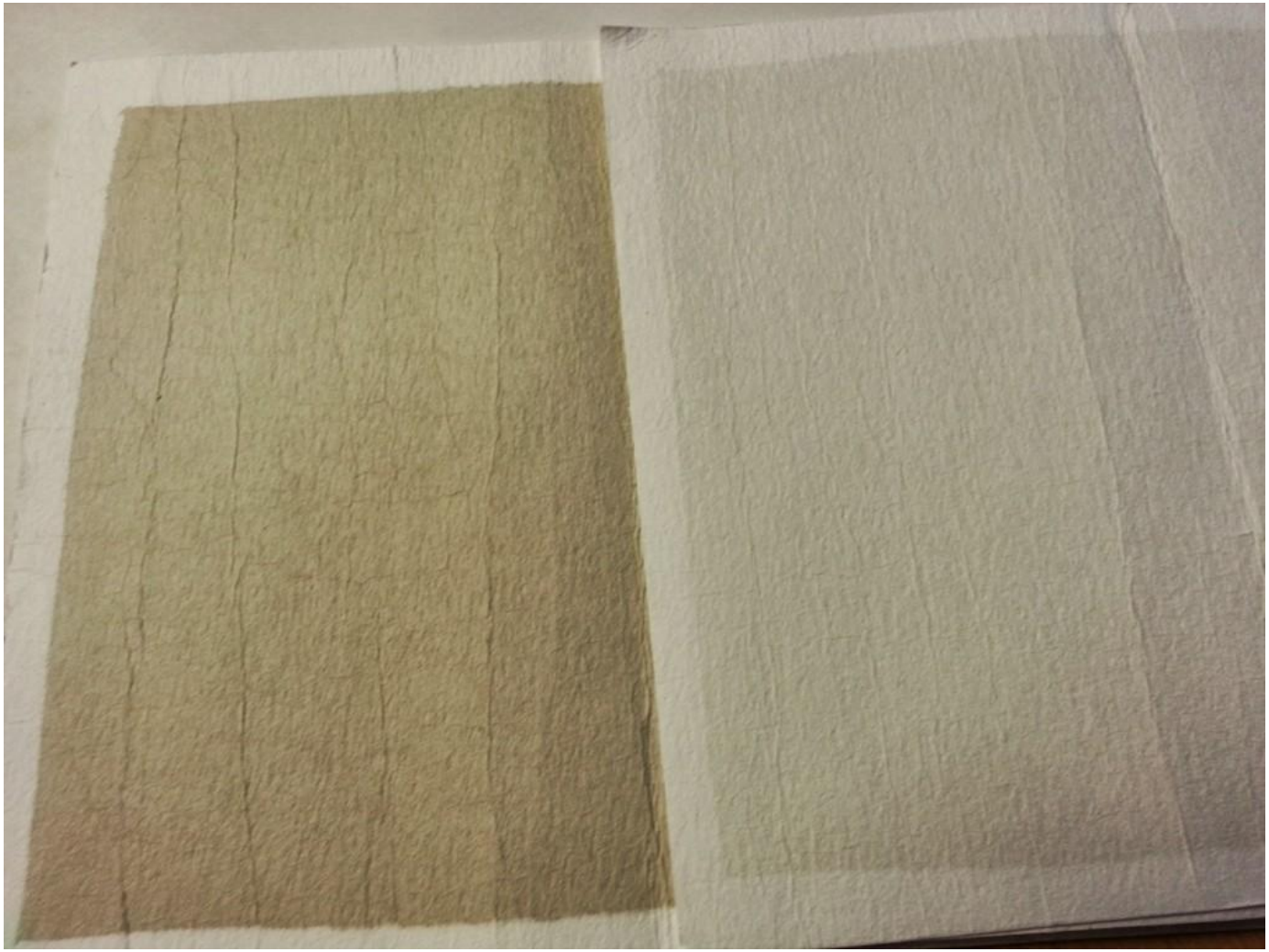


20 May Filter



The last four samples it has been noted that the results are higher. The filter colour is also noticeably darker as shown below.

20th August 2013 – 10 µg/m^3	7 August 2013 – 0.8 µg/m^3



APPENDIX B

PM_{10} Monitoring and Meteorological Conditions

Table B1 shows the predominant wind direction, wind speed and rain fall for each of the days that was sampled. The wind speed and wind direction data was obtained from the Wallacetown meteorological monitoring site operated by the MetService (Site Number 93878). The rainfall data was obtained from the Invercargill Airport monitoring site which is part of the National Climate Station network (Site number 12444) the closest site with rainfall data available.

Table B1: Results of the Alliance Lorneville PM_{10} monitoring programme.

Date	Start time	24-hour average PM_{10} concentration ($\mu g/m^3$)	Predominant wind speed Low < 2 ms^{-1} Med. 2 to 6 ms^{-1} High > 6 ms^{-1} (% of the day)	Predominant wind direction (% of day)	Rain Fall Low < 1 mm Med. 1 to 5 mm High > 5 mm
20-May-13	9:28am	5.5	Low to medium - 100 %	S to E- 88 %	Low
23-May-13	9:07am	2.5	Low to medium - 88 %	S to SW – 63 %	Low
28-May-13	10:27am	1.6	High – 67 %	SW to NW – 96 %	Med
30-May-13	9:15am	<0.5	Medium to high – 96 %	N – 75 %	High
4-Jun-13	9:47am	1.1	Medium - 79 %	N to NE – 71 %	None
5-Jun-13	9:50am	2.4	Low to medium – 96 %	N to E – 71 %	Low
10-Jun-13	10:35am	2.4	Low to medium – 100 %	N to NE – 100 %	None
12-Jun-13	2:25pm	1.6	Low to medium – 100 %	N to E – 58 %	Med
15-Jun-13	10:35am	0.9	Low - 50%	NE to SE – 88 %	None
17-Jun-13	9:21am	1.7	Medium – 54 %	E to SE – 92 %	Low
26-Jun-13	9:09am	4.2	Low to medium – 100 %	NW to N – 67 %	Low
27-Jun-13	9:13am	2.3	Low – 65 %	N to NE – 52 %	Med
1-Jul-13	9:03am	1.9	High – 79 %	NW to N – 88 %	Med
4-Jul-13	8:34am	2.7	High - 88 %	N – 75 %	High
9-Jul-13	12:38pm	1.1	Low to medium – 87 %	N to NE – 59 %	Med
11-Jul-13	11:00am	1.9	Low to medium - 100%	N to NE -96 %	None
15-Jul-13	9:50am	2	Medium – 96 %	W to N – 100 %	None
16-Jul-13	12:57pm	1.3	Medium to high – 87 %	NW to N – 79 %	Low
17-Jul-13	12:59pm	3.7	Low to medium – 88 %	W – 29 %, E 21 %	Low
22-Jul-13	11:54am	3.4	Low to medium – 87 %	N to E – 80 %	Low
25-Jul-13	1:14pm	3.0	High – 92 %	W to NW – 100 %	High

29-Jul-13	10:22am	2.8	Low to medium – 91 %	N to E – 100 %	Low
31-Jul-13	9:10am	3.9	Low – 46 %	SE to SW – 63 %	Med
5-Aug-13	9:15am	3.9	Medium – 67 %	N to NE – 54 %	None
7-Aug-13	10:35am	0.8	Medium – 67 %	N to NE – 83 %	Low
12-Aug-13	8:44am	3.1	Low to Medium – 83 %	NW to NE – 64 %	Low
14-Aug-13	8:25am	2.3	Medium to high – 84 %	W to N – 88 %	Med
19-Aug-13	12:41pm	2.6	Medium to high – 100 %	NE – 88 %	None
20-Aug-13	12:47pm	10.0	Low to medium – 92 %	NE to SE – 92 %	None
26-Aug-13	1:09pm	5.9	Medium to high – 100 %	W to N – 95 %	None
2-Sep-13	11:16am	9.8	Low to medium – 88 %	W to N – 67 %	None
3-Aug-13	1:14pm	8.7	High – 67 %	SW to W – 71 %	High

APPENDIX C

Watercare Ambient Air Quality Monitoring Report 2014

Site Meta Data

Site Name:	Alliance - Lorneville
Location Address:	237 Steel Road, Lorneville, Invercargill
Watercare Site Number:	AQGLS08
Date of Commission:	30 January 2014
Date of Decommission:	22 May 2014
Period of Data Requested:	31 January to 22 May 2014
Coordinates (NZTM):	E1240278, N485697
Site Class and Scale:	Neighbourhood, Industrial[1]
Equipment Owner:	Watercare Services Limited
Equipment Operator:	Watercare Services Limited (NZS/ISO/IEC 17025:2005)
Data Owner:	Golder Associates Limited
Equipment Housing:	Shed approx. 2.5 x 2.0 x 2.4m
Housing Environment:	Air-conditioned (at 25°C ± 3°C)

Monitoring Objectives:

The monitoring was carried out to examine the ambient air quality impact of the Alliance meat processing plant emissions. The Alliance plant is located at 205 State Highway 99 in Underwood, Invercargill. The monitoring was commissioned as part of a resource consent requirement.

Site Location:

The Alliance air quality monitoring station was located at 237 Steel Road on the border of Lorneville and Underwood, Invercargill. The site was situated in a paddock 70m behind the house, 190m west of Steel Road, 510m south of SH 99 and 695m east of the Alliance stacks. The area is prominently rural farm land, 1.8km west-southwest of Lorneville Township and 7.0km northwest of the Invercargill CBD. The local topography is flat with the Makarewa River 2.2km to the west.

There were no neighbouring trees that may affect the site's monitoring. However, there were tall trees 300m to the northwest and 120m to the southwest with a clear line of sight between the site and the stacks.

Major Emission Sources:	Industrial
Special Events:	None
Site Above Sea Level:	Approx 10 metres

[1] MfE Good Practice Guide for air quality monitoring and data management (2009) – Section 6.2 Site Selection Criteria

Pollutants Measured:

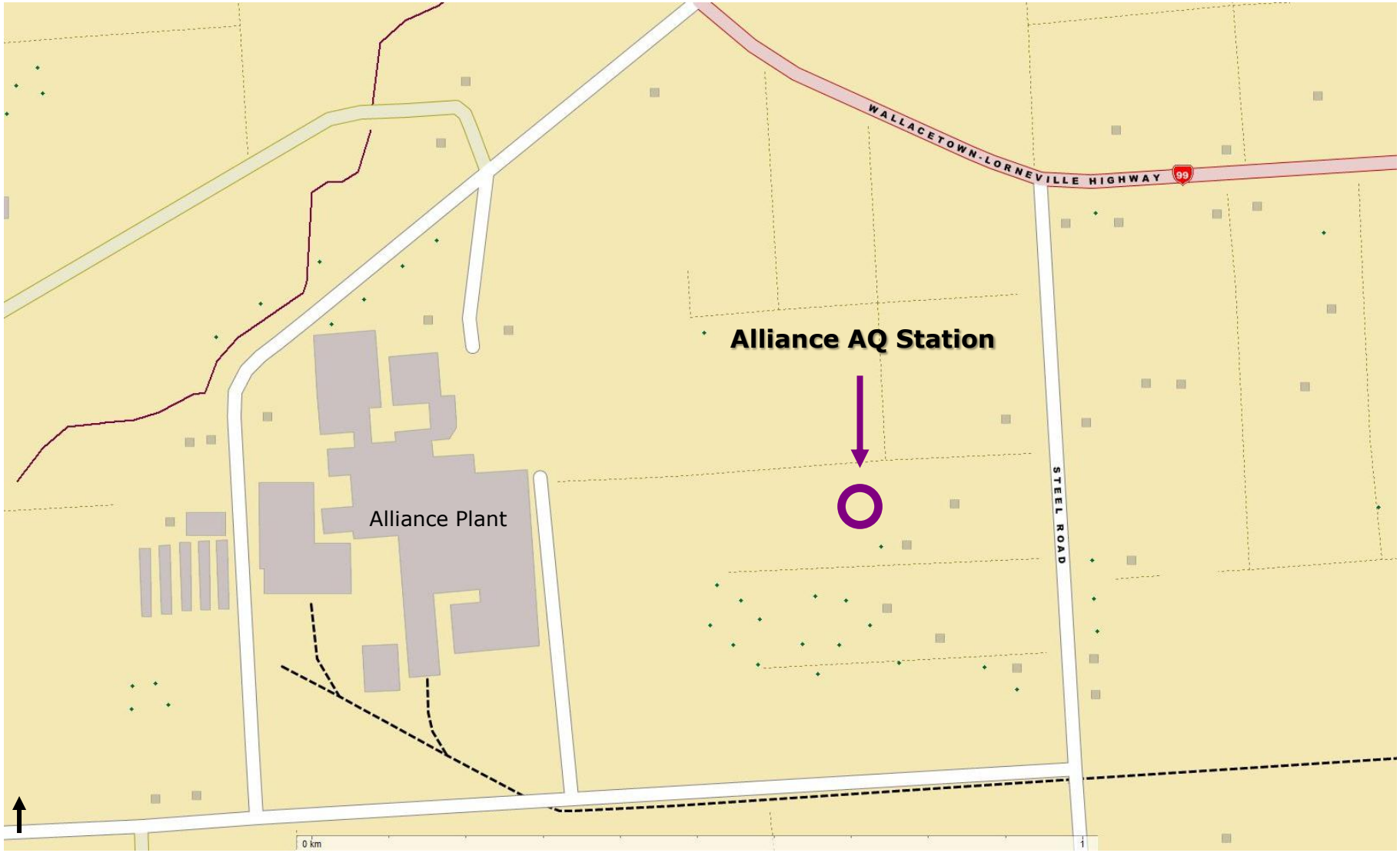
Sulfur Dioxide from 31 January 2014 00:10 to 22 May 2014 13:10 in accordance with AS 3580.4.1:2008 'Determination of sulfur dioxide—Direct reading instrumental method' using an Ecotech EC 9850

Particulate Matter as PM_{10} from 31 January 2014 00:10 to 22 May 2014 13:10 in accordance with AS/NZ 3580.9.11:2008 'Determination of suspended particulate matter—PM_{10} beta attenuation monitors' using a Thermo Series FH62-C14 Beta Attenuation Monitor (BAM)

Data Collection:	Daily data collection via IP router
Data Logger:	Envidas data logger (SQL db)
Sampling Period:	10 minutes
Calibration Frequency:	Autocalibrations performed on alternate days
Sample Inlet Specifications:	AS/NZS 3580.1.1:2007 Criteria[2]
Clear sky angle (>120°):	>120°
Unrestricted airflow (360°):	360°
Inlet height above ground:	3m
Nearest vertical structure:	No
Nearest major road:	Wallacetown – Lorneville SH 99 510m (north)
Nearest trees:	20m (below inlet level)
Boiler or incinerator nearby:	No
Meteorological Variables[3]:	Wind speed: from 09-04-2014 12:50 to 22-05-2014 13:10. (Metservice's Wallacetown site data from 31-01-2014 07:40 to 09-04-2014 12:40) Wind direction: from 31-01-2014 07:40 to 22-05-2014 13:10. (Recalculated using Metservice's Wallacetown site wind speed data from 31-01-2014 07:40 to 09-04-2014 12:40) Relative humidity: from 31-01-2014 00:10 to 22-05-2014 13:10. Ambient temperature: from 31-01-2014 00:10 to 22-05-2014 13:10.
Meteorological Mast Height:	6m from ground level (situated on top of shed)
Deviations from Siting Standard:	No

[2] AS/NZS 3580.1.1:2007 Methods for sampling and analysis of ambient air - Guide to siting air monitoring equipment
[3] MfE Good Practice Guide for air quality monitoring and data management (2009) – Recommendation 8 – Meteorological monitoring

Site Map


WALLACETOWN-LORNEVILLE HIGHWAY
99
Alliance AQ Station
Alliance Plant
STEEL ROAD
0 km
1

Photos

The photos on the left were taken facing west.

The photo on the right was taken facing south.

Instrument History

Instrument	Date	AQG	Planned Maintenance	Service Information	Technician
Gas Analyser – Sulphur Dioxide EC 9850					
	30/01/2014	1579	Quarterly Maintenance	Commissioned	B Kaushal
	12/02/2014	1579	Monthly Maintenance	Recalibration	B Kaushal
	14/03/2014	1579	Monthly Maintenance	Audit calibration	B Kaushal
	09/04/2014	1579	Monthly Maintenance	Recalibration	B Kaushal
	22/05/2014	1579	Monthly Maintenance	Decommissioned	B Kaushal
PM_{10} BAM – FH62-C14					
	30/01/2014	1730	Quarterly Maintenance	Commissioned	B Kaushal
	12/02/2014	1730	Monthly Maintenance	Parameters Checked	B Kaushal
	14/03/2014	1730	Monthly Maintenance	Parameters Checked	B Kaushal
	09/04/2014	1730	Monthly Maintenance	Parameters Checked	B Kaushal
	22/05/2014	1730	Monthly Maintenance	Decommissioned	B Kaushal
Gas Dilution Calibrator EC 1000					
	30/01/2014	987	Quarterly Maintenance	Commissioned	B Kaushal
	12/02/2014	987	Monthly Maintenance	Parameters Checked	B Kaushal
	14/03/2014	987	Monthly Maintenance	Parameters Checked	B Kaushal
	09/04/2014	987	Monthly Maintenance	Parameters Checked	B Kaushal
	22/05/2014	987	Monthly Maintenance	Decommissioned	B Kaushal
Vaisala WXT Weather Sensor					
	30/01/2014	1931	Six-Monthly Maintenance	Commissioned	B Kaushal
	12/02/2014	1931	Call out	Audit	B Kaushal
	14/03/2014	1931	Call out	Calibration	B Kaushal
	09/04/2014	1931	Six-Monthly Maintenance	Removed	B Kaushal
	09/04/2014	1857	Six-Monthly Maintenance	Installed	B Kaushal
	22/05/2014	1857	Six-Monthly Maintenance	Decommissioned	B Kaushal

Site Performance – 31 January to 22 May 2014

Parameters	Averaging period	Valid data (%)	Site notes
Sulfur Dioxide	10 min	92	No data from 05-02-2014 04:20 to 07-02-2014 10:40 and from 13-02-2014 11:10 to 18-02-2014 09:10. This was due to a water leak in the roof causing the circuit breaker to trip and disconnecting power to the station.
PM_{10}	10 min	93	
Ambient temperature	10 min	93	
Relative humidity	10 min	93	
Wind speed	10 min	93	
Wind direction	10 min	93	

Auto Calibration Setup

Instrument	Auto-calibration & duration	Times	Frequency
SO_2	Yes (40 minutes)	02:10 – 02:40	Alternate days
BAM PM_{10}	No	-	-

APPENDIX D

Watercare Validation History of Wind Speed and Wind Direction Data

Watercare Laboratory Services

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Our Ref.: O-2024390

03 June 2014

Wind Speed and Wind Direction Data Validation History – Alliance, Lorneville

This document contains the wind validation history of the wind speed and wind direction parameters at Alliance, Lorneville for the monitoring period 31 January 2014 to 22 May 2014. The meteorological sensor initially installed on 31 January 2014 was a Vaisala WXT Weather Sensor with the serial number F4020023 (AQG 1931).

At the initial installation, the wind direction sensor was incorrectly aligned to magnetic south as the field technician's compass was broken in transit to the site. This was corrected to true north from 31 January 2014 07:30 to 14 March 2014 10:00. To correct the data to true north this period 180° was added to the wind direction and the declination of 25° was subtracted.

The wind speed data were identified as variable and high over night. This was detected on 07 April 2014 and a site visit was undertaken on 09 April 2014. During the site visit the wind speed calibration audit was unstable and failed. This Vaisala WXT Weather Sensor was consequently replaced and sent back to the supplier (Ecotech) to conduct further calibrations. Based on the report from Ecotech, the wind speed sensor was unstable and that the data could not be recovered as the sensor could not be calibrated. The 10-minute wind speed averages from the Alliance, Lorneville site were invalidated from 31 January 2014 07:30 to 09 April 2014 12:40 and replaced with 10-minute wind speed averages from Metservice's Wallacetown station.

Due to the instability of the wind speed data and the vector relationship between wind speed and direction the 1-minute wind direction parameters were retrieved from the site data logger. The 1-minute arithmetic averaged wind direction results were used to recalculate vector averaged wind direction using 1-minute wind speed data from Metservice's Wallacetown station. This recalculated period was from 31 January 2014 07:30 to 09 April 2014 12:40.

The new meteorological sensor installed on 09 April 2014 was successfully calibrated on site. This wind speed and wind direction data were used to compared the wind speed and wind direction at Metservice's Wallacetown station without issue.

These issues will be addressed based on our in-house quality system procedures. We have registered this in our query system as a corrective action. If you have any queries please refer the query number 14-0299.

Yours sincerely

Kath McLeod
Senior Air Quality Technician
Ambient Data Management
Watercare Services Limited

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