

Presented to Technical Committee 25/11/15

Decision:

1. *That the report be received.*
2. *That the state of air quality in Otago be noted.*

REPORT

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Prepared For: Technical Committee

Prepared By: Director Engineering, Hazards and Science

Date: 23/10/2015

Subject: **2015 Air Quality Results**

1. Précis

Ambient air quality monitoring of PM₁₀¹ continued this year at eight sites throughout Otago. Year-round monitoring fulfilled requirements of the National Environmental Standard for Air Quality (NESAQ) at four sites: Alexandra, Arrowtown, Mosgiel and Central Dunedin. At the remaining four sites monitoring was performed from April-September.

The NESAQ sets a daily PM₁₀ threshold concentration of 50 micrograms per cubic metre of air ($\mu\text{g}/\text{m}^3$); one day a year over that threshold is allowed. The NESAQ sets a final compliance date of 1 September 2020, with an interim target of no more than three days over the threshold by 1 September 2016. Days with PM₁₀ greater than 50 $\mu\text{g}/\text{m}^3$ are referred to as exceedances, or high-pollution days.

The following table shows the number of days with PM₁₀ values exceeding 50 $\mu\text{g}/\text{m}^3$ this year at locations around Otago.

Table 1. Number of exceedances recorded at Otago PM₁₀ monitoring sites.

Location	Number of exceedance days
Alexandra	24
Arrowtown	29
Balclutha	11
Clyde	9
Cromwell	26
Dunedin	0
Milton	32
Mosgiel	8

Central Dunedin is meeting the NESAQ this year; no exceedances have been recorded to date for this calendar year. The remainder of the monitored centres have all had multiple exceedances, with Milton having the greatest number (32 days).

¹ Particulate matter with an aerodynamic diameter of less than 10 micrometres

All Central Otago towns had better-than-usual air quality this winter, with Alexandra and Cromwell having their lowest numbers of exceedances since continuous monitoring began in those towns (2005 in Alexandra, 2008 in Cromwell). The increased frequency of weather patterns favourable to dispersion is the likely cause of this result; this is discussed in Section 4 of this report.

2. Introduction

A 10-year State of the Environment (SoE) report was presented to Council earlier this year². That report described the current state of Otago's ambient air quality and the long-term trends in air quality over the 10 years from 2005 through 2014.

This annual State of the Environment report describes the monitoring results for 2015 and provides a comparison to the current ambient condition as reported in the 10-year SoE. The relationship of Otago airsheds to the NESAQ is also discussed.

3. Winter summary

Air quality monitors were operated in Alexandra, Arrowtown, Clyde, Cromwell, Balclutha, Central Dunedin, Milton and Mosgiel this year.

The key indicators in the table below show that the numbers of exceedances range from zero in Central Dunedin to 32 in Milton. The table also lists the maximum one-day values, the second-highest value, and the winter average (May – August) for each site.

Table 2. Annual summary statistics for daily PM₁₀ in 2015. (Unless noted, all units are µg/m³).

Location	Number of exceedances (days)	Winter average (May-Aug)	Maximum PM ₁₀	Second highest PM ₁₀
Alexandra	24	38	111	76
Arrowtown	29	38	168	148
Balclutha	11	31	72	70
Clyde	9	27	62	61
Cromwell	26	35	93	86
Dunedin	0	18	42	41
Milton	32	39	121	108
Mosgiel	8	27	93	80

A spreadsheet with a wider range of descriptive statistics for each site is attached.

4. Comparison to typical winter PM₁₀ conditions

A State of the Environment (SoE) paper was submitted to Council earlier this year describing the condition of ambient air quality in Otago. In the report, the typical situation was derived by aggregating PM₁₀ data over the three most recent years, 2012-2014. This was done to minimise the influence of annual climatic differences.

² Air Quality State of the Environment in Otago Report: 2005-2014, Report Number 2015/0927

PM₁₀ statistics for 2015 are compared to that aggregated dataset to see if this year's air quality was better or worse than usual at the monitored sites. Figures 1 and 2 show the following values for both 2015 and for the defined typical period (2012-2014):

- the number of exceedances, and
- the average winter PM₁₀

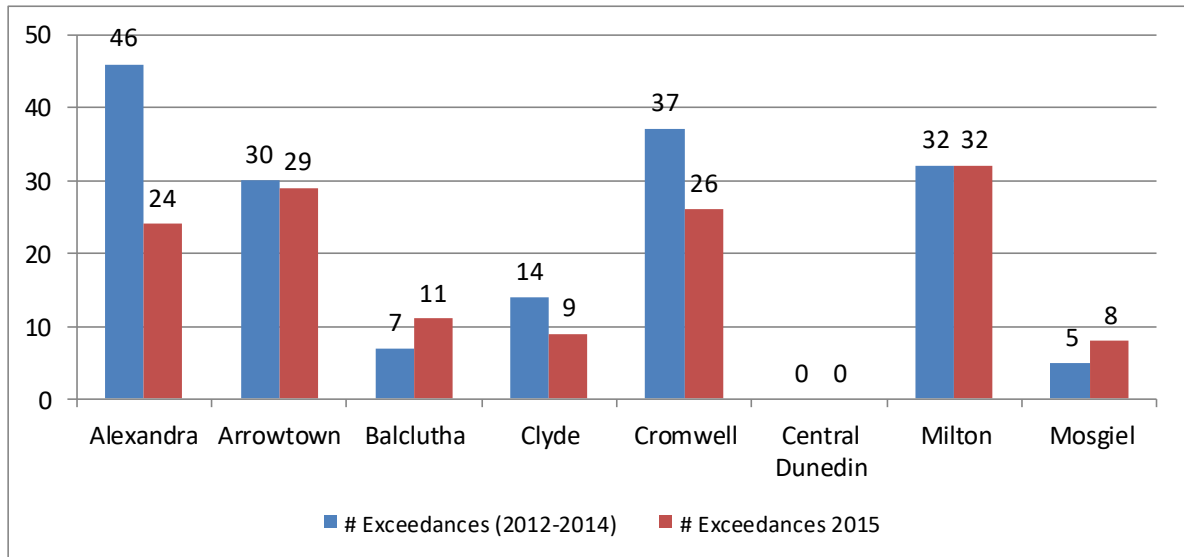


Figure 1. Comparison of number of days exceeding the NESAQ for 2015 (red bars) versus the typical condition (blue bars).

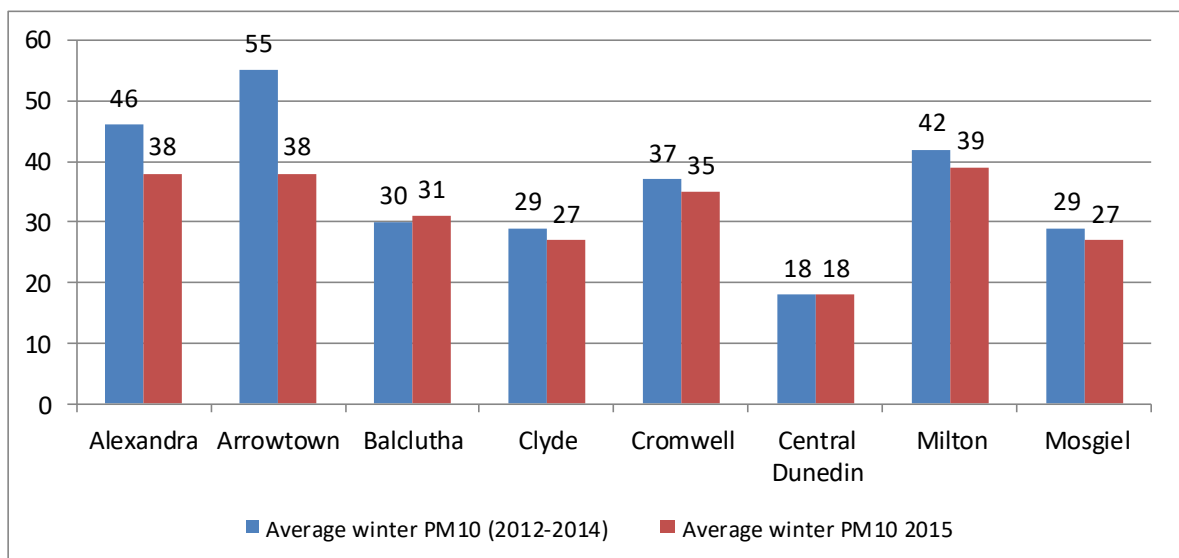


Figure 2. Comparison of average winter PM₁₀ for 2015 (red bars) versus the typical condition (blue bars).

These graphs show that this year ambient air quality was better than usual in most centres, particularly in Central Otago. The important features of this comparison include:

1. Alexandra had only 24 exceedances this year compared to the typical 46 days (Figure 1). This is the fewest number of exceedances ever recorded in Alexandra.
2. Cromwell had 26 exceedances, 11 fewer than the usual 37 days. This is the fewest number of exceedances ever recorded in Cromwell.³
3. The winter average for all sites, except Balclutha and Central Dunedin, was lower this year than usual. This was most pronounced in Arrowtown and Alexandra.
4. Central Dunedin continues to meet the national standard for daily PM₁₀ (50 µg/m³) and the World Health Organisation guideline for annual PM₁₀ (20 µg/m³).

Ambient PM₁₀ concentrations reflect the synergistic relationship of emissions and atmospheric conditions at any given time. This year's better-than-usual result in Central Otago implies that one or both of these settings were significantly different than in previous years. A brief discussion of both emissions and weather patterns follows.

Emissions

This calendar year⁴, 112 building consents were granted for installations of new burners into existing Central Otago residences located in Alexandra, Arrowtown, Clyde and Cromwell. The geographic breakdown follows:

- Alexandra 37 (includes the 5 Bridge Hill consents)
- Arrowtown 18
- Clyde 15
- Cromwell 42

These numbers are all tracking slightly behind 2014 consent numbers and are well down on most years. To provide some context, in Alexandra during 2011, 147 consents were issued for new wood burners; this was the greatest number in one year. On average, about 65 consents are issued each year in Alexandra over the past 11 years.

In 2006⁵, there were about 1400 solid-fuel burners in use in Alexandra, presumably none of them compliant with the 0.7 g/kg or 1.5 g/kg required emission rate. Since 2005, approximately 740 consents have been issued in Alexandra.

Based on these figures, it is reasonable to assume that the lower-than-usual PM₁₀ figures are not due to a sudden and large reduction in emissions.

³ In 2011, there were 20 exceedances reported, but only 56% of winter days were sampled.

⁴ Through the end of September 2015

⁵ Statistics New Zealand, 2013Census

Weather

According to NIWA's winter climate summary⁶, Central Otago experienced some of the lowest temperatures ever recorded in New Zealand during late June. This is reflected in the temperature record at the four Central Otago air quality monitoring sites where minimum temperatures were significantly lower this year than last.

In addition to low temperatures, the configuration of synoptic patterns this winter resulted in increased zonal flows (westerly winds) over the South Island, creating windier conditions in Central Otago.

A recent analysis of wind anomalies (differences from the normal situation) done by Greater Wellington Regional Council⁷ indicates that the strong El Niño conditions this year resulted in much more frequent periods of zonal (westerly) winds and stronger-than-normal seasonal average wind speeds. Figure 3 depicts the winter wind anomalies for the years 2012-2015. The red tones show stronger westerlies, a distinct feature of this winter's weather.

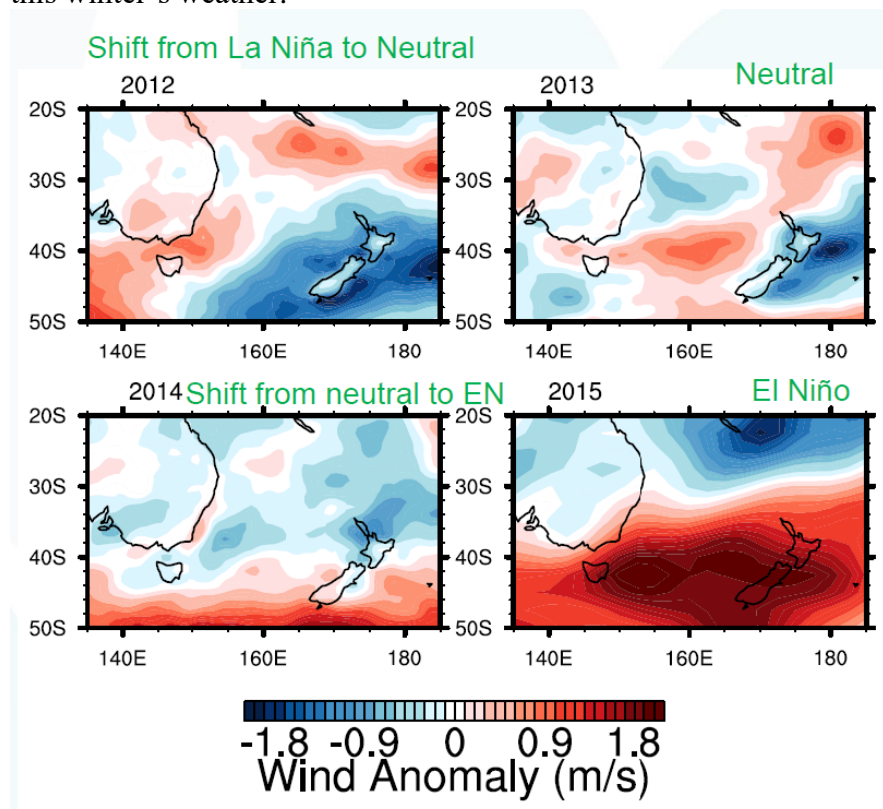


Figure 3. Winter (May-August) wind anomalies are shown from 2012-2015. Red tones indicate stronger westerlies, blue tones indicate weaker westerlies. Strong westerlies influenced the New Zealand weather this winter as evidenced by the bottom right-hand map where the large-scale climate dataset indicates that mean winter wind speeds were almost 2 m/s higher than normal this year.

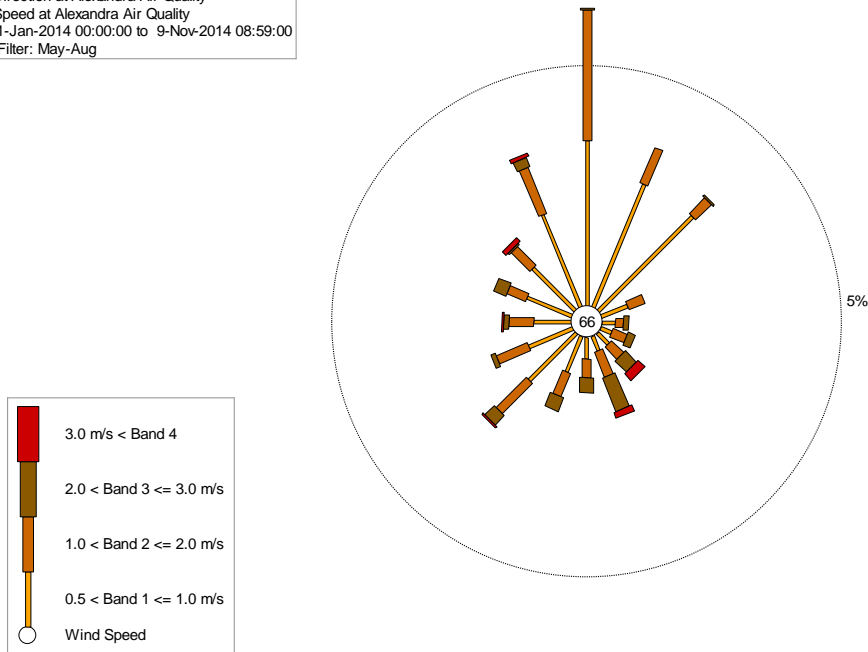
Examining the wind record in Alexandra revealed that there were fewer periods of calm winds this year as compared with last year (Figure 4). The percentage of hours with wind speeds less than 0.5 m/s for 2014 and 2015 is shown below for annual and winter time periods.

⁶ NIWA National Climate Centre, *Seasonal Climate Summary: Winter 2015*, Issued: 4 September 2015

⁷ Fiddes S., Pezza A., Mitchell T., Kozyniak K., Mills D.; *Synoptic weather evolution and climate drivers associated with winter air pollution in New Zealand*, under review

Time period	2014	2015
All year	57	43
Winter (May-Aug)	66	48

Wind Direction at Alexandra Air Quality
Wind Speed at Alexandra Air Quality
From 1-Jan-2014 00:00:00 to 9-Nov-2014 08:59:00
Month Filter: May-Aug



Wind Direction at Alexandra Air Quality
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From 1-Jan-2015 00:00:00 to 9-Nov-2015 08:59:00
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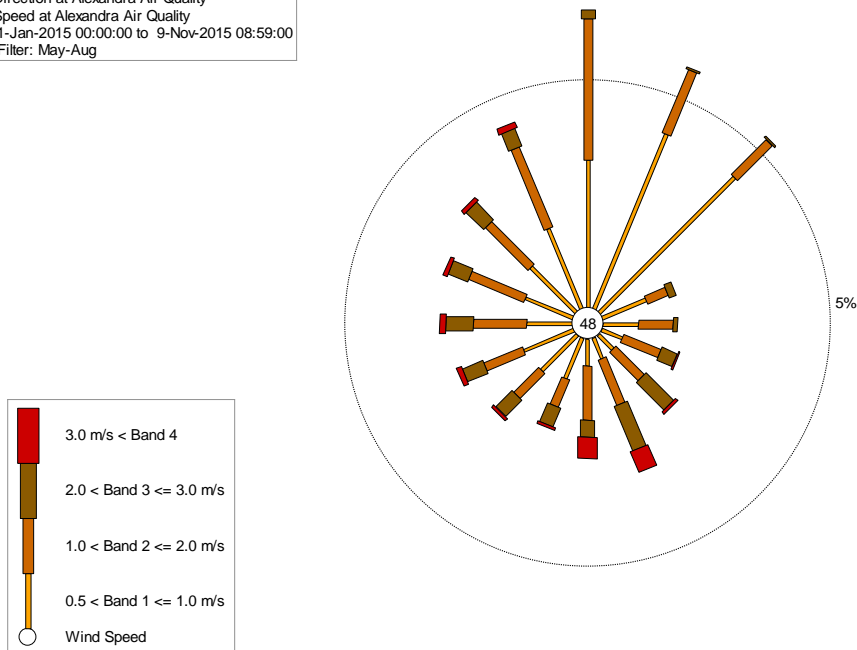


Figure 4. Alexandra winter wind roses for the past two years show that, overall, winter 2015 was windier than 2014 with considerably fewer periods of calm winds.

Discussions held at the recent National Air Quality Working Group meeting⁸ revealed that several councils across the country reported better-than-usual air quality results this winter.

These features point to the likelihood of increased dispersion of PM emissions this winter in Central Otago towns and underscore the influence that weather and climate have on air pollution.

5. Relation to NESAQ compliance

The NESAQ sets an average daily threshold concentration of 50 µg/m³ as sufficient for protecting public health. By 2020, only one exceedance per year is allowed. As an interim target, by 1 September 2016, three exceedances per year are allowed.

Currently, Central Dunedin meets the NESAQ target. All other monitored sites exceed the daily target on multiple days every year.

Given the results from this winter it is unlikely that most towns, particularly those in Central Otago, will meet the 2016 interim target.

6. Recommendations

1. That this report be received.
2. That the state of air quality in Otago be noted.

Gavin Palmer
Director Engineering, Hazards and Science

⁸ 29-30 October meeting of the National Air Quality Working Group, Wellington

2015	Alexandra	Arrowtown	Balclutha	Clyde	Cromwell	Dunedin	Milton	Mosgiel
Summary								
Winter average PM ₁₀ (May-Aug)	38	38	31	27	35	18	39	27
Number Exceedances (days)	24	29	11	9	26	0	32	8
Maximum PM ₁₀	111	168	72	62	93	42	121	93
2 nd highest PM ₁₀	76	148	70	61	86	41	108	80
Number of days > 100µg/m ³	1	7	0	0	0	0	2	0
Monthly exceedances (days)								
January	0					0		0
February	0					0		0
March	0					0		0
April	0	0	1	0	2	0	2	0
May	6	7	2	1	4	0	5	2
June	5	5	1	1	6	0	7	2
July	7	11	4	5	10	0	9	4
August	6	6	3	2	4	0	9	0
September	0	0	0	0	0	0	0	0
Winter days (123 days)								
# days < 35 µg/m ³	56	76	78	85	64	118	62	90
# days between 35-50 µg/m ³	43	18	31	29	19	2	31	16
# days > 50 µg/m ³	24	29	10	9	24	0	30	8
% days < 35 µg/m ³	46	62	66	69	60	98	50	79
% days between 35-50 µg/m ³	35	15	26	24	18	2	25	14
% days > 50 µg/m ³	20	24	8	7	22	0	24	7
Monthly averages								
May	37	32	29	24	30	17	35	25
June	35	38	28	24	32	14	39	25
July	43	54	35	31	44	19	43	32
August	37	29	32	30	36	20	39	26

