Environmental Science and Policy Committee

Meeting will be held in the Council Chamber, Level 2, Philip Laing House, 144 Rattray Street, Dunedin

This meeting will be livestreamed to the ORC Official YouTube Channel

Members:
Cr Lloyd McCall (Co-Chair)
Mr Edward Ellison (Co-Chair)
Ms Karen Coutts
Cr Alexa Forbes
Cr Gary Kelliher
Cr Michael Laws
Cr Kevin Malcolm
Cr Tim Mepham
Cr Andrew Noone
Cr Gretchen Robertson
Cr Bryan Scott
Cr Alan Somerville
Cr Elliot Weir
Cr Kate Wilson

Senior Officer: Richard Saunders, Chief Executive

Meeting Support: Trudi McLaren, Governance Support Officer

20 March 2024 09:00 AM

Agenda Topic Page

1. WELCOME

2. APOLOGIES

No apologies received at time of publication.

3. PUBLIC FORUM

Representatives of the Strath Taieri Irrigation Group.

4. CONFIRMATION OF AGENDA

Note: Any additions must be approved by resolution with an explanation as to why they cannot be delayed until a future meeting.

5. DECLARATION OF INTERESTS

Members are reminded of the need to stand aside from decision-making when a conflict arises between their role as an elected representative and any private or other external interest they might have. Councillor interests are published on the ORC website.

6. PRESENTATIONS

At the time of printing no requests to present had been received.

7. CONFIRMATION OF MINUTES 3

That the minutes of the Environmental Science and Policy Meeting of 13 December 2023 be received and confirmed as a true and accurate record.

8. OPEN ACTIONS FROM THE RESOLUTIONS OF THE COMMITTEE

There are currently no open actions for this committee.

9. MATTERS FOR CONSIDERATION 40

This report presents the results of two air quality projects undertaken during 2023: black carbon monitoring in Arrowtown and spatial PM10 monitoring in Alexandra.

This report presents the results of an air quality pilot study for sulphur dioxide (SO2) undertaken at Port Otago during 2022-2023.

This annual report discusses the results of the State of the Environment (SOE) monitoring for air quality for the year 2023.

10. CLOSURE

Otago Regional Council

Environmental Science and Policy Committee
MINUTES

Minutes of an ordinary meeting of the Environmental Policy and Science Committee held in the Council Chamber, Level 2 Philip Laing House, 144 Rattray Street, Dunedin on Wednesday 13 December 2023, commencing at 11:30 AM.

PRESENT

Edward Ellison	Chairperson
Cr Alexa Forbes (online)	
Cr Gary Kelliher	
Cr Kevin Malcolm	
Cr Lloyd McCall	
Cr Tim Mepham	
Cr Andrew Noone	
Cr Gretchen Robertson	
Cr Bryan Scott	
Cr Alan Somerville (online)	
Cr Elliot Weir	
Cr Kate Wilson	

1. WELCOME

Chairperson Edward Ellison welcomed Councillors, members of the public and staff to the meeting at 11:35a.m. Staff present included Richard Saunders (Chief Executive), Anita Dawe (GM Policy and Science), Gavin Palmer (GM Operations), Joanna Gilroy (Acting GM Regulatory), Amanda Vercoe (GM Governance, Culture and Customer), Kylie Darragh (Governance Support), Vita Manning (Senior Policy Analyst) Fleur Matthews (Manager Policy and Planning) Tom Dyer (Manager Science) James Adams (Senior Policy Analyst).

2. APOLOGIES

Resolution: Edward Ellison Moved, Cr Wilson Seconded:
That the apologies for Karen Coutts and Cr Michael Laws be accepted.
MOTION CARRIED

3. PUBLIC FORUM

Associate Professor Alexandra Macmillan spoke firstly from her role as deputy chair of the Cosy Homes Trust and secondly as an environmental health academic from the University of Otago. After speaking on behalf of the Cosy Homes Trust, on collaboration with ORC, there was an opportunity for questions from Councillors.

As an academic of Preventive and Social Medicine, Otago University Dr Macmillan spoke to the Air Plan Issues and the research around the health effects of air pollution on populations. There was time for Councillors to ask questions and Chair Ellison thanked Alexandra for attending.

4. CONFIRMATION OF AGENDA

It was moved by Edward Ellison and seconded by Cr Wilson:
That the agenda be confirmed as published.
CARRIED

5. DECLARATIONS OF INTERESTS

No changes to Councillor Declarations of Interests were noted.

6. PRESENTATIONS

No presentations were held.

7. CONFIRMATION OF MINUTES

Resolution ESP23-117: Cr Wilson Moved, Cr Mepham Seconded

That the minutes of the (public portion of the) Committee meeting held on 11 October 2023 be received and confirmed as a true and accurate record.
MOTION CARRIED

8. OPEN ACTIONS FROM RESOLUTIONS OF THE COMMITTEE

There are no current open actions for this committee.

9. MATTERS FOR CONSIDERATION

9.1. Otago Air Plan Issues and Options

This paper sought to approve issues and options to progress to phase 2 of ORC's Air Plan review, as the first stage of engagement. Vita Manning (Senior Policy Analyst) and James Adams (Senior Policy Analyst) and Anita Dawe (General Manager, Policy, and Science) were available to respond to questions.
The resolution was amended with the additional issues raised at the Air Plan Workshop; the Committee addressed the resolution in parts.

Resolution ESP23-118: Cr Wilson Moved, Cr Weir Seconded
That the Committee*:*

1. ***Confirm*** *the list of issues for engagement, including any additional issues developed through the Air Plan Review Issues and Options Workshop:*

- domestic heating
- outdoor burning
- vehicle emissions
- discharges from industrial and trade premises
- odour
- dust
- agrichemical spray drift

MOTION CARRIED

Resolution ESP23-119: Cr Wilson Moved, Cr Weir Seconded
That the Committee*:*

2. ***Confirm*** *the options for engagement on domestic heating, including seeking feedback on different fuel types and whether some options should apply in some or all of Otago, as:*

a) Option 1A: Status Quo: Domestic Heating Appliances in 'Zone 1' towns must meet the ULEB criteria.
b) Option 1B: New installations of solid fuel burners must meet ULEB standards.
c) Option 1C: Phase out Non-Ultra Low Emission Burners.
d) Option 1D: No new installations of burners in new dwellings or existing dwellings using other heating methods.
e) Option 1E: Phase out all solid fuel burners.
f) Option 1F: Non-regulatory Options: Behaviour change campaign.
g) NEW Option 1G: Phase out burning of coal.
h) NEW Option 1H: Promote regulatory and non-regulatory solutions for related matters, such as improvements to housing design and insulation.

MOTION CARRIED

Resolution ESP23-120: Cr Wilson Moved, Cr Malcolm Seconded
That the Committee*:*

3. ***Confirm*** *the list of options for engagement on outdoor burning as:*

a) Option 2A: Status Quo.
b) Option 2B: Ban outdoor burning over the winter months.

c) Option 2C: Require smoke management plans for large-scale / long-lasting outdoor burning events.
d) Option 2D: Ban outdoor burning on properties less than 2 hectares.
e) Option 2E: Require alternatives to burning.
f) Option 2F: Non-regulatory Options.

MOTION CARRIED

Resolution ESP23-121: Cr Scott Moved, Cr McCall Seconded
That the Committee*:*

3. ***Confirm*** *the list of options for engagement on outdoor burning as:*

g) NEW Option 2G: Consider numerical discharge limits for outdoor burning that would apply at a property boundary.

MOTION CARRIED

Resolution ESP23-122: Cr Weir Moved, Cr Noone Seconded
That the Committee*:*

4. ***Confirm*** *the list of options for engagement on vehicle emissions as outlined in Attachment 1.*

MOTION CARRIED

Resolution ESP23-123: Cr Wilson Moved, Cr Scott Seconded
That the Committee*:*

5. ***Confirm*** *the list of options for engagement on discharges from industrial and trade premises as outlined in Attachment 1.*

6. ***Confirm*** *the list of options for engagement on odour as outlined in Attachment 1.*

7. ***Confirm*** *the list of options for engagement on dust as outlined in Attachment 1.*

8. ***Confirm*** *the option for engagement on agrichemical spray drift is to "Update the existing rules for agrichemical spraying".*

9. ***Endorse*** *the lists of issues and options referred to in recommendations 1 to 8 as the basis for the first round of engagement for the Air Plan review.*

MOTION CARRIED

12. CLOSURE

There was no further business and Chairperson Ellison said a karakia and declared the meeting closed at 12:27p.m.

_____ _____
Chairperson Date

Air Plan: Issues and Options

Introduction

1.1 Purpose and structure of this Paper

1.1.1 This paper forms part of the Air Plan review and identifies issues and options related to air quality in Otago. It is intended to support discussion at the 13 December 2023 Environmental Science and Policy Committee workshop and subsequent meeting.

1.1.2 Staff require confirmation of the issues to be addressed through the Air Plan, and the range of approaches to be considered.

1.1.3 The paper is structured by topic area, setting out issues, contributing factors and options to address air pollution from domestic heating, outdoor burning, vehicle emissions and other sources.

1.2 Background

1.2.1 Air pollution is the largest environmental threat to human health and a contributor to non-communicable disease. Exposure to air pollution can cause and aggravate existing health issues, on both short and long-term scales. Health impacts range from reduced activity days through to premature death [1].

1.2.2 The National Environmental Standards for Air Quality (NESAQ) require regional councils to monitor urban areas where air quality exceeds the standards and take action to reduce emissions where a breach of the standards has occurred. The Air Plan, along with the Air Strategy and implementation plan, is crucial to meeting the Council's obligations under the NESAQ. Beyond urban areas, air quality sits under the remit of sustainable management under the RMA.

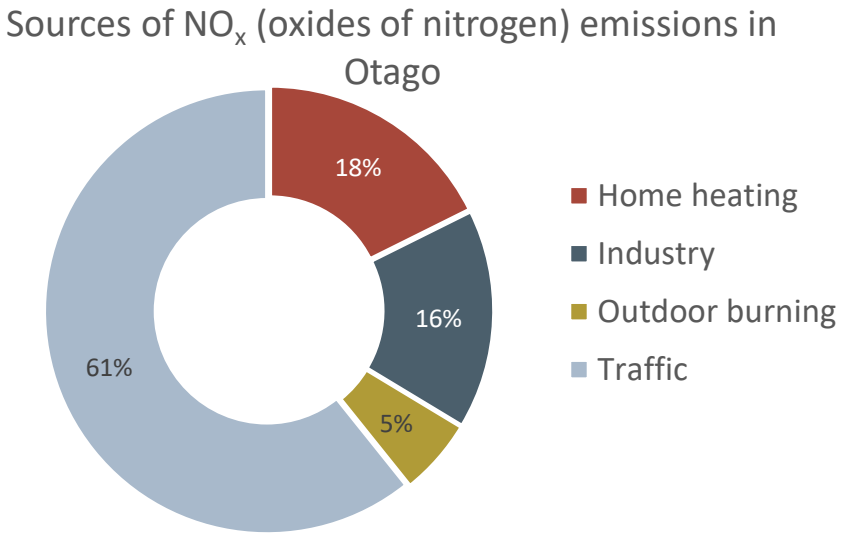
1.2.3 The existing Otago Regional Plan: Air (Air Plan) was prepared under the Resource Management Act 1991 (RMA) and was made operative in 2003, followed by updates in 2006 and 2009. The RMA requires that the Air Plan be reviewed no later than 10 years from the date upon which it becomes operative. The Air Plan review started in May 2023.

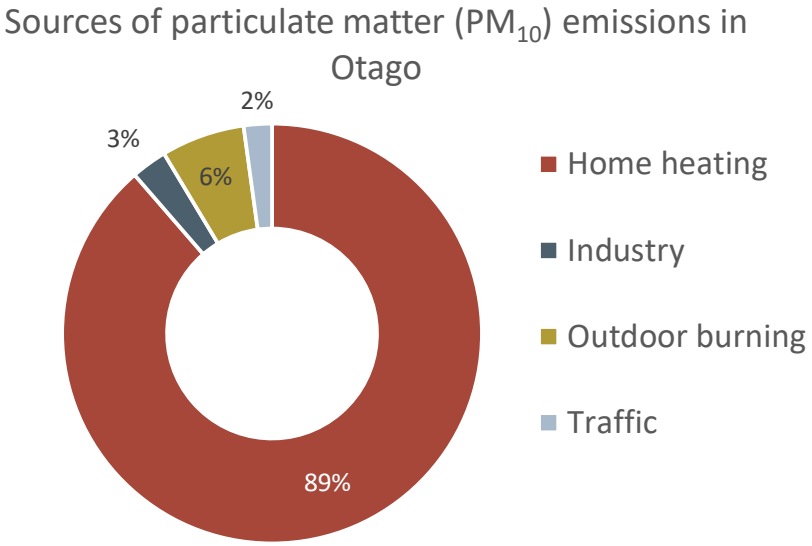
1.2.4 The Air Plan review provides an opportunity to consider how the existing rules can be amended and/or new rules developed to tackle air pollution. Rules need to be measurable and enforceable, and definitions need to be clear.

1.2.5 The sources of emissions for air pollution are the same sources which contribute to climate change. The Air Plan review provides the opportunity to improve air quality alongside the co-benefits of reducing carbon emissions which will assist with achieving the national target for emissions reduction.

[1] Health and air pollution in New Zealand 2016 (HAPINZ 3.0)

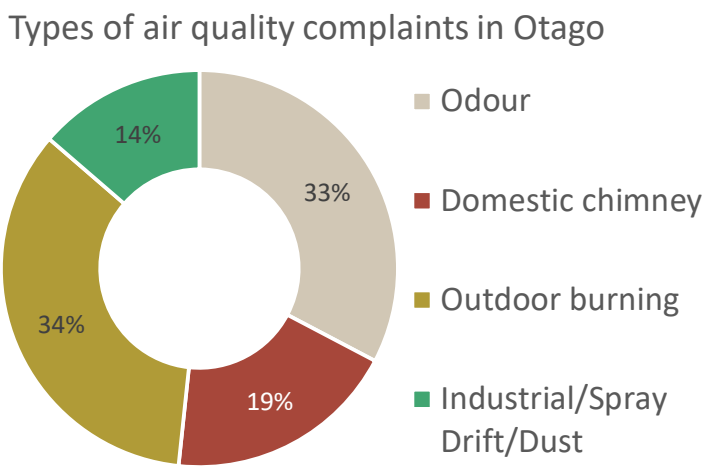
1.2.6 The main pollutants of concern in Otago are particulate matter (PM_{10} and $PM_{2.5}$) and nitrogen oxides (NO_X). The main sources of these air pollutants are set out in the diagrams below[2], along with the types of complaints received by the council about air quality[3].





[2] Information taken from Wilton, E. (2016). Alexandra, Arrowtown, Mosgiel and Milton Air Emission Inventory – 2016. Environet Limited and Wilton, E. (2019). Wanaka, Cromwell and Clyde Air Emission Inventory – 2019. Environet Limited.

[3] Information taken from ORC's complaints database 2016-2022.


Types of air quality complaints in Otago
14%
33%
34%
19%
Odour
Domestic chimney
Outdoor burning
Industrial/Spray Drift/Dust

3

1.3 Issues and Options development

1.3.1 This Issues and Options paper is the culmination of work by staff across the council since May 2023. Work includes analysis of air quality monitoring and public health research, national legislation and policies, the proposed RPS, and the effectiveness of rules in the existing Air Plan. Staff have also been investigating what other regional councils are doing in their recent Air Plans, particularly our regional neighbours, and seeing where we might be able to align our own Air Plan.

1.3.2 A workshop for the Environmental Science and Policy (ESP) committee members on the Air Plan review was held in September 2023. Committee members were invited to put forward their ideas to address some key issues and identify the level of intervention required. A summary of these responses is set out for each topic area below.

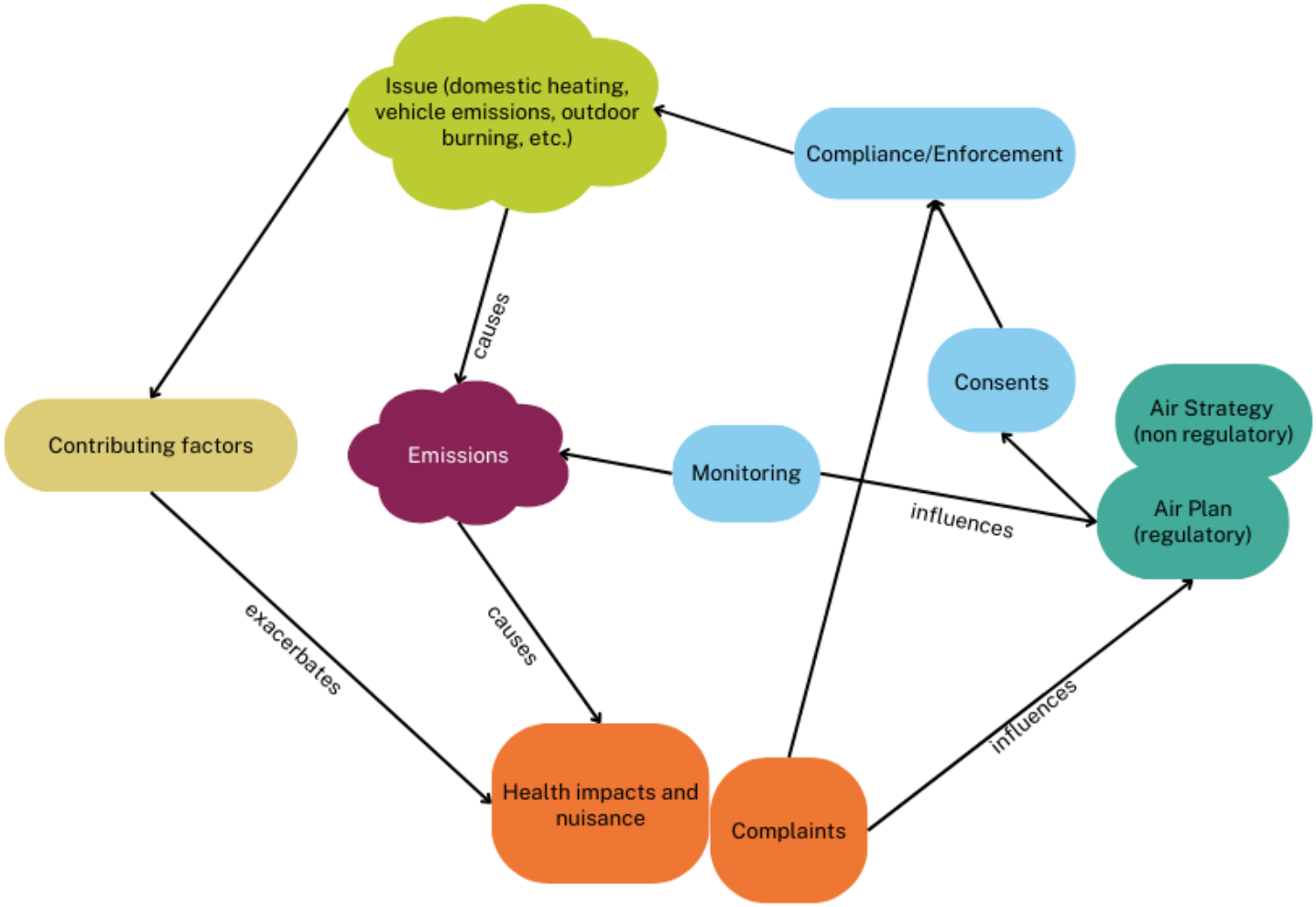
1.3.3 A consultant, specialising in air science, has been engaged to provide independent expert advice and look in detail at options to reduce pollution from domestic burners in our towns. A full Technical Paper will be available to support the next stages of the Air Plan review for stakeholders, and will be made available to the Committee ahead of that engagement.

1.4 Assessing options

1.4.1 Options have been developed to address the issues and contributing factors. Except for the status quo, the options are not mutually exclusive and ***all, some*** or ***none*** can be chosen. The aim of the options is to minimise the health impacts and nuisance from discharges to air. Other options may be put forward through engagement. A high-level assessment of the costs and benefits for each option is also included and these will be developed further throughout the Plan-making process, culminating in forming part of the section 32 analysis required to support plan reviews.

1.4.2 At a strategic level, councillors may wish to consider whether the Air Plan should tailor air quality management options to each specific town, or group of towns, or if some of the proposed interventions should apply across all urban areas, or across all Otago.

1.4.3 The diagram below shows how the Air Plan review is taking account of the sources of air pollution, contributing factors, health impacts and monitoring data; and how the Air Plan can influence the consenting and compliance/enforcement functions of council.


Issue (domestic heating, vehicle emissions, outdoor burning, etc.)
Compliance/Enforcement
causes
Consents
Air Strategy (non regulatory)
Contributing factors
Emissions
Monitoring
Air Plan (regulatory)
influences
exacerbates
causes
Health impacts and nuisance
Complaints
influences

5

Issue 1: Domestic heating

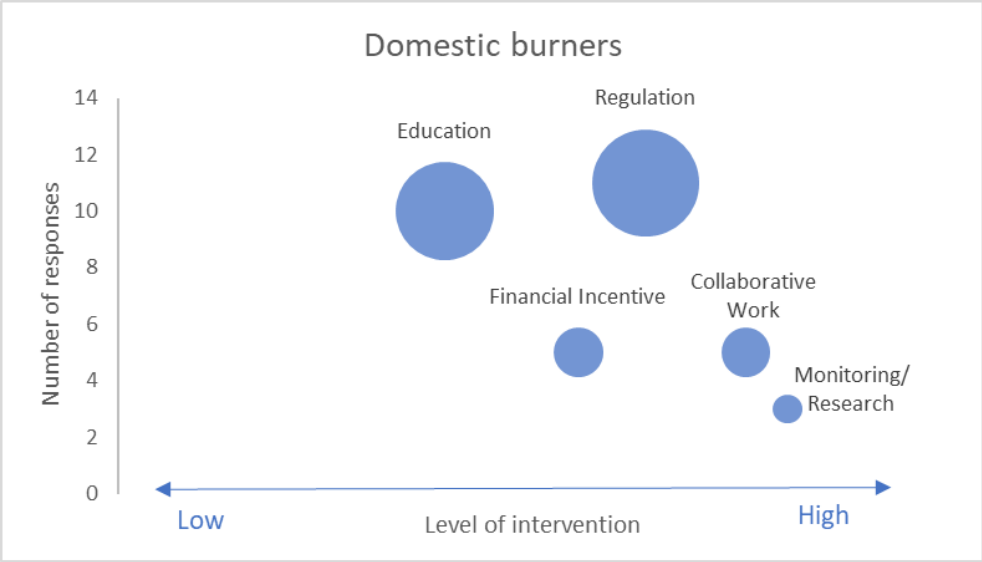
2.1 Introduction

2.1.1 Solid fuel burning for domestic home heating is used extensively throughout Otago. Solid fuel heating appliances in Otago include wood burners (most commonly used), pellet burners, open fires, and multi fuel burners (wood and coal). Solid fuel burners are the main source of air pollution in Otago's urban areas. Solid fuel burners contribute an average of 89% of particulate matter (PM_{10}) and 18% of nitrogen oxides (NO_x) emissions to the air people breathe. Exposure to harmful emissions produced by solid fuel burners cause harm to human health and has been found to contribute to premature deaths. Burning also releases carbon dioxide which contributes to climate change.

2.1.2 Solid fuel burners contribute an average of 89% of particulate matter (PM_{10}) and 18% of nitrogen oxides (NO_x) emissions to the air people breathe. A report[4] has been commissioned for the Air Plan review to evaluate management options to reduce particulate matter from domestic heating to meet requirements of the NESAQ and its initial findings have informed the options in this paper. "Domestic chimneys" generate a fifth of complaints to the pollution hotline (194 complaints in 2022).

2.2 Committee Workshop

2.2.1 A workshop on the Air Plan review was held in September 2023. ESP Committee members were invited to consider a number of key topic areas, including domestic heating, and put forward their ideas to address the issue and level of intervention. A summary of the types of responses is set out in the diagram below. These responses have helped develop the options to minimise the health impacts and nuisance from domestic burning.



[4] "Air Quality Management In Otago: An evaluation of management options to achieve air quality targets for PM10 and PM2.5 in Arrowtown, Clyde, Clyde, Cromwell, Milton and Mosgiel."
This report will be available mid-December 2023.

2.3 Contributing Factors

2.3.1 There are a number of contributing factors which exacerbate the health impacts and nuisance of discharges from domestic heating which are set out below.

Factor 1.1: Technology of Burner

2.3.2 Domestic heating appliances must meet an emissions limit (described as grams of particulate per kilogram of fuel burnt or g/kg) and an efficiency requirement (described as a percentage). The NESAQ requires all new wood burners on properties less than 2 hectares to have emissions of less than 1.5 g/kg and a thermal efficiency of not less than 65%. Burners that meet this standard are known as Low Emissions Burners (LEB). Otago's current Air Plan is more stringent and requires an emissions standard for new burners of 0.7 g/kg in 'Zone 1' towns[5]. Burners that meet this standard are known as Ultra Low Emissions Burners (ULEB). The Ministry for the Environment (MfE) has produced a list of authorised wood burners to help purchasers and building consent officers find compliant models. However, many older burners continue to be used in urban areas, including coal burning appliances; these may not meet the required emissions standards and can be more polluting. A growing number of homes use electricity for heating, for example heat pumps, which does not contribute to air pollution.

Factor 1.2: Operation of Burners

2.3.3 Regardless of whether households have a ULEB or LEB, the burner needs to be operated properly to ensure a smoke-free burning technique and a reduction in emissions. These include building the fire correctly, using dry wood, not burning any prohibited materials, correct use of air control and cleaning the flue system.

Factor 1.3: Costs

2.3.4 The cost of buying, installing and operating a ULEB is similar to a LEB and non-compliant burners. Heat pumps can be more expensive to run than wood burners because of the cost of electricity from the grid; however, installation of renewable energy sources such as solar panels has the potential to off-set this in the longer term.

2.3.5 The attractiveness of wood burners as a heating option is likely a combination of the relatively low operating cost (some households can source firewood for free or low cost) and the ability to heat larger spaces or less insulated properties. Operational costs for electric heating options are likely to be higher, both in terms of electricity prices and the relative efficiency of a heat pump to heat larger spaces. Reliability of electricity supply is also a factor when households are considering a move away from burners for heating. The ability of households to improve home insulation will also have an impact on running costs.

Factor 1.4: Weather conditions

2.3.6 The impact of discharges from domestic heating tends to be worse in winter because burners are used more in colder weather but the inversion layer means the smoke cannot disperse. Wind speed and direction is also a factor in the impact of smoke on adjacent properties. Very cold winter temperatures mean that some form of heating is required in all of Otago's homes and places of work.

Factor 1.5: Applying the Air Plan Rules

[5] Alexandra, Arrowtown, Clyde, Cromwell

2.3.7 Currently there are different rules for domestic heating burners depending on the size and location of the property. This can create uncertainty for householders around which rules apply to their circumstances. Small-scale commercial burners are not currently included in the rules, although the effects on air pollution are the same. This type of approach brings up a question of equity; should some households be restricted to ultra low emission burners while other households and commercial properties be allowed to operate high emission burners?

Factor 1.6: Enforcement

2.3.8 In order for the council to enforce the provisions of the Air Plan, rules need to be clear and measurable, and staff must be able to investigate and collect evidence of any breach. ORC staff do not enter people's homes and so evidence of a breach must be collected from outside the property. Clear and measurable rules could include a no visible smoke rule such as the one in Environment Canterbury's Air Plan. There are still monitoring challenges around this as often people don't light their fires until the evenings which would require an adjustment to our monitoring approach.

Factor 1.7: National Standards

2.3.9 The NESAQ rules about burners only apply to wood burners. MfE explains that there is no list of authorised multi-fuel burners (including coal burners) or open fires as these are not recommended forms of heating because of the increased particulate matter emissions they produce. The proposed amendments to the NESAQ included reducing the emission standard to no more than 1.0g/kg (down from 1.5g/kg) and applying this to all types of new domestic solid-fuel burners, including coal burners, multi-fuel burners, pellet burners, open fires, cookers, and water boilers.

2.3.10 Insulation affects the amount of fuel needed to heat a home. Thermal insulation standards are set out in the Building Code. Territorial Authorities are the building consent authority and are responsible for ensuring new buildings are compliant with the Building Code. There is currently no requirement to upgrade existing non-compliant homes unless they are rental properties, when the Healthy Homes standards would apply[6]. All new building work is required to comply with the Building Code.

2.4 Options

Option 1A: Status Quo: Domestic Heating Appliances in 'Zone 1' towns must meet the ULEB criteria

2.4.1 The current Air Plan rules, which have been in place since 2009, require new installations of wood burners in 'Zone 1' towns to meet the ULEB standards and new installations in other urban areas to meet LEB standards. The rules also include a phasing out of older burners by 2013. This target has not been achieved, resulting in some households operating burners that are technically prohibited.

Option 1B: New installations of solid fuel burners must meet ULEB standards

2.4.2 Require new installations of all types of solid fuel burners to meet the ULEB criteria. This option could be applied to either all properties in 'Zone 1' towns, properties in all urban areas, all properties less than 2ha, or all properties in Otago. This approach should be supported by new 'good practice' rules to ensure that the maximum benefit of ULEBs is realised and that enforcement is possible. Examples of new rules include types of permitted

[6] Healthy homes standards - Te Tūāpapa Kura Kāinga - Ministry of Housing and Urban Development (hud.govt.nz)

fuel, operation of burners in line with the manufacturer's manual, and no visible smoke for more than 15 minutes after start-up and 5 minutes after refuelling. These types of regulation have been applied in neighbouring regions.

2.4.3 The Air Plan review could also explore emissions requirements for all small-scale burners, including commercial heaters, diesel or gas burning devices, as well as other types of domestic heating.

Option 1C: Phase out Non- Ultra Low Emission Burners

2.4.4 Phase out burners not meeting the ULEB criteria over a certain time. While burner replacement and insulation schemes have had some success, many people have not taken advantage of the loans and grants on offer and there are still non-compliant burners in urban areas despite existing phase-out rules. Measures to replace solid fuel burners, and the timeframes involved, should be considered in the context of household income, fuel poverty, health, and the ability to access funding schemes. This regulation has been applied in neighbouring regions but has not been entirely successful without intervention in the form of financial assistance and/or fines for non-compliance. Development and maintenance of a database of existing burners would be required for intervention at the householder level but accurate information would take time to collect.

Option 1D: No new installations of burners in new dwellings or existing dwellings using other heating methods

2.4.5 Prohibit the installation of solid fuel burners in new dwellings or existing dwellings using other heating methods. This rule means that new dwellings are unable to install a solid fuel burner regardless of the emission standard that it can meet. Existing dwellings that previously used other heating methods are also unable to install solid fuel burners. When considered in conjunction with a burner phase out a key consideration is whether you allow households that do not replace phased out burners by the required dates the ability to install a replacement burner. This is most effective in areas where population increases are projected and where domestic heating is a key contributor to air pollution. This regulation has been applied in neighbouring regions.

Option 1E: Phase out all solid fuel burners

2.4.6 This option is to phase out all solid fuel burners and replace these with non-polluting heating appliances such as heat pumps. This would be achieved in two stages: firstly, prohibiting the installation of new solid fuel burners in any dwellings (as per Option 1D above) and secondly phasing out of existing dwellings based on a 20 year useful life. A total ban on the use of solid fuel burning has the potential for unintended consequences for the Otago Region because of very cold wintertime temperatures, the quality of the existing housing stock and thus the high potential for reduced household warmth. As the benefits of improved air quality are unlikely to be realised if at the expense of warm homes, further analysis of the impact on household warmth and consequently health is recommended if this option is to be pursued. No councils have fully prohibited the use of solid fuel burners in any areas of New Zealand to date.

Option 1F: Non-regulatory Options: Behaviour change campaign

2.4.7 Behaviour change or education programmes targeting the operation of solid fuel burners will be crucial to support any regulatory approach to reducing air pollutants from domestic heating. This should include information about the type of fuel used, potentially supported by a 'Trusted Wood Supplier' scheme, instructions on how to build a fire correctly, details about consents and conditions, and information about financial support for replacing

burners and installing insulation. A publicised 'compliance check', which could include neighbourhood audits of smoky chimneys, checks on TA consents databases to identify households with prohibited burners and fines for non-compliance.

2.4.8 Education programmes can also highlight the financial assistance for insulation and heater grants available to low-income homeowners through the central government Warmer Kiwi Homes programme. There may be barriers for people to replace their non-compliant burners and additional support for some residents may be required.

2.4.9 In the longer-term, the council could explore alternative energy sources such as community-level renewables.

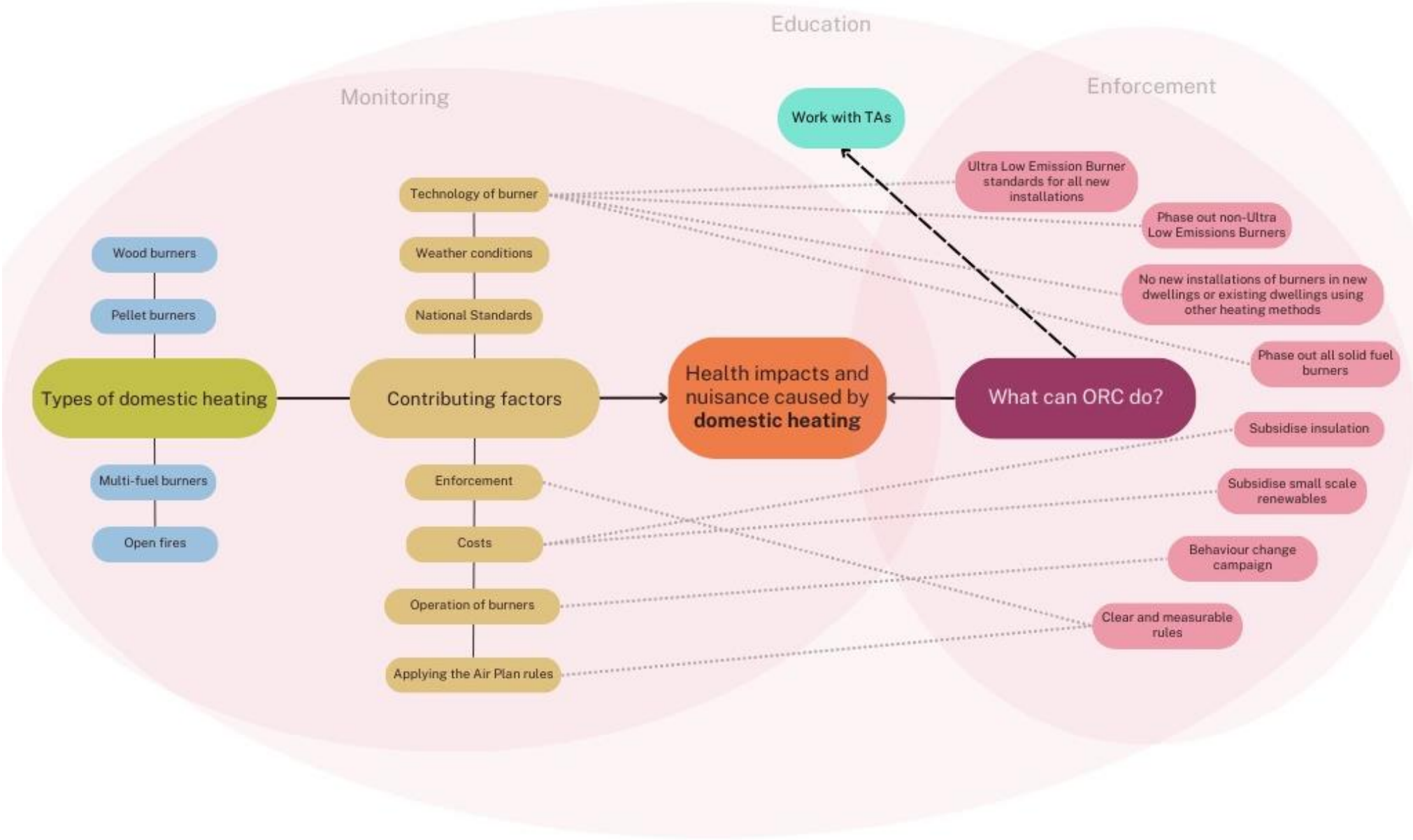
2.4.10 Non-regulatory methods should be included in a new Air Quality Strategy/Action Plan.

2.5 Domestic heating options: Environmental, social and economic benefits / costs

Option	Benefits	Costs
Option 1A: Status Quo: Wood burners in 'Zone 1' towns must meet the ULEB criteria	More freedom for individuals when compared to the other options.	The status quo has not been sufficient to meet clean air targets in many urban areas in Otago. The status quo results in the inequality of different burner rules for residents depending on location and size of property. The status quo means some households are operating prohibited burners.
Option 1B: New installations of solid fuel burners must meet ULEB standards	Requiring new installations of all types of solid fuel burners to meet the ULEB criteria will reduce emissions and align the Air Plan with the proposed NESAQ. Requiring the gradual replacement of the solid fuel burners with ULEB through natural attrition is a low to no cost option for improving pollution from domestic heating. The price point between ULEB and non-ULEB is negligible. More stringent rules will mean reduced health impacts and less nuisance for residents.	Total replacement of the solid fuel burners with those meeting ULEB standards through natural attrition would be a very lengthy process and unlikely to be achieved in a 30 year timeframe, if at all. Extending the rules to include phasing out of small-scale commercial heaters which do not meet ULEB standards could result in costs for businesses who are not planning to replace their burner over the next 15-20 years. More stringent rules will mean more enforcement and

Option	Benefits	Costs
	Extending the rules to include small-scale commercial heaters will reduce emissions. Applying the ULEB standards across a wider range of properties will reduce emissions and improve equity across the region. Extending the rules to include small-scale commercial heaters will reduce emissions and improve equity across the region. 'Best practice' rules will enable householders and consent holders to have more certainty over their activities and avoid costs associated with enforcement action. 'Best practice' rules on burner operation to assist compliance officers with enforcement will help reduce emissions. Having cleaner air in winter may benefit tourism centres and businesses in Central Otago.	education resulting in greater costs to the council.
Option 1C: Phase out Non-Ultra Low Emission Burners	As for Option 1B , plus A phase out of non-compliant burners will mean reduced emissions sooner than Option 1B.	Phasing out non-ULEB burners could result in costs for households who are not planning to replace their burner over the next 15-20 years. This option will require enforcement and education resulting in greater costs to the council.
Option 1D: No new installations of burners in new dwellings or existing dwellings using other heating methods	This is a low to no cost option for the council. This option will mean no growth in burner emissions with increasing population.	The cost of this option for householders depends on the source of electricity for heating (grid or renewables).

Option	Benefits	Costs
Option 1E: Phase out all solid fuel burners	A total ban on the use of solid fuel burning in Otago would improve air quality to meet the most stringent targets.	The increased costs for household associated with a total ban on the use of solid fuel burning risks cold homes. A total ban on the use of solid fuel burning in Otago is likely to increase installation and operational costs of alternative heating options. This option could result in the loss of employment opportunities for those working in the firewood supply industry.
Option 1F: Non-regulatory Options: behaviour change / education / compliance campaign	A behaviour change / education / compliance campaign is likely to reduce air pollution as best practice is adopted.	A behaviour change campaign will mean more enforcement and education resulting in greater costs to the council.


Education
Monitoring
Enforcement
Work with TAs
Ultra Low Emission Burner standards for all new installations
Phase out non-Ultra Low Emissions Burners
No new installations of burners in new dwellings or existing dwellings using other heating methods
Phase out all solid fuel burners
Subsidise insulation
Subsidise small scale renewables
Behaviour change campaign
Clear and measurable rules
Technology of burner
Weather conditions
National Standards
Enforcement
Costs
Operation of burners
Applying the Air Plan rules
Wood burners
Pellet burners
Multi-fuel burners
Open fires
Types of domestic heating
Contributing factors
Health impacts and nuisance caused by domestic heating
What can ORC do?

Issue 2: Effects of outdoor burning

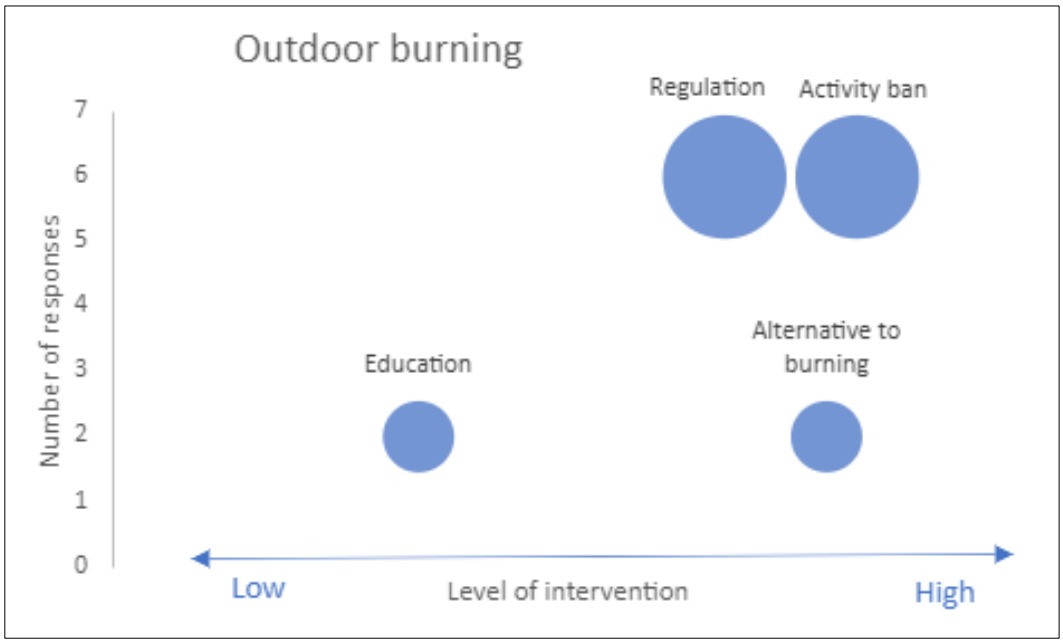
3.1 Introduction

3.1.1 Outdoor burning means the burning of materials in open air. It includes small-scale practices like bonfires and large-scale rural activities like tussock burn-offs. Outdoor burning can cause adverse effects beyond the property boundary, including smoke, odour, ash deposit, and discharges that may be noxious or dangerous. Outdoor burning also contributes to climate change.

3.1.2 In urban areas, outdoor burning contributes an average of 6% of particulate matter (PM_{10}) and 5% of nitrogen oxides (NO_x) emissions to the air people breath. Data for outdoor burning emissions comes from emissions inventories undertaken in 2013, 2016 and 2019. No additional research has been commissioned for the air plan review. This information does not take into account outdoor burning in rural areas that may travel to and impact urban areas. Nationally, 22% of PM_{10} is emitted by outdoor burning. While outdoor burning is not the largest contributor to air pollution, it generates a third of complaints to the ORC pollution hotline (194 complaints in 2022).

3.2 Committee Workshop

3.2.1 A workshop on the Air Plan review was held in September 2023. ESP Committee members were invited to consider a number of key topic areas, including outdoor burning, and put forward their ideas to address the issue and level of intervention. A summary of the types of responses is set out in the diagram below. These responses have helped develop the options to minimise the health impacts and nuisance from outdoor burning.



3.3 Contributing Factors

3.3.1 There are a number of contributing factors which exacerbate the health impacts and nuisance of outdoor burning which are set out below.

Factor 2.1: Materials burnt

3.3.2 All burning releases particulate matter which is dangerous to human health, but some material creates greater adverse effects than others. Burning of non-organic material is usually prohibited because it produces toxic discharges which can cause serious health problems. Burning organic material also causes harmful pollution and when it has a high moisture content produces more smoke than dry material and can cause odour, nuisance and visibility impacts. Although it is prohibited, household and commercial rubbish is sometimes burnt as an alternative to paying for a waste collection service, resulting in noxious and dangerous emissions.

Factor 2.2: Weather conditions

3.3.3 The impact of outdoor burning tends to be worse in winter because the inversion layer means the smoke cannot disperse. Wind speed and direction is also a factor in the impact of outdoor burning on adjacent properties. FENZ allows, restricts or prohibits fires depending on the activity and weather conditions. However, the weather conditions preferred by FENZ for outdoor burning, for example low wind and low temperatures, are the same conditions which exacerbate poor air quality in urban areas.

Factor 2.3: Proximity to residential properties

3.3.4 Poor air quality from outdoor burning affects people's health, wellbeing, and amenity. It can also cause visual and odour nuisance. The current Air Plan has more stringent outdoor burning rules for urban areas. Outdoor burning is not permitted on residential properties unless it takes place at least 50m away from the boundary (except for celebratory fires and cooking). For commercial properties the setback is 100m. Smoke, odour and particulate matter should not be offensive or objectionable beyond the property boundary.

Factor 2.4: Applying the Air Plan Rules

3.3.5 Currently there are different rules for outdoor burning depending on the type, size, and location of the property. This can create uncertainty for householders / landowners around which rules apply to their circumstances.

Factor 2.5: Enforcement

3.3.6 In order for the council to enforce the provisions of the Air Plan, rules, including definitions, need to be clear and measurable, and staff must be able to investigate and collect evidence of any breach. Clear and measurable rules could include a list of what can be burnt (rather than what cannot be burnt), directions on the correct way to build a fire, maximum size and minimum fuel quality specifications (for example moisture content of wood).

Factor 2.6: Disposal of waste material

3.3.7 All burning contributes to air pollution but certain materials such as plastics and treated wood are more toxic and are banned from being burned. Burning of waste is prohibited and it is important that all households have access to waste collection services so burning of waste does not take place. Over the next few years, many of the district and city councils in Otago will be providing household rubbish collections to towns as part of their rateable services and so there will be an alternative to the practice of burning rubbish. For

commercial activities, including production land, alternatives to burning waste material could be an additional cost.

Factor 2.7: Permitted activities

3.3.8 Discharges into air from outdoor cooking and outdoor burning of organic material for community and cultural events are permitted activities, providing the correct fuel is used and that any discharge of smoke, odour or particulate matter is not offensive or objectionable at or beyond the boundary of the property. It is proposed to continue to permit these activities and definitions for each will be clearly defined.

3.3.9 It is also proposed to continue to allow discharges into air from outdoor burning where the burning is for fire-fighting research and training, or is undertaken as a requirement of the Biosecurity Act.

3.4 Options

Option 2A: Status Quo

3.4.1 The existing Air Plan includes rules intended to manage the impacts of outdoor burning on residents in urban areas. The rules permit dry paper, cardboard, vegetative matter and untreated wood to be burnt outdoors with certain conditions and in certain circumstances. There is also a list of prohibited materials in the current Air Plan.

3.4.2 The current Air Plan has more stringent outdoor burning rules for urban areas than for rural areas. Except for community and cultural events and cooking, outdoor burning is not permitted on residential properties in most urban areas unless it takes place at least 50m away from the boundary. This means outdoor burning is not permitted on properties less than 1 hectare. For commercial properties the setback is 100m. Good management practices for outdoor burning on production land are encouraged but not required by the Air Plan. In all cases smoke, odour and particulate matter should not be offensive or objectionable beyond the property boundary.

3.4.3 The rules in the existing Air Plan have not been sufficient to prevent air pollution from outdoor burning affecting people and properties in the urban areas and changes to the suite of rules are recommended.

Option 2B: Ban outdoor burning over the winter months

3.4.4 A number of other regional councils have Air Plan rules which prohibit outdoor burning in certain locations during winter months when the inversion layer means that the smoke cannot disperse. ‘Winter months’ would be defined as April-September.

3.4.5 There may need to be exemptions to a winter burning ban, for example if there is a biosecurity risk.

3.4.6 A further consideration is that the advice from Fire and Emergency New Zealand (FENZ) is to burn when there is no wind. This is the opposite of the preferred conditions to avoid air pollution.

Option 2C: Require smoke management plans for large-scale / long-lasting outdoor burning events

3.4.7 Smoke Management Plans (SMPs) are required by other regional councils to manage the impacts of large-scale outdoor burning on residents. The content of SMPs could include dates of the intended burn, type and condition of material to be burned, forecast windspeed and direction, affected parties (such as neighbouring properties), and the methods for minimising impacts on people affected. SMPs would need to be submitted to the council by the landowner/occupier before the burn event takes place, and neighbouring properties would be notified.

Option 2D: Ban outdoor burning on properties less than 2 hectares

3.4.8 There is currently a 50 metre set back rule for outdoor burning on residential properties in most urban areas. This means that properties under 1ha are not allowed to burn outdoors. However, due to smoke drift beyond the property boundary, this 50m rule does not always alleviate the effects of smoke for neighbours. To better manage this issue, other regional councils have adopted a ban on outdoor burning on properties less than 2ha. This size threshold also helps to align rules for domestic burners which also apply to properties less than 2ha.

Option 2E: Require alternatives to burning

3.4.9 There are a number of alternative disposal and management options to outdoor burning and landowners / householders could be required to opt for a suitable alternative and only burn material if there is no other practicable choice. This could be defined using the RMA's 'Best Practicable Option' which means the best method for preventing or minimising the adverse effects on the environment, having regard to the nature of the discharge and receiving environment, financial implications and available technology. There are a number of options for untreated vegetative matter including wood chipping and composting which could be done on-site or collected for off-site management. Even diseased trimmings can be composted safely in some circumstances. Most household recycling collections allow paper and cardboard to be collected for recycling and national legislation means that councils will be required to offer recycling and food waste collection services in urban areas. Many councils already offer or will offer general rubbish and garden waste collection services. Household and commercial rubbish, including treated wood, should never be burned and should always be disposed of through a proper waste collection service. Alternatives to burning should sit alongside the policy direction being considered under the LWRP in relation to farm landfills.

2F: Non-regulatory Options

3.4.10 Non-regulatory options are those outside the Air Plan, for example education campaigns, enforcement and activities carried out by the district and city councils. Education campaigns will be needed to support changes to rules and there will be a cost to council for this work.

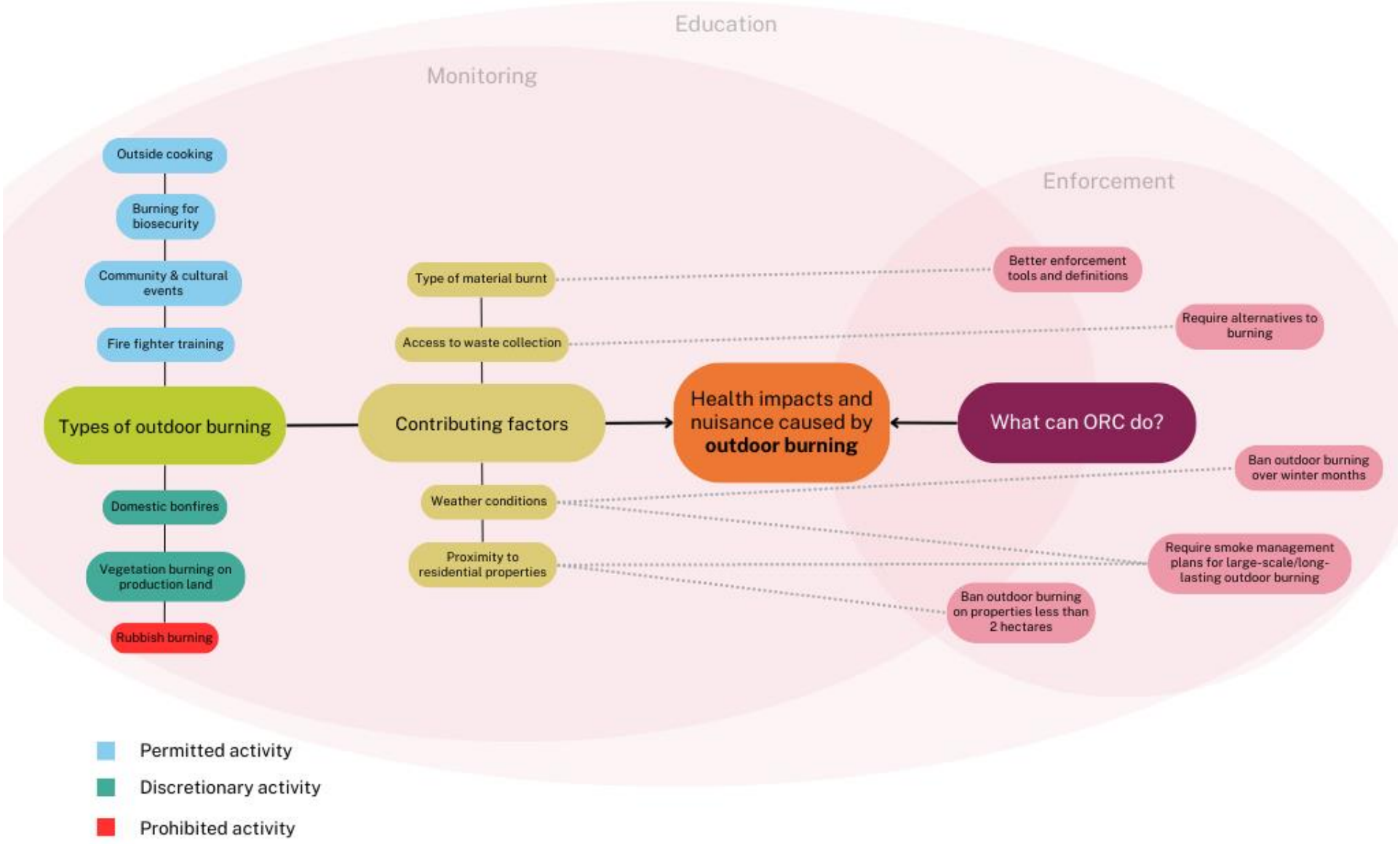
3.4.11 For the council to enforce the provisions of the Air Plan, the rules and definitions need to be clear and measurable, and staff must be able to investigate and collect evidence of any breach. Clear and measurable rules could include a list of what can be burnt (rather than what cannot be burnt), directions on the correct way to build a fire, maximum size of burn pile and minimum fuel quality specifications (for example moisture content of wood).

3.4.12 District and city councils have a role to play in reducing discharges to air from outdoor burning, for example through providing waste collection services. Until recently, it was cheaper to burn waste and pay the fine than it was to get waste collected. The fines are set by central government and have recently been increased, but there are still parts of the region that do not have a waste collection service. The Air Plan review provides the opportunity to liaise with the TAs about the improvements to air quality which could be made by providing an appropriate waste collection service to all properties.

3.5 Outdoor burning options: Environmental, social and economic benefits / costs

Option	Benefits	Costs
Option 2A: Status Quo	More freedom for individuals when compared to the other options.	The status quo (rules in the existing Air Plan) is not sufficient to prevent air pollution from outdoor burning affecting people and properties.
Option 2B: Ban outdoor burning over the winter months	Banning outdoor burning over the winter months will reduce emissions when the inversion layer prevents their dispersion. More stringent rules will reduce health impacts and nuisance for residents. Having cleaner air in winter may benefit tourism centres and businesses in Central Otago.	There may be conflict between householders / landowners who wish to restrict outdoor burning and those who wish to continue outdoor burning with no further restrictions.
Option 2C: Require smoke management plans for large-scale / long-lasting outdoor burning events	Requiring smoke management plans will ensure burning takes place during optimal weather conditions to disperse smoke and particulate matter away from neighbouring properties. Requiring smoke management plans will provide greater regulatory oversight of activities and is likely to result in positive environmental effects. Requiring smoke management plans will let residents know when large-scale outdoor burning is happening so they can prepare accordingly. More stringent rules will reduce the risk of poor visibility for drivers from outdoor burning events.	Landowners may incur costs in preparing and submitting a smoke management plan. Smoke management plans will need to be assessed and approved by council staff.
Option 2D: Ban outdoor burning on properties less than 2 hectares	Banning outdoor burning on properties less than 2 hectares will the reduce emissions and the number of residents affected by outdoor burning from nearby properties.	Householders may incur costs for sourcing alternatives to burning.

Option	Benefits	Costs
Option 2E: Require alternatives to burning	This option will avoid emissions from burning and the associated environmental and health impacts. There may be economic benefits for services such as wood chipping and composting, as well as commercial waste collectors.	Landowners may incur costs for sourcing alternatives to burning. Requiring alternatives to burning could result in increased vehicle emissions from taking the material off site for disposal.
2F: Non-regulatory Options: behaviour change / education / compliance campaign	An education campaign alongside better-defined rules will enable consent holders and householders to have more certainty over their activities and proposed mitigation measures, and avoid costs associated with enforcement action.	More stringent rules will mean more enforcement and education resulting in greater costs to the council.


Education
Monitoring
Enforcement
Outside cooking
Burning for biosecurity
Community & cultural events
Fire fighter training
Types of outdoor burning
Domestic bonfires
Vegetation burning on production land
Rubbish burning
Type of material burnt
Access to waste collection
Contributing factors
Weather conditions
Proximity to residential properties
Health impacts and nuisance caused by outdoor burning
What can ORC do?
Better enforcement tools and definitions
Require alternatives to burning
Ban outdoor burning over winter months
Require smoke management plans for large-scale/long-lasting outdoor burning
Ban outdoor burning on properties less than 2 hectares
Permitted activity
Discretionary activity
Prohibited activity

Issue 3: Vehicle Emissions

4.1 Introduction

4.1.1 Air pollution from motor vehicles is mainly nitrogen oxides (NO_X) and particulate matter from exhausts but pollution also occurs from tyre and brake wear as well as road abrasion. Exposure to these harmful emissions causes harm to human health and has been found to aggravate respiratory diseases such as asthma and lung infections, which impacts on hospital admissions and premature deaths. Vehicle emissions are also one of the main sources of greenhouse gases which contribute to climate change.

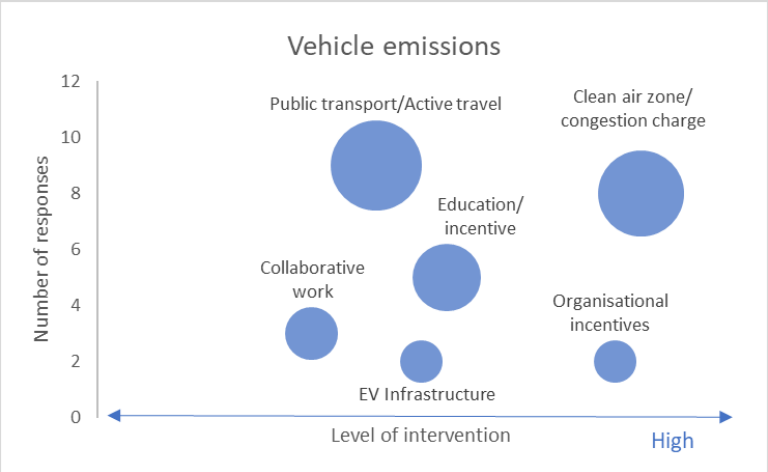
4.1.2 The recent HAPINZ 3.0 report[7], which evaluates the effects of air pollution on human health across New Zealand and the resulting social costs, recommends air quality management strategies provide much more focus on addressing motor vehicle emissions. The Air Plan is limited in the policies and rules it can apply to reducing vehicle emissions, but the council has a number of other non-regulatory pathways to do so, including the joint Otago Southland Regional Land Transport Plan (RLTP), the Otago Regional Public Transport Plan (RPTP), the Climate Strategy and the Air Quality Strategy.

4.1.3 The RLTP contains strategic objectives which aim to reduce vehicle emissions, and Strategic Objective 3 echoes many of the options set out here; for example, developing public transport systems to meet the needs of local communities, ensuring access to safe walking and cycling networks, integrating land use and transport networks, and provision of electric charging hubs.

4.2 Committee Workshop

4.2.1 A workshop on the Air Plan review was held in September 2023. ESP Committee members were invited to consider a number of key topic areas, including vehicle emissions, and put forward their ideas to address the issue and level of intervention. A summary of the types of responses is set out in the diagram below. These responses have helped develop the options to minimise the health impacts from vehicle emissions.

[7] Kuschel et al (2022). *Health and air pollution in New Zealand 2016 (HAPINZ 3.0): Volume 1 – Finding and implications.* Report prepared for Ministry for the Environment, Ministry of Health, Te Manatū Waka Ministry of Transport and Waka Kotahi NZ Transport Agency, March 2022.



4.3 Contributing Factors

4.3.1 There are a number of contributing factors which exacerbate the use of vehicles leading to health impacts from vehicle emissions which are set out below.

Factor 3.1: Lack of public knowledge

4.3.2 The impacts of vehicle emissions are a growing issue in New Zealand with the increase of road transport. While health impacts from domestic burners are well known, the effects of vehicle emissions are less widely understood by the public and this leads to behaviour which contributes to an increase in vehicle emissions. An example of this is the number of drivers who run their car engines ('idle') when parked. Idling engines not only pollute the air outside the vehicle, but passengers inside the car can be exposed to even higher levels of air pollution. By comparison, in the UK the issue is widely understood; idling is illegal and drivers can be fined.

Factor 3.2: Alternatives to private road transport

4.3.3 Many communities in Otago have little alternative transport choice other than private car. Even in the main centres of Dunedin and Queenstown, there is limited choice, with historically poor but improving access to public transport, limited public transport routes beyond the urban centre, and low-quality walking and cycling facilities. This has resulted in an increasing use of private vehicles and less demand for investment in other modes. What infrastructure there is becomes degraded or remains underdeveloped, causing fewer people to want to use alternative modes. Freight transportation is also constrained and dominated by road vehicles with little investment in alternative water and rail routes.

Factor 3.3: Type of vehicle

4.3.4 Diesel vehicles are 23% of the national fleet but produce 82% of health impacts because they produce more PM and NOx. Diesel vehicles includes heavy goods vehicles and buses. Decarbonising these fleets will be important.

Larger cars such as SUVs also emit more than smaller cars. The age of the vehicle is also related to the emissions, with older cars more polluting than newer models. Government recently proposed bringing in stronger vehicle emissions standards for new and used cars, but these still fall short of the vehicle emissions standards in Europe. All-electric vehicles produce zero exhaust emissions but still contribute to PM through from tyre and brake wear as well as road abrasion.

4.3.5 Port activities such as shipping and cruise ships can generate air pollution, particularly for $PM_{2.5}$ and SO_2. In 2022 NZ signed up to The International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI, which means that domestic ships will be required to use higher grade fuels and reducing sulphur emissions. From 2020, international ships entering New Zealand ports were already complying with Annex VI fuel standards. Support vehicles and truck activity also contribute to port emissions and material handling can result in the generation of dust (see 'other' issues for discussion on dust).

Factor 3.4: Quality of the urban environment

4.3.6 Reducing vehicle emissions is linked to reducing private motor vehicle movements, and the quality of the urban environment is fundamental to enabling this.

4.3.7 Urban sprawl embeds the necessity for private vehicles to get around. Single use zones mean that there are few or no local amenities within walking or cycling distance to residential areas which means people use their cars.

4.3.8 People will choose alternative modes of transport if these are the most attractive options. This means making walking, cycling and public transport use more convenient, pleasant and appealing than private car use. Design of the public realm is fundamental to have a safe and welcoming urban environment, prioritise the needs of pedestrians and cyclists, and to rebalance the transport system away from the dominance of cars. The Healthy Streets Approach is a framework for embedding public health in transport, public realm and planning and is currently being piloted in New Zealand.

4.3.9 The availability of parking is an important factor for which mode of transport people use to get to a destination. Ensuring enough safe and secure cycle parking in the right places, such as near work places, shops, educational institutions, transport hubs and recreation facilities, help more people to travel by bike if they want to. While there will always be a need for accessibility parking to be provided, limiting the overall availability of car parking and introducing car park time restrictions and charges helps disincentivise travel by private motor vehicle.

4.4 Options

4.4.1 Many of the solutions are outside the remit of the Air Plan but non-regulatory policies could be included to require ORC and the district/city councils to address pollution from vehicle emissions. A number of options have been developed to address the issue and factors set out above. Except for the status quo, the options are not mutually exclusive and ***all, some*** or ***none*** can be chosen. The aim of the options is to minimise the health impacts from vehicle emissions. Analysis of the costs and benefits of these options is set out below. Other options may be put forward through consultation.

Option 3A: Status Quo

4.4.2 The existing Air Plan policy for motor vehicle emissions focuses on advocating for national interventions and encouraging city and district councils to use land use planning and traffic management mechanisms to avoid the occurrence of localised air quality problems. The existing Air Plan does not mention the health impacts of NO_X and does not propose any actions for the ORC to carry out. It is recommended that this is addressed through the Air Plan review.

Option 3B: New Air Plan rules and policies

4.4.3 The current Air Plan contains a policy to "encourage" city and district councils to use land use planning and traffic management mechanisms to reduce air pollution from motor vehicles. There may be more opportunities for the Air Plan review to strengthen the requirements for TAs, include a wider remit to include increasing active travel, and provide more detail of how to reduce reliance on motor vehicles. There is also an opportunity to strengthen the existing policy direction to reduce vehicle emissions, for example by requiring the avoidance of discharge of contaminants into air from vehicle maintenance and servicing.

Option 3C: Ensure reliability, availability and safety of public transport

4.4.4 This option sits outside the Air Plan but within ORC's influence. ORC has a number of workstreams to improve the reliability and availability of public transport. This ranges from additional bus routes, improving the frequency of services and keeping fares low. Other programs could include liaising with bus operators to introduce cycle training for bus drivers to ensure they understand how to safely share the road with cyclists and e-scooter riders.

Option 3D: Vehicle decarbonisation

4.4.5 This option sits outside the Air Plan but within ORC's influence. There are two types of vehicles the council has direct control over: buses and ORC fleet vehicles. ORC is preparing a carbon reduction policy for public transport which includes a commitment to no new diesel vehicles. Electrification of the buses will happen over the course of the next few years as contracts are renewed. The council also has the opportunity to continue to move away from higher -polluting diesel vehicles , towards decarbonising the ORC vehicle fleet.

Option 3E: Education / behaviour change campaign

4.4.6 This option sits outside the Air Plan but within ORC's influence. There are opportunities for joint education campaigns with the city and district councils as well as initiatives for ORC staff. This could include a 'No Idling' campaign and signage, road safety and cycling education, ORC staff travel plans, and improved cycle parking at all office locations.

Option 3F: Work with TAs and other authorities

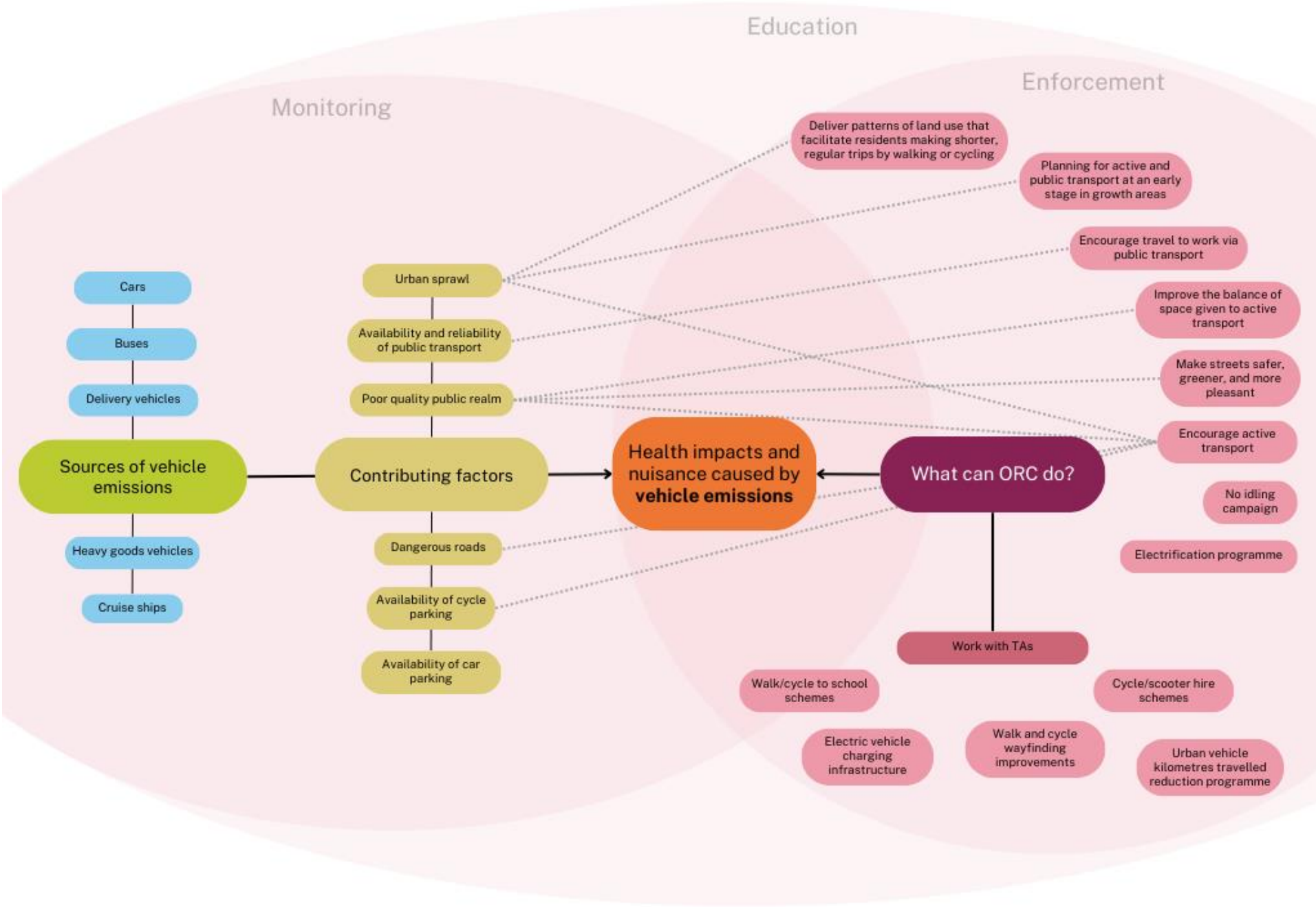
4.4.7 This option sits outside the Air Plan but within ORC's influence. ORC already engages with central government on the issue of vehicle emissions, for example responding to the recent consultation on vehicle emissions standards. The council should continue to support and advocate for government and international initiatives to reduce vehicle emissions.

4.4.8 The city and district councils in Otago have regulatory and non-regulatory powers to put in place a series of measures to reduce vehicle emissions. ORC is already working collaboratively with QLDC and DCC to produce Vehicle Kilometres Travelled (VKT) reduction plans and Future Development Strategies and there is an opportunity to put in place air quality improvements through this work. Other schemes underway in Otago's urban areas include public realm improvements, such as the improvements to George Street in Dunedin, and there may be opportunities to work collaboratively on schemes such as protected bike lane network, improved cycle parking, school travel plans, re-routing freight, parking strategies and road pricing.

4.4.9 There is also an opportunity to work with DCC and Port Otago on emissions from Port activities.

4.5 Vehicle emissions options: Environmental, social and economic benefits / costs

Option	Benefits	Costs
Option 3A: Status Quo	No benefits identified.	The status quo does not address the impacts of NOx on public health.
Option 3B: New Air Plan rules and policies	Intervening to reducing vehicle emissions will improve air quality.	Potential cost to TAs to implement any policies.
Option 3C: Ensure reliability, availability and safety of public transport	More people choosing to travel by public transport rather than private vehicle will result in improved air quality. Having an improved public transport system and cleaner air may benefit tourism centres and businesses.	Costs associated with ORC's public transport responsibilities
Option 3D: Vehicle decarbonisation	Electrification of the bus fleet and ORC vehicle fleet will result in cleaner air and better public health.	Costs associated with EV infrastructure
Option 3E: Education / behaviour change campaign	More people choosing to walk, cycle and travel by public transport rather than travel by private motor vehicle will result in cleaner air and better public health. Lower costs from avoiding hospitalisations and days lost to ill health through better public health.	There will be a cost to council to run education campaigns.
Option 3F: Work with TAs and other authorities	More people choosing to walk, cycle rather than travel by private motor vehicle will result in cleaner air and better public health. Providing a safe and welcoming public realm will encourage people to dwell allow better social interaction.	There may be public resistance as the transportation system is rebalanced towards walking and cycling.


Education
Enforcement
Monitoring
Cars
Buses
Delivery vehicles
Sources of vehicle emissions
Heavy goods vehicles
Cruise ships
Urban sprawl
Availability and reliability of public transport
Poor quality public realm
Contributing factors
Dangerous roads
Availability of cycle parking
Availability of car parking
Health impacts and nuisance caused by vehicle emissions
What can ORC do?
Deliver patterns of land use that facilitate residents making shorter, regular trips by walking or cycling
Planning for active and public transport at an early stage in growth areas
Encourage travel to work via public transport
Improve the balance of space given to active transport
Make streets safer, greener, and more pleasant
Encourage active transport
No idling campaign
Electrification programme
Work with TAs
Walk/cycle to school schemes
Cycle/scooter hire schemes
Electric vehicle charging infrastructure
Walk and cycle wayfinding improvements
Urban vehicle kilometres travelled reduction programme

Issue 4: Other Air Quality Issues

5.1 Introduction

5.1.1 Other air quality issues include discharges from industrial and trade premises, odour, dust and agrichemical spray drift. The effects from these sources range from serious health impacts to nuisance. They have been grouped together for the Issues and Options paper because often the options address a number of issues (the structure of this section reflects this by repeating options where applicable). In addition, the Air Plan review has not identified a fundamentally different approach to these issues to that taken by the existing Air Plan.

5.2 Committee Workshop

5.2.1 A workshop on the Air Plan review was held in September 2023. ESP Committee members were invited to consider a number of key topic areas and put forward their ideas to address the issue and level of intervention. Responses from the 'other' category have helped develop the options to minimise the health impacts and nuisance from air discharges from industrial and trade premises, odour, agrichemical spray drift and dust.

5.3 Discharges from industrial and trade premises

Issues and contributing factors

5.3.1 Discharges to air from industry include pollutants such as particulate matter, nitrogen dioxide and sulphur dioxide into the air as well as odour and dust. In urban areas industry is the source of 16% of nitrogen oxides and 3% of particulate matter emissions. Industry, spray drift and dust collectively represent 14% of complaints.

5.3.2 Discharges of contaminants into air from any industrial or trade premises in Otago is allowed only if it is expressly authorised by a permitted activity rule in the Air Plan, a resource consent or by regulations. Typically, the existing Air Plan rules require that discharges do not cause an adverse effect beyond the boundary of the property of origin.

5.3.3 ORC ran a successful campaign between 2007-2012 to reduce industrial emissions. Existing discharges were required to reduce PM_{10} emissions to 50 mg/m³ and new discharges were required to meet a limit of 25 mg/m³. This resulted in industries using best practice techniques in reducing emissions such as bag filters or changing fuel type from coal to wood.

5.3.4 Adverse effects of emissions can arise when the location of the industrial or trade activity is in close proximity to sensitive receptors such as residential properties. This is matter of land-use planning which is the responsibility of the territorial authorities.

Option 4A: Strengthening existing rules for industrial and trade premises

5.3.5 There is an opportunity to strengthen rules around permitted activities, consents renewal, emission control, best practice, and type of fuel to ensure enforcement can take place if rules are breached. For example, some small-scale activities which are permitted by the Air Plan have been found to have an impact on neighbouring properties from dust and odour. The Air Plan review is an opportunity to consider if further rules are needed to control cumulative effects and discharges from a wider range of activities.

5.3.6 The current Air Plan includes a policy which encourages the adoption of management practices to avoid, remedy or mitigate any adverse effects of emissions beyond the boundary of the property. This could be strengthened to require that emissions do not cause an adverse effect beyond the property boundary.

Option 4B: New Rule to require Best Practicable Option

5.3.7 The Air Plan could be strengthened by an explicit requirement for discharges allowed by a resource consent (both new and renewed) to apply the best practicable option to prevent or minimise adverse effects on air quality. 'Best practicable option' (BPO) is a tool which is defined in the RMA and means the best method for preventing or minimising the adverse effects on the environment, having regard, among other things, to:

a) the nature of the discharge and receiving environment; and
b) the financial implications; and
c) the current state of technical knowledge and the likelihood that the option will be successful.

Option 4C: Buffer Zones

5.3.8 Existing businesses and activities should not have unreasonable restrictions placed on them as a result of development permitted after they were established (i.e. 'reverse sensitivity'). For example, a pig farm should not have to cease operation because new residential development is built close by and property owners object to the odour. There is an opportunity for the Air Plan to protect the continued operation of **existing activities** which emit discharges which are likely to be offensive or objectionable and require territorial authorities to ensure that existing land uses are taken into account when subdivision takes place, for example by introducing buffer zones, to ensure new cases of reverse sensitivity do not occur.

5.3.9 The Air Plan could also include rules about buffer zones or distance rules for **new activities** which are likely to result in a discharge which causes an offensive or objectionable effect beyond the property boundary.

5.4 Odour

Issues and contributing factors

5.4.1 Odour can cause a nuisance and affect amenity and generates 33% of complaints to the pollution hotline. Odour can arise from sources such as industrial and trade premises, waste management activities and farming. Odour can also result from all types of burning. Adverse effects of odour can arise when the location of the discharging activity is in close proximity to sensitive receptors such as residential properties. This is matter of land-use planning which is the responsibility of the territorial authorities.

5.4.2 Poor odour management practices also occur, and this is the responsibility of the producers. Adverse odour effects are usually managed through conditions on resource consents or through best practice methods and technologies.

5.4.3 The current Air Plan rules focus on avoiding or mitigating the discharge of odours which are "offensive" or "objectionable" beyond the property boundary. Odour is subjectively defined and people respond to smells differently. This means it can be difficult to investigate and enforce breaches. The council's approach to investigating odour complaints is through

observations made by Council officers, taking into account the FIDOL factors, which is the only available tool for investigating complaints of odour. These are:

- Frequency of the odour occurrence;
- Intensity of the odour;
- Duration of exposure to the odour;
- Offensiveness of the odour; and
- Location of the discharge.

Option 4A: Strengthening existing rules for industrial and trade premises

5.4.4 There is an opportunity to strengthen rules around permitted activities, consents renewal, emission control, best practice, and type of fuel to ensure enforcement can take place if rules are breached. For example, some small-scale activities which are permitted by the Air Plan have been found to have an impact on neighbouring properties from dust and odour. The Air Plan review is an opportunity to consider if further rules are needed to control cumulative effects and discharges from a wider range of activities.

5.4.5 The current Air Plan includes a policy which encourages the adoption of management practices to avoid, remedy or mitigate any adverse effects of emissions beyond the boundary of the property. This could be strengthened to require that emissions do not cause an adverse effect beyond the property boundary.

Option 4B: New Rule to require Best Practicable Option

5.4.6 The Air Plan could be strengthened by an explicit requirement for discharges allowed by a resource consent (both new and renewed) to apply the best practicable option to prevent or minimise adverse effects on air quality. 'Best practicable option' (BPO) is a tool which is defined in the RMA and means the best method for preventing or minimising the adverse effects on the environment, having regard, among other things, to:

a) the nature of the discharge and receiving environment; and
b) the financial implications; and
c) the current state of technical knowledge and the likelihood that the option will be successful.

Option 4C: Buffer Zones

5.4.7 Existing businesses and activities should not have unreasonable restrictions placed on them as a result of development permitted after they were established (i.e. 'reverse sensitivity'). For example, a pig farm should not have to cease operation because new residential development is built close by and property owners object to the odour. There is an opportunity for the Air Plan to protect the continued operation of **existing activities** which emit discharges which are likely to be offensive or objectionable and require territorial authorities to ensure that existing land uses are taken into account when subdivision takes place, for example by introducing buffer zones, to ensure new cases of reverse sensitivity do not occur.

5.4.8 The Air Plan could also include rules about buffer zones or distance rules for **new activities** which are likely to result in a discharge which causes an offensive or objectionable effect beyond the property boundary.

Option 4D: New Rules to require Dust and Odour Management Plans

5.4.9 The Air Plan could be strengthened by requiring a dust and/or odour management plan for activities which are likely to result in a discharge of dust and/or odour which causes an offensive or objectionable effect beyond the property boundary. Management plans could

be required for any discharge to air consent be supplied to the council on request. Dust and Odour Management Plans could take account of cumulative impacts, set out mitigation measures to minimise the effects and would be implemented by the person responsible for the discharge into air.

Option 4E: Include more information about FIDOL assessments

5.4.10 The Air Plan could also contain more detail about the FIDOL factors and which assessment tools and evaluation criteria will be used by council officers when investigating activities that may be causing offensive or objectionable discharges. This would allow complainants to understand the process and how best to provide feedback and evidence of the event.

5.5 Dust

Issues and contributing factors

5.5.1 Dust arises from industrial processes, unsealed roads, mining, land clearance and subdivision, construction and demolition, farming, and also natural sources. While dust is an emission to air (for which the Regional Council has primary responsibility) it is an effect generated by land use activities which are managed by district and city councils. Controls on dust are implemented and enforced by the district and city councils through conditions on land use consents and ORC issued consents on certain activities such as mining and quarrying. Dust controls may also form part of industry codes of practice or other mechanisms which promote good management practices.

5.5.2 Once emitted, dust is difficult to control because the emissions are generally intermittent and difficult to contain. Managing the adverse effects of dust discharges is therefore best achieved through avoiding dust emissions by using appropriate land management practices.

5.5.3 A concentration of dust emissions-generating activities can result in a cumulative impact that individual consents may not always take into account. Dry conditions and wind direction also have an impact on how residents are affected by dust.

5.5.4 Cost is a factor for remedying dust from unsealed roads. There are higher initial costs for permanently sealing roads when compared to a temporary seal or dust suppressant measures. The responsibility for sealing roads is sometimes unclear, with TAs sometimes deferring responsibility to residents. TAs do not have responsibility for private roads or long rights of ways. Unsealed roads can create dust which impairs driver visibility which is a safety issue. The use of dust suppressants is a matter currently managed under the Regional Plan: Waste, and was amended as part of Plan Change 1 to the Regional Plan: Waste in 2022.

Option 4A: Strengthening existing rules for industrial and trade premises

5.5.5 There is an opportunity to strengthen rules around permitted activities, consents renewal, emission control, best practice, and type of fuel to ensure enforcement can take place if rules are breached. For example, some small-scale activities which are permitted by the Air Plan have been found to have an impact on neighbouring properties from dust and odour. The Air Plan review is an opportunity to consider if further rules are needed to control cumulative effects and discharges from a wider range of activities.

5.5.6 The current Air Plan includes a policy which encourages the adoption of management practices to avoid, remedy or mitigate any adverse effects of emissions beyond the boundary of the property. This could be strengthened to require that emissions do not cause an adverse effect beyond the property boundary.

Option 4B: New Rule to require Best Practicable Option

5.5.7 The Air Plan could be strengthened by an explicit requirement for discharges allowed by a resource consent (both new and renewed) to apply the best practicable option to prevent or minimise adverse effects on air quality. 'Best practicable option' (BPO) is a tool which is defined in the RMA and means the best method for preventing or minimising the adverse effects on the environment, having regard, among other things, to:

a) the nature of the discharge and receiving environment; and
b) the financial implications; and
c) the current state of technical knowledge and the likelihood that the option will be successful.

Option 4C: Buffer Zones

5.5.8 Existing businesses and activities should not have unreasonable restrictions placed on them as a result of development permitted after they were established (i.e. 'reverse sensitivity'). For example, a pig farm should not have to cease operation because new residential development is built close by and property owners object to the odour. There is an opportunity for the Air Plan to protect the continued operation of **existing activities** which emit discharges which are likely to be offensive or objectionable and require territorial authorities to ensure that existing land uses are taken into account when subdivision takes place, for example by introducing buffer zones, to ensure new cases of reverse sensitivity do not occur.

5.5.9 The Air Plan could also include rules about buffer zones or distance rules for **new activities** which are likely to result in a discharge which causes an offensive or objectionable effect beyond the property boundary.

Option 4D: New Rules to require Dust and Odour Management Plans

5.5.10 The Air Plan could be strengthened by requiring a dust and/or odour management plan for activities which are likely to result in a discharge of dust and/or odour which causes an offensive or objectionable effect beyond the property boundary. Management plans could be required for any discharge to air consent be supplied to the council on request. Dust and Odour Management Plans could take account of cumulative impacts, set out mitigation measures to minimise the effects and would be implemented by the person responsible for the discharge into air.

Option 4E: Include more information about FIDOL assessments

5.5.11 The Air Plan could also contain more detail about the FIDOL factors and which assessment tools and evaluation criteria will be used by council officers when investigating activities that may be causing offensive or objectionable discharges. This would allow complainants to understand the process and how best to provide feedback and evidence of the event.

5.6 Agrichemical and fertiliser spray drift

Issues and contributing factors

5.6.1 Agrichemicals are used in horticulture, agriculture, arable farming, forestry and fruit production to control pests and diseases. Adverse effects of agrichemical and fertiliser spraying can occur when the spray drifts onto non-target areas and onto neighbouring properties.

5.6.2 Agrichemicals and their use are subject to national legislation and codes of practice including the Hazardous Substances and New Organisms Act 1996 and NZS8409: Management of Agrichemicals. NZS8409 is updated often and referring to a specific edition (for example 1999 in the current Air Plan) is unhelpful to sprayers who need up-to-date rules to follow.

5.6.3 Under the Health and Safety at Work Act and associated regulations, all users of hazardous substances must be trained in their use. Whilst there is no specific certification requirement, the "Growsafe" certificates have been designed to meet the requirements set out in the regulations.

5.6.4 The main factors influencing the occurrence of agrichemical spray drift are weather conditions, whether buffer zones exist between the intended spray area and non-target areas, the application method, and the frequency and duration over which agrichemicals are applied.

5.6.5 Any controls on agrichemicals under the Air Plan will need to be consistent with the direction under the draft LWRP.

Option 4F: Strengthening existing rules for agrichemical spraying

5.6.6 Agrichemical spraying is a permitted activity in the current Air Plan, providing that application is undertaken in accordance with best practice standards. This could be strengthened to include a requirement to notify the council and properties which may be affected by spray drift in advance of spraying activities. The notification could include details such as the area of spraying, duration, the agrichemical to be used, and the name and contact details of the applicator. This will help the council to investigate any breaches of the rules and help affected property owners / occupiers prepare.

5.6.7 In the existing Air Plan fertiliser application has a separate rule from agrichemical spraying but there is an opportunity to address these issues together as the discharge of agrichemicals and fertilisers into air requires the same controls.

5.6.8 The Air Plan could also contain more detail about the FIDOL factors and which assessment tools and evaluation criteria will be used by council officers when investigating activities that may be causing offensive or objectionable odour. This would allow complainants to understand the process and how best to provide feedback and evidence of the event.

5.7 Other Issues: Environmental, social and economic benefits / costs

Option	Benefits	Costs
Option 4A: Strengthening existing rules for industrial and trade premises	More stringent rules will mean reduced health impacts and less nuisance for residents. Better defined rules will enable operators and consent holders to have more certainty over their activities and proposed mitigation measures, and avoid costs associated with enforcement action.	There may be conflict between those who prefer tighter controls on emissions and those who wish to continue with no further restrictions.

Option	Benefits	Costs
Option 4B: New Rule to require Best Practicable Option	Improvements to practices will mean reduced health impacts and less nuisance for residents. There may be economic benefits for services associated with emissions control.	Operators may incur costs from improving emissions control methods and technologies. More enforcement and education may result in costs to the council.
Option 4C: Buffer Zones	Protects the continued operation of existing activities and avoids new cases of reverse sensitivity.	Cost to TAs to implement the policy.
Option 4D: New Rules to require Dust and Odour Management Plans	Requiring dust and odour management plans will provide greater regulatory oversight of activities and is likely to result in positive environmental effects.	Dust and odour management plans will need to be assessed and approved by council staff. Operators may incur costs in preparing and submitting dust and odour management plans.
Option 4E: Include more information about FIDOL assessments for odour and dust	Best practice for staff when assessing consent breaches and complaints. Greater certainty for complainants about the assessment tools and evaluation criteria will be used by council officers when investigating activities.	No costs identified.
Option 4F: Strengthening existing rules for agrichemical spraying	More stringent rules will mean clarity for sprayers less nuisance for residents. Notification in advance of spraying would help the council to investigate any breaches of the rules and help property owners/occupiers prepare.	Notifications will need to be assessed by council staff.

9.1. Air quality activities 2023 update

Prepared for:	Environmental Science and Policy Committee
Report No.	SPS2402
Activity:	Environmental: Air
Author:	Sarah Harrison, Scientist - Air Quality
Endorsed by:	Anita Dawe, General Manager Policy and Science
Date:	20 March 2023

PURPOSE

[1] This report presents the results of two air quality projects undertaken during 2023: black carbon monitoring in Arrowtown and spatial PM_{10} monitoring in Alexandra.

EXECUTIVE SUMMARY

[2] Black carbon was monitored as a trial study at Arrowtown from March to October 2023. The instrument performed well, and the data was analysed in comparison to temperature and PM_{10} data.

[3] NIWA conducted a spatial study using 42 low-cost sensors within the Alexandra airshed to understand more about the variation in PM_{10} concentrations. It was found that the location of peak average concentrations is located to the northwest of the town, and those concentrations are approximately double the concentrations in other parts of town.

RECOMMENDATION

That the Council:

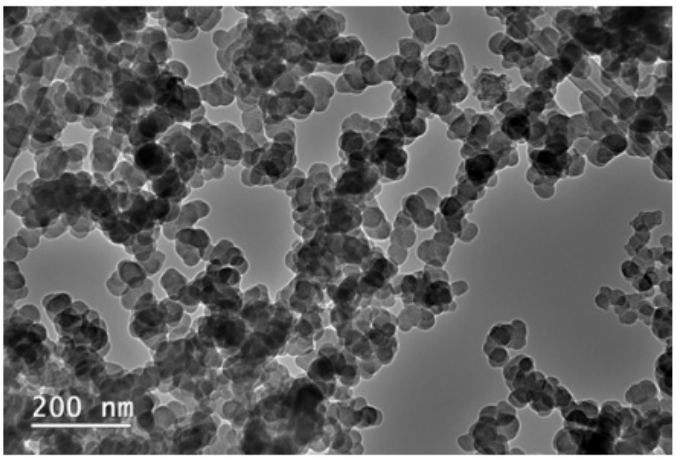
1) ***Notes** the two studies undertaken as part of the Air Quality programme.*

BLACK CARBON MONITORING AT ARROWTOWN

[4] Black carbon (BC) is a pollutant of emerging importance for both climate change and human health. BC is any light-absorbing chemical component of particulate matter (PM), and it comes from incomplete combustion. BC falls into the ultrafine size range of PM, generally between 10-30 nanometres for individual particles, to larger chains of 300-500 nm[1] (Figure 1), however the size, shape and composition of BC particles change as they age and react to other chemicals in the atmosphere.

[1] For comparison, the upper size limit of $PM_{2.5}$ is 2500 nm. BC particles are too small to be picked up by instruments that monitor PM_{10} and $PM_{2.5}$.

Figure 1 BC particle chains from biomass combustion. Source: Davy and Ancelet, 2015



[5] Because BC is black, it absorbs light and heat, contributing to warming the atmosphere. It is a short-lived pollutant, spending about one week in the atmosphere, however it is an important pollutant for radiative forcing[2] after CO_2 and methane. It can also impact cloud formation and increases ice and snow melt when it settles on these surfaces. New Zealand research shows that black carbon concentrations are likely to be highest in areas of either high traffic or high use of solid fuel burning for home heating (Davy and Trompetter, 2018).

[6] During winter 2023 ORC had the opportunity to monitor BC using a Magee Aethelometer AE33 on loan from Benchmark Monitoring. The AE33 is a continuous instrument which uses optical absorption to calculate the concentration of BC as the particles accumulate on the filter tape.

[7] The data shows a strong seasonal pattern, with higher concentrations during winter, which is similar to that of PM_{10} in Arrowtown, however on a much smaller scale (Figure 2). Figure 2 also shows the ambient temperature which has an inverse relationship to both pollutants. The daily pattern of BC indicates two periods of time during the day that BC is highest: at 08:00-09:00 and 19:00-21:00 (Figure 3), which is similar to the home heating pattern found in PM_{10} data. The data differs however as usually the PM_{10} evening peak is much higher than the morning peak. Overall, the BC data is similar in seasonal and daily patterns to PM. This is expected as they have the same source, home heating emissions.

[2] Radiative forcing refers to factors that alter the balance between the sun's incoming energy and the outgoing energy from the Earth's atmosphere. Climate pollutants can impact this balance as either cooling or warming forces and these can be added up to calculate total radiative forcing in Watts/m².

Figure 2 Black carbon, PM_{10} and ambient temperature for Arrowtown, 2023 (24-hour average)

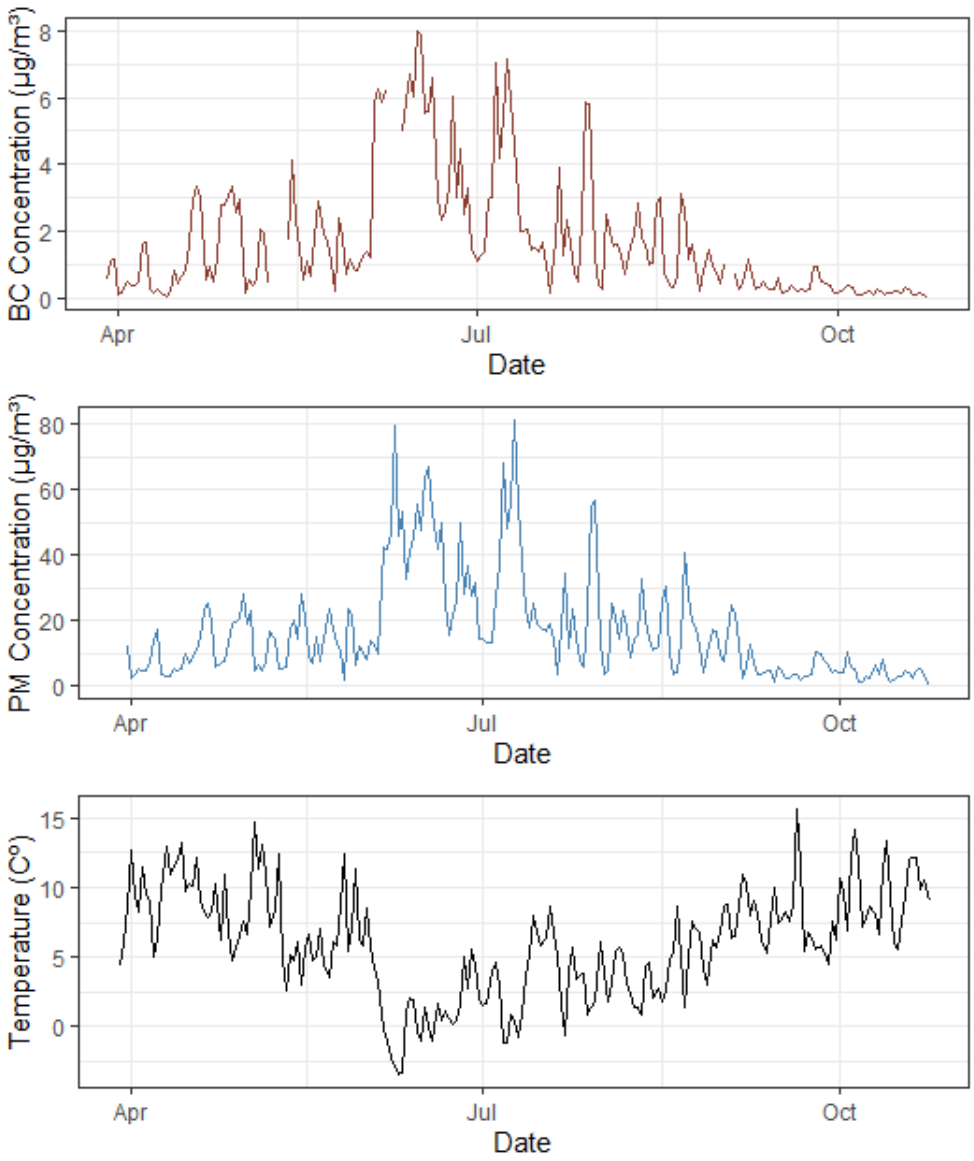
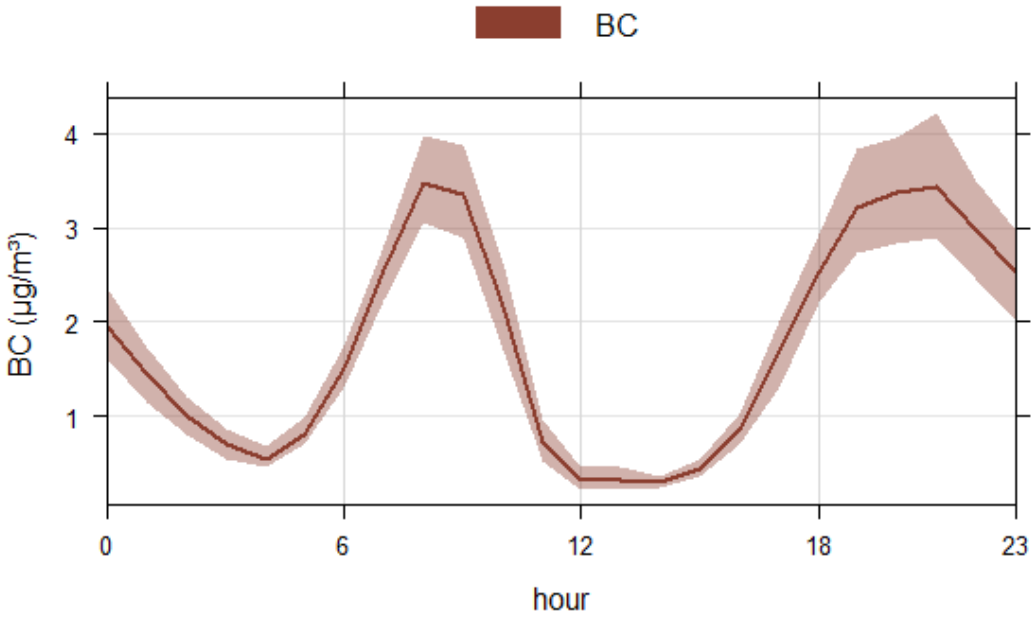


Figure 3 Diurnal mean of black carbon at Arrowtown (shading represents 95% confidence interval in the mean)



[8] Internationally aethalometers have many applications, including transport and shipping emissions, industrial monitoring, assessing urban policies such as low emission zones and home heating rules, and for climate change and/or atmospheric monitoring. On a national level, BC is currently being monitored by several other councils in New Zealand. It is monitored at sites that are influenced by domestic heating emissions or traffic exhaust, or both.

[9] In 2021 World Health Organization (WHO) produced a good practice statement recommending that regional authorities measure BC, undertake emissions inventories and source apportionment for BC, and take measures to reduce emissions, and where possible develop targets for BC concentrations (WHO, 2021).

PM_{10} SPATIAL MONITORING AT ALEXANDRA

[10] Stationary instruments monitor air quality at a single location within each airshed in ORC's SOE network. Depending on the size of the town, sources of pollution and the complexity of its terrain, the results may not be representative of the entire area. The National Environmental Standards for Air Quality (NESAQ) requires monitoring to be undertaken where the standards are likely to be breached by the greatest margin or the highest frequency.

[11] Methods to investigate spatial variability within airsheds have evolved recently to include networks of low-cost sensors. These sensors are not as accurate or reliable as

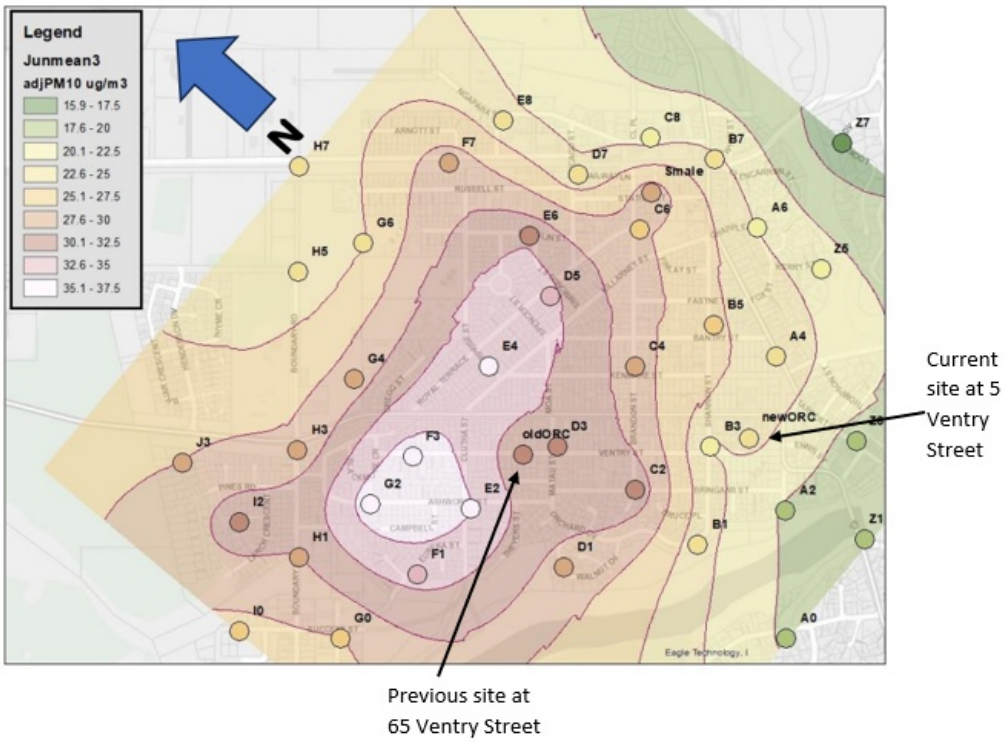
NESAQ compliant monitors[3], however because there are so many, they can provide an idea of where pollutants build up, and sometimes how they move around within an airshed. The meteorology of the Alexandra basin is very complex, and converging winds (Tate, 2011) are likely to cause zones of still air in which pollution can accumulate (Price, 2014).

[12] During June 2023, 42 low-cost sensors were in a dense network across Alexandra in order to understand the high-resolution spatial patterns of PM_{10} and assess how representative the ORC monitoring site is. The project was partially funded by ORC and ORC's Environmental Monitoring team assisted NIWA with the field work. NIWA's additional goals were to understand the optimal density of monitors required to understand air quality spatial variation and to find out more about how concentrations vary over space and time. As part of this work, NIWA were also able to determine the relationship between the current and previous Alexandra monitoring sites for June 2023. This was important because the change in locations meant they have different typical pollutant concentrations. This issue is discussed further in the 2017 Annual Air Quality report (ORC, 2017) and the SOE report of 2021 (ORC, 2021).

[13] This study identified the area of average peak PM_{10} concentrations in Alexandra, which is located to the northwest of the centre of town (Figure 4). This area on average, had double the concentrations than of the outskirts of town. The percentage difference between the previous and current SOE monitoring sites was calculated to be 23%, and a correction factor was produced. Unfortunately, as the concentrations in June did not get very high, especially compared to previous years' data, this correction factor may not be suitable for use in long term trend analyses. For any correction factor to work well it must incorporate a wide range of concentrations. However, this correction factor may be used for analyses of more recent data, within the concentration range that occurred during June 2023.

[3] Known as reference method instruments, these are a monitoring requirement under the NESAQ.

Figure 4 Spatial PM_{10} results for Alexandra, June 2023. Source: Longley, 2023

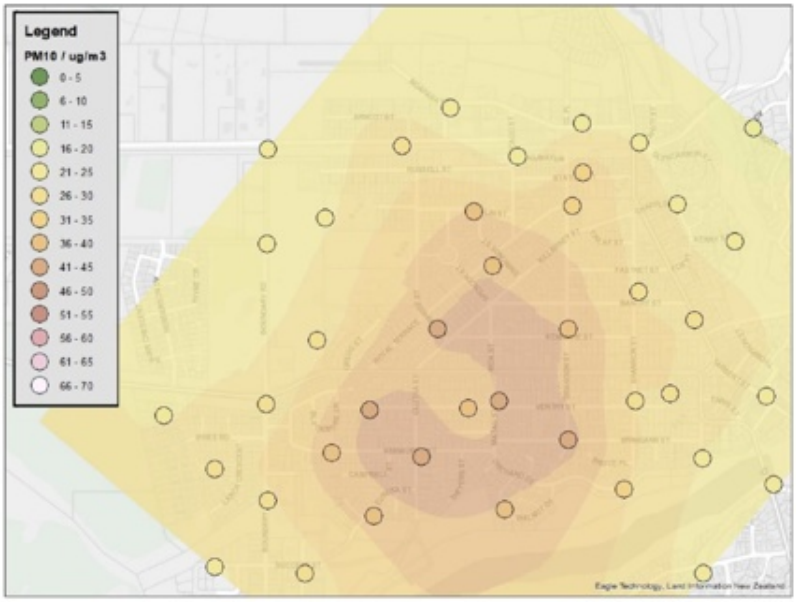


[14] Some examples of the high pollution days (as recorded at the SOE monitoring site) are highlighted in Figure 5. The area of highest concentrations was further to the southeast on 11 June, which is closer to the SOE monitoring site. This caused the third highest pollution night in June (38 µg/m³, 24-hour average) because of this proximity. In contrast on 19 June, the peak concentrations were up to 20 µg/m³ higher, but further to the northwest, and as such, a much lower concentration (29 µg/m³, 24-hour average) was recorded at the SOE site. This shows that as the area of peak concentrations moves around, it can greatly impact what is recorded at ORC's stationary monitoring site.

[15] Wind direction appears to have some influence on these concentrations. On average the dominant wind direction for June was the northeast (Figure 6). Some of the variations are displayed for the different days, such as the addition of the north-northeast direction on 11 June, which may have pushed the pollution further towards the south instead of the west. Overall, these wind speeds are very low, mostly below 1 m/s.

Figure 5 Examples of high pollution days in Alexandra, June 2023. Source: Longley, 2023

11 June 2023



19 June 2023

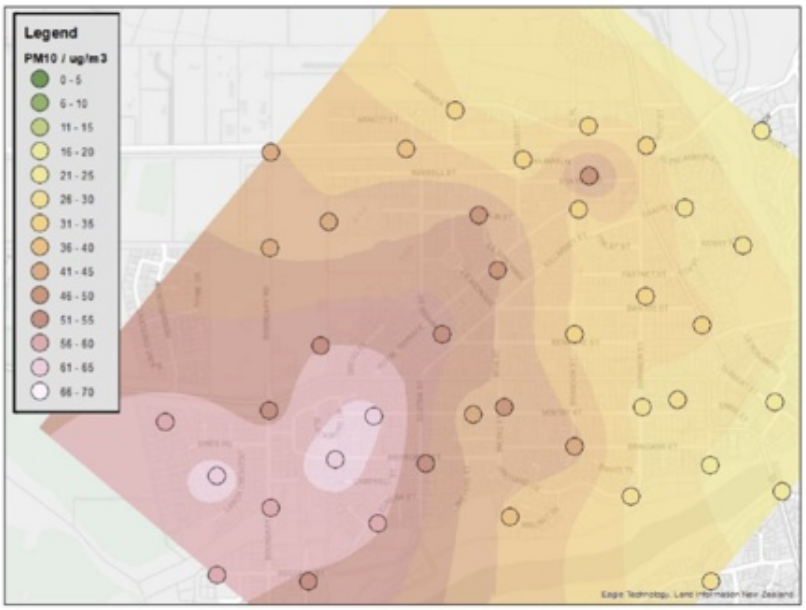
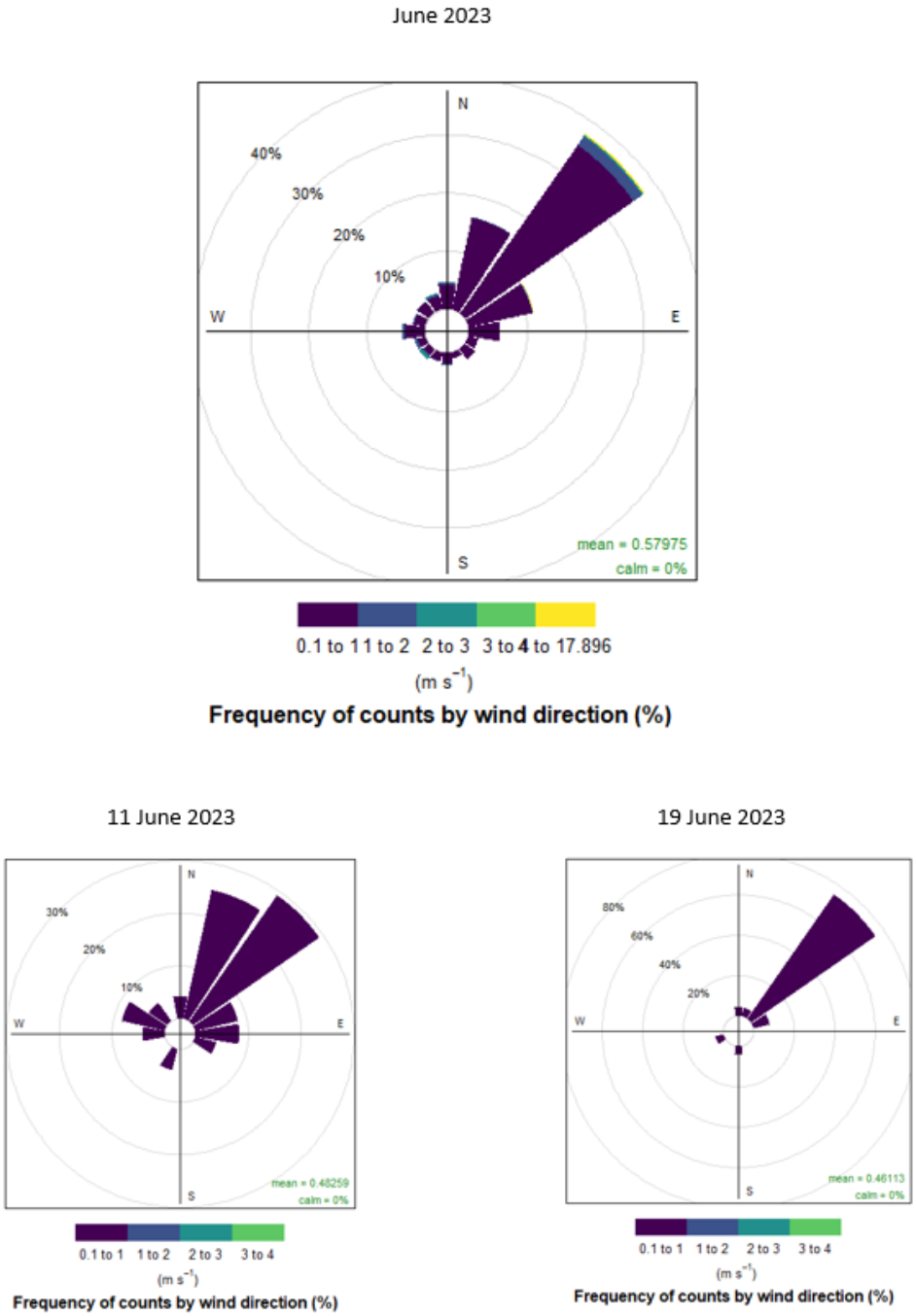


Figure 6 Wind roses for Alexandra, June 2023 (1-hour average)



[16] The requirement of the NESAQ to monitor in the area where standards are likely to be breached by the greatest margin or the highest frequency has not been possible in Alexandra since 2016 due to very low availability of suitable monitoring sites. Further

work to compare the previous and current Alexandra sites is recommended. Twelve months' worth of data that covers a wide range of concentrations is the minimum amount recommended for understanding this relationship.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[17] The work outlined in this paper contributes to the following elements of ORC's Strategic Direction:

- Monitoring air quality in the region and investigate pollution sources.
- Provide best available information on Otago's air quality.

Financial Considerations

[18] Air quality work is a budgeted and planned activity.

Significance and Engagement

[19] N/A

Legislative and Risk Considerations

[20] N/A

Climate Change Considerations

[21] N/A

Communications Considerations

[22] N/A

NEXT STEPS

[23] Options for continuous monitoring of black carbon are currently in the draft LTP. Due to its relationship with PM, it would be beneficial for additional sites to monitor BC in Otago, and this would line up with World Health Organization recommendations.

[24] Further investigation (12 months+) is required to best understand the relationship between the previous and current Alexandra sites. This project needs consideration due to the lack of available sites at Alexandra, and possible monitoring instruments will need to be carefully considered.

ACKNOWLEDGEMENTS

ORC would like to thank Jason Potts and Matthew Anderson from Benchmark Monitoring for the loan and installation of the aethalometer, and for their technical support during the monitoring period. The author would also like to thank the ORC Environmental Monitoring team for looking after both the Arrowtown and Alexandra projects.

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ATTACHMENTS

1. NIWA Client Report 2023190 AK ORC Alexandra Air Quality 2023 FINAL [**9.2.1** - 34 pages]

NIWA
Taihoro Nukurangi

Mapping of winter air quality in Alexandra

Prepared for Otago Regional Council

November 2023

Climate, Freshwater & Ocean Science

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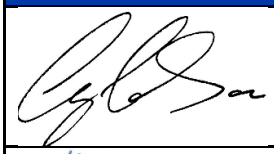
NIWA CLIENT REPORT No: 2023190AK
Report date: November 2023
NIWA Project: ORC23101

Revision	Description	Date
Version 0.1	Draft in preparation/in review	04/08/2023
Version 1.0	Draft version sent to client	30/08/2023
Version 1.1	Minor amendments	20/11/2023

Quality Assurance Statement		
	Reviewed by:	Guy Coulson, Principal Air Quality Scientist
	Formatting checked by:	Carole Evans
	Approved for release by:	Jonathan Moores, Regional Manager Auckland

Contents

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Executive summary

Otago Regional Council (ORC) is responsible for the management of air quality across the Otago region. Previous research by NIWA and others has shown how air quality can be highly variable in time and space within airsheds, especially smaller towns with prevalent use of winter wood-burning, such as Alexandra.

Determining spatial variation in air quality within towns is vital for understanding the representativeness (and hence fitness for purpose) of air monitoring sites. Better spatial information may also identify previously unknown localised air quality hot-spots, or intense emission sources.

Spatial and temporal variation in air quality, represented by particulate matter smaller than 10 microns (PM_{10}) was monitored in Alexandra, using 42 Clarity Node-S air monitors over the period 2nd June – 3rd July 2023. The monitors were deployed in an approximately uniform grid across the whole urban area of Alexandra (excepting Bridge Hill).

The data generated was used to create maps of daily average and whole campaign average PM_{10} levels across the town.

The data clearly show a large and consistent spatial variation in PM_{10} across Alexandra. Concentrations varied by an approximate factor of 2 with the highest concentrations being consistently found over a relatively small area between Ashworth Street and Simmonds Street, most frequently peaking around Table Top Park.

Current guidance states that air quality monitoring for regulatory purposes should be conducted at the most polluted location within an airshed. However, in advance of highly spatially detailed monitoring such as this (which has only very recently become feasible), it is very difficult to ascertain where such a location is, and how large an area can be considered to qualify.

This work has now revealed how localised the area of peak concentrations is in Alexandra and how the representativeness of any single monitoring site is highly sensitive to its precise location. This work clearly shows that the “new” monitoring site adopted by ORC for regulatory monitoring in 2017 reports concentrations around 23 % lower than the previous site, despite it being only 720 m away along the same road (Ventry Street). The current site is representative of median or average concentrations across the town, but both the current, and the previous site under-represent the maximum concentrations in the town, as required by current guidance.

As a consequence of the findings of this work we make the following recommendations to ORC:

- To comply with current regulatory guidance, we recommend that consider ORC re-locating their monitoring station again, closer to the “hot-spot” area identified in this work.
- We recommend that a “virtual” time series of PM_{10} be created both retrospectively and on an ongoing basis to estimate the concentrations at the previous ORC site to enable long-term analysis of trends. Compared to the precious ORC monitoring site, the new site has been reporting concentrations approximately 23 % lower. 24-hour PM10 concentrations from the new site could therefore be adjusted to create a “virtual” record for the previous site by multiplying concentrations by 1.295.

- Such spatial variation is also likely in most Otago towns, and we therefore recommend ilar monitoring assessment of other towns.
- We recommend ORC work with MfE and other regional councils to promote a review of regulatory guidance and requirements regarding air monitoring sites to better enable a consistent approach to site representativeness, trend analysis and compliance reporting. This could be informed by additional monitoring of the type demonstrated in this work.

1 Introduction

1.1 Background

Otago Regional Council (ORC) is responsible for the management of air quality across the Otago region. This includes a requirement to monitor air quality where non-compliance with National Environmental Standards is likely. Under the Otago Regional Air Plan towns with similar risk have been grouped into two Air Zones, with Air Zone 1 representing a higher risk. At present, monitoring of Air Zone 1 is conducted at four monitoring sites – one each in Arrowtown, Cromwell, Clyde and Alexandra.

Previous research by NIWA and others has shown how air quality can be highly variable in time and space within airsheds, especially smaller towns with prevalent use of winter wood-burning, such as the Air Zone 1 towns. This makes it quite difficult to assess the degree to which any given monitoring site meets the current guidance from MfE, that monitoring sites should be located at the persistently most polluted location within the airshed.

This was starkly illustrated when the ORC monitoring site for Alexandra was moved a mere 700 m in 2017. This led to an apparent sudden and permanent improvement in the air quality results, which are intended to represent the whole town. However, a period of overlap between the old and new stations, and subsequent unpublished research by NIWA, showed that the improvement could easily be explained by genuine differences in air quality between the two sites.

Determining spatial variation in air quality within towns is vital for understanding the representativeness (and hence fitness for purpose) of air monitoring sites, and this is especially so in smaller towns with large numbers of intense emission sources such as wood-burning domestic chimneys.

Spatial information can also be informative about the processes driving the formation of hot spots, such as whether prevalent airflows cause pollution to accumulate in particular areas, or whether some emission sources have more impact than others. This could indicate the potential for locally targeted mitigation options that may be more effective than airshed-wide approaches.

Finally, better spatial information may also identify previously unknown localised air quality hot-spots, or intense emission sources.

1.2 Scope

This project aims to deliver a clearer picture of how winter air quality (expressed in terms of PM_{10} and $PM_{2.5}$) varies in space across Alexandra, and how that spatial variation also varies in time. We understand that this information may be used to select a new regulatory monitoring site in Alexandra, and/or be used to better interpret the data from current or future sites.

To assist with the main aim, we also aimed to create an equation or mathematical formulation which expresses the relationship between $PM_{2.5}$ and PM_{10} values recorded at the former ORC monitoring site at 65 Ventry Street and the current site at 5 Ventry Street so that “virtual” datasets for the one site based on the other might be created.

2 Methods

2.1 Overview

Maps of wintertime air quality in Alexandra have been generated based on observational data captured using a network of PM_x monitors over the period 27th April – 3rd July 2023. This period is sub-divided into three phases depending on the number of active monitoring sites, as described in Table 2-1.

Table 2-1: The three observational periods making up the observational campaign upon which analysis is based.

Period name	Starts	Ends	#sites
Initial	27 April	4 May	11
Intermediate	4 May	2 June	30
Full	2 June	3 July	42

This report focusses on data from the "Full" period only as it is better placed to address the questions this report seeks to address.

Maps of air quality are provided for two different timeframes:

- Full-period average.
- Daily averages for each day of the campaign.

Maps of air quality are provided in two forms:

- Values at measurement points for each period.
- Interpolated maps over the study domain created by ordinary kriging (using ArcGIS Desktop 10.6).

Air quality is represented by concentrations of PM_{10}.

All maps are provided in Appendix A.

2.2 Observational methods

2.2.1 Instruments used

Original data for this study was collected using Clarity Node-S air quality monitors (www.clarity.io). These devices monitor particulate matter (PM) in a self-powered, FCC/CE certified, UV-resistant, and weatherproof package incorporating solar harvesting, internal battery, and global cellular communications.

Clarity monitors were installed on power poles and streetlight poles across Alexandra in as regular a grid pattern as was practically achievable. All monitors were installed at approximately 2.5 m height.

2.2.2 Instrument siting design

Our primary purpose was to produce high accuracy maps of PM_{10}. Previous research indicated that kriging of data derived from a regular grid of monitors is likely to be the best method of achieving this.

We therefore aimed to deploy monitors in a regular rectangular grid. 42 monitors were available for this project, allowing a grid of 6 x 7. However, deployment locations were limited to accessible streetlight poles and power poles, meaning that some intended locations were not viable. In addition, 2 monitors were dedicated to the current and previous ORC monitoring sites.

2.3 Data adjustment

2.3.1 PM_{10}

The Clarity monitor is not an approved method for regulatory purposes. It is based on a different sensor technology (optical scattering) from the method used in ORC's regulatory monitoring network (beta attenuation). To allow for our data and ORC regulatory data to be compared and combined, one Clarity monitor was placed at the ORC regulatory site in Alexandra for the full observational campaign. Figure 2-1 shows the relationship between hourly PM_{10} measured by the Clarity and the regulatory monitor. It can be seen that the Clarity over-estimates "regulatory" PM_{10} by an approximate factor of three. Based on this data a polynomial equation has been fitted and used to convert all Clarity PM_{10} data into regulatory-equivalent estimates of PM_{10}.

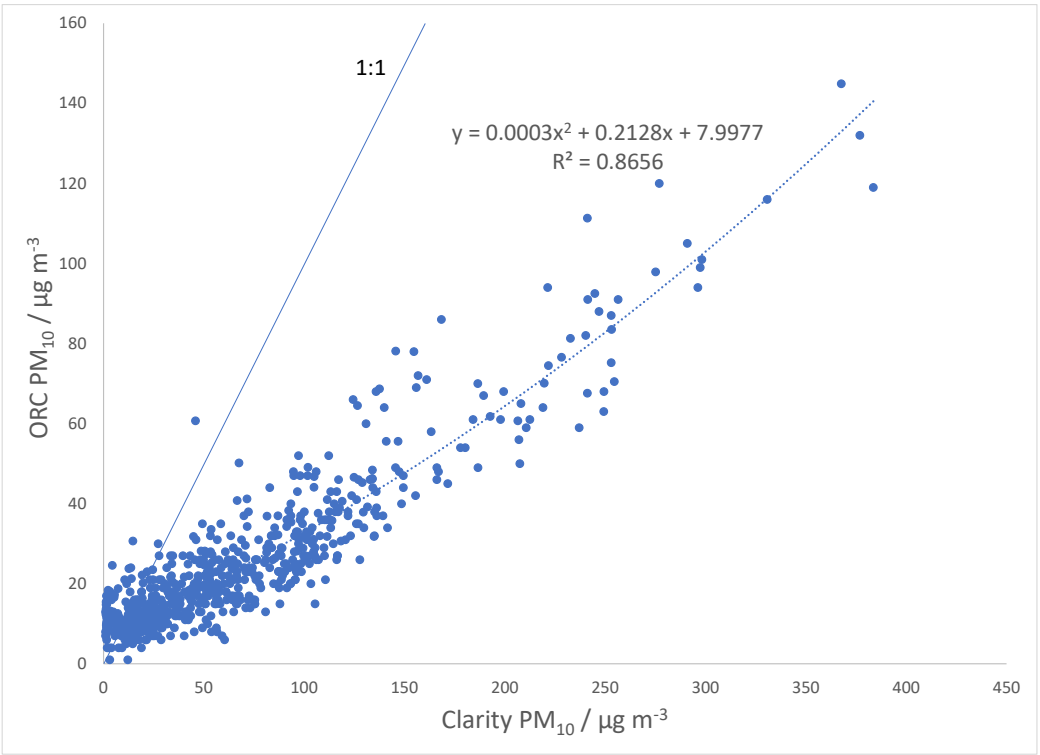


Figure 2-1: Relationship between hourly PM_{10} measured by ORC regulatory monitor and co-located Clarity monitor.

2.3.2 $PM_{2.5}$

Although $PM_{2.5}$ was measured by ORC at the Alexandra site during our campaign, a non-standard instrument (ES-642) was used. Therefore, we cannot apply an adjustment to $PM_{2.5}$ data as we have for PM_{10} data.

In our professional opinion there is considerable uncertainty in the way the Clarity monitors distinguish between $PM_{2.5}$ and PM_{10}. The interquartile range of the hourly ratio of PM_{10} to $PM_{2.5}$ reported by the Clarity monitors was 1.26 – 1.47 (i.e., $PM_{2.5}$ ranged from 68 – 79 % of PM_{10}). In our professional opinion the true percentage may be higher.

For these reasons, this report does not include $PM_{2.5}$ results.

3 Results

3.1 Long-term mean spatial variation

Figure 3-1 presents our map of average (adjusted) PM_{10} for the whole of the "full" campaign. Each site is given a "row & column" ID (e.g., D3). Maps for each 24-hour period (midnight to midnight) are provided in Appendix A.

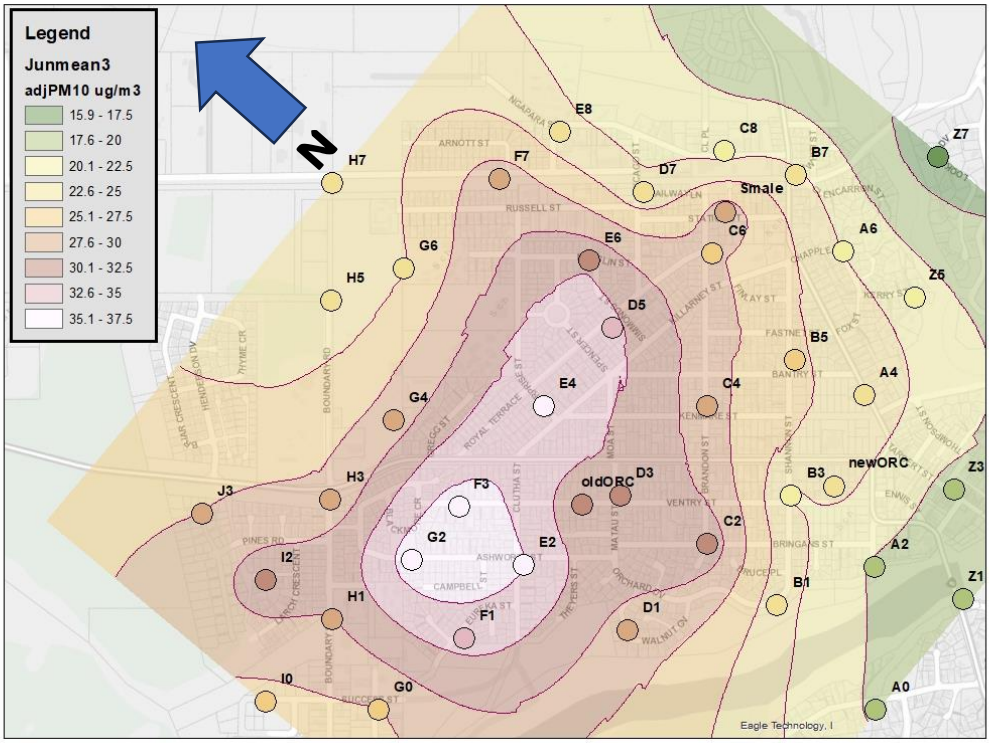


Figure 3-1: Mean adjusted PM_{10} for the period 2nd June (12:00) - 3rd July (12:00).

Figure 3-1 shows that month-average PM_{10} concentrations varied from 15.9 – 36.4 μg m^{-3}. The highest concentrations were recorded in the vicinity of Table Top Park and Ashworth Street (white zone in Figure 3-1), especially at site G2. The lowest concentrations were recorded at site Z7 on Lookout Drive (top right corner in Figure 3-1). The second lowest concentrations (19.2 – 19.7 μg m^{-3}) were all recorded close to the Clutha River (bottom right corner in Figure 3-1).

The median concentration across the grid was 24.5 μg m^{-3} and the mean concentration was 26.8 μg m^{-3}. Their similarity indicates very little skew in the concentration distribution, consistent with the gradual concentration gradients seen in Figure 3-1. This can also be seen in Figure 3-2 which plots each day's concentration distribution in space as a box and whisker plot. Figure 3-3 shows the same data but with days ordered in terms of median concentration. Figure 3-3shows that, broadly, going from less polluted days (left) towards more polluted (right) concentrations increase across the whole town, widening the concentration distribution in absolute terms. It also appears to show that, over the main campaign in June 2023, low, medium and high concentration days were roughly equally prevalent.

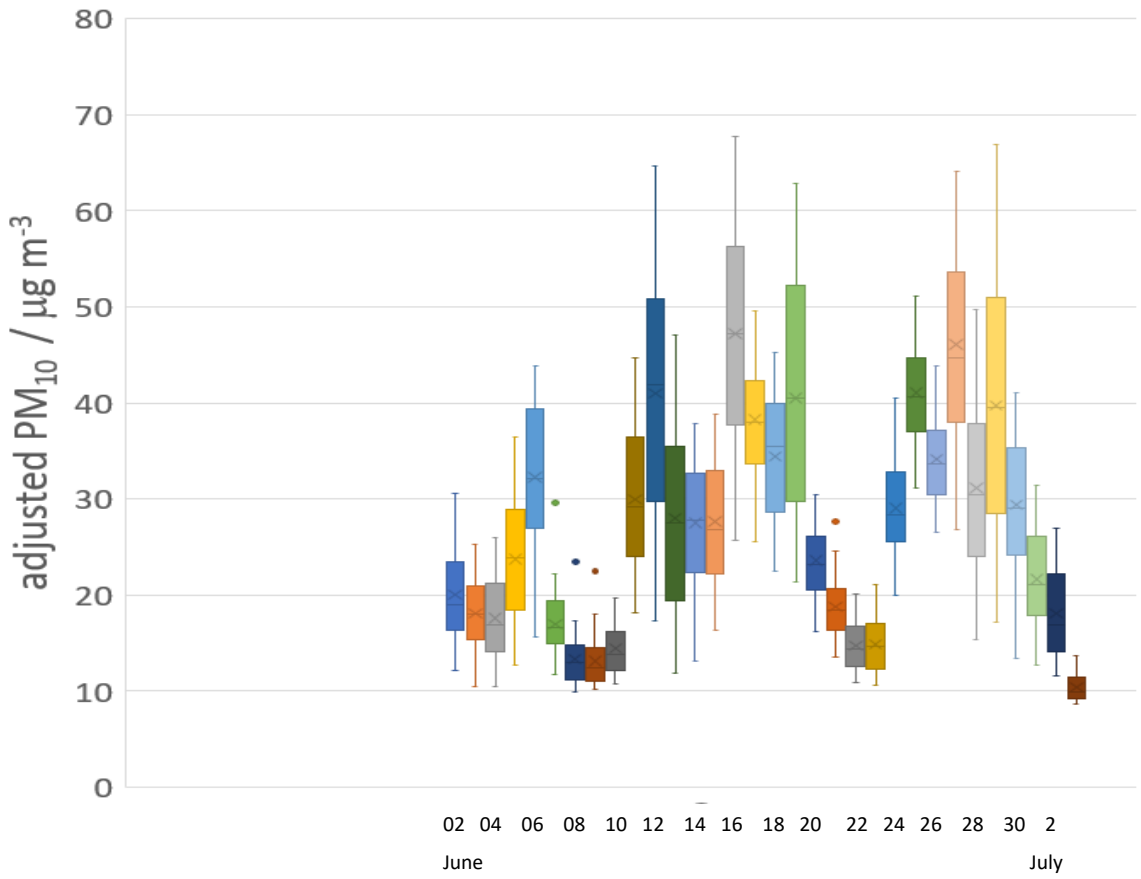


Figure 3-2: Distributions of 24-hour PM_{10} concentrations across the grid for each day.

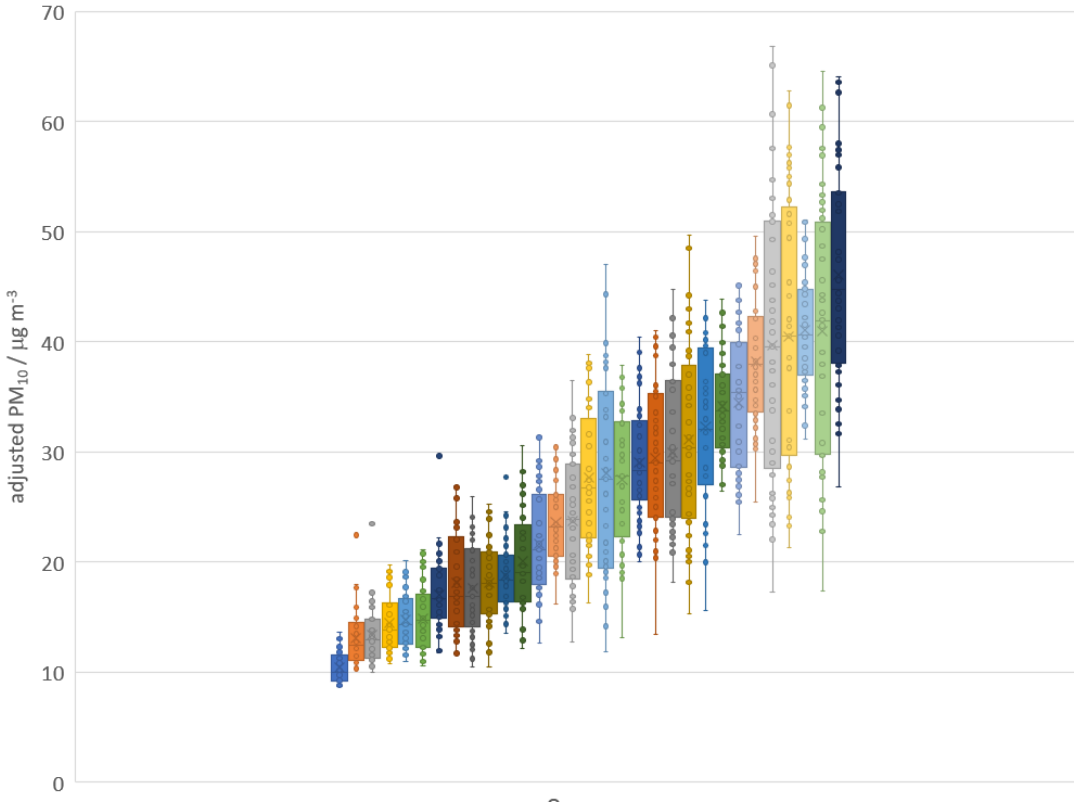


Figure 3-3: Distributions of 24-hour PM_{10} concentrations across the grid for each day. Days are ranked in terms of median concentration.

Figure 3-4 depicts the number of exceedances of the National Environmental Standard for PM_{10}, based on each individual monitor, including an interpolated prediction. The current ORC site recorded one exceedance during the full monitoring campaign (on 16th June). Our monitoring suggests that 3 exceedances would have been recorded using the previous monitoring site, and 6 if monitoring were conducted at the true hot spot.

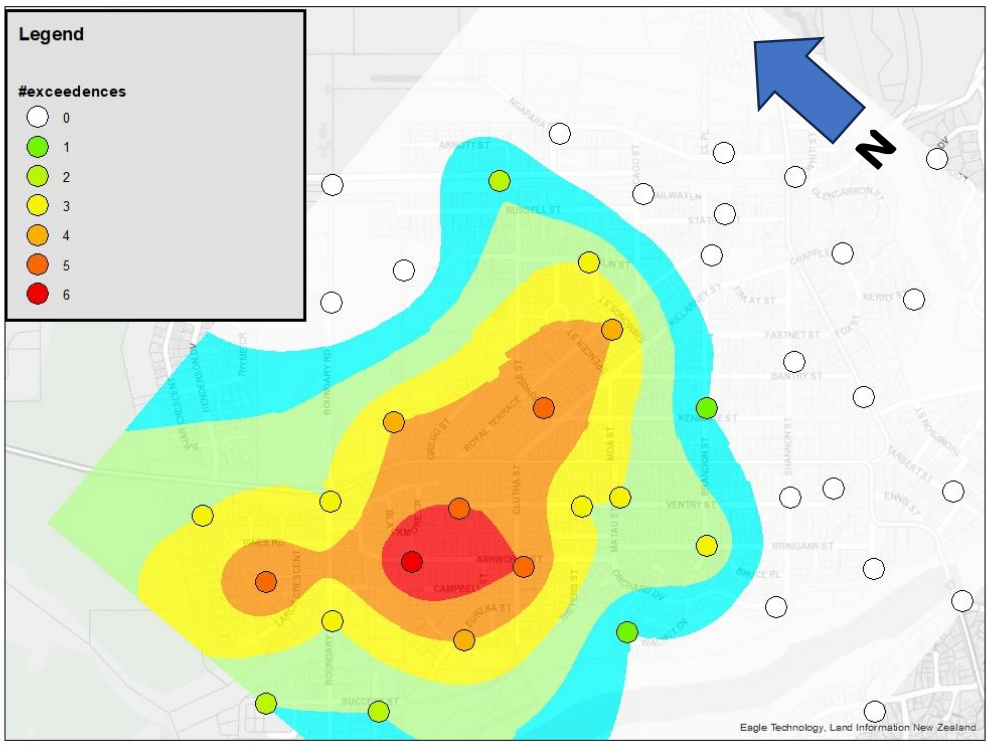


Figure 3-4: Predicted number of NES exceedances based on individual monitors for the period 3rd Jun - 2nd Jul 2023 inclusive.

3.2 Day-to-day variability in spatial variation

Comparing the map for each 24-hour period (Appendix A) it can be seen that the general spatial pattern changes little. The site reporting the maximum concentration in each 24 -hour period was always within a narrow area defined by the 32.5 μg m^{-3} contour line in Figure 3-1, with only one exception. This was 15th June when the maximum concentrations lay approximately 500 m further south of the normal position, i.e., towards the SE end of Ashworth Street.

The lowest concentration was consistently recorded on Lookout Drive on every day. The second lowest concentration was usually recorded at one of the sites near the rivers, but was occasionally recorded to the eastern, northern or western periphery of the grid.

Figure 3-5 shows the relationship between 24-hour average concentrations measured at the peak site of G2 and site A0 on the grid's south-western edge near Poplar Grove in Bridge Hill – one of the sites recording systematically lower concentrations. This figure indicates that, as a rough guide, concentrations at the edge of the town grid were approximately half of the maximum concentrations recorded within the grid.

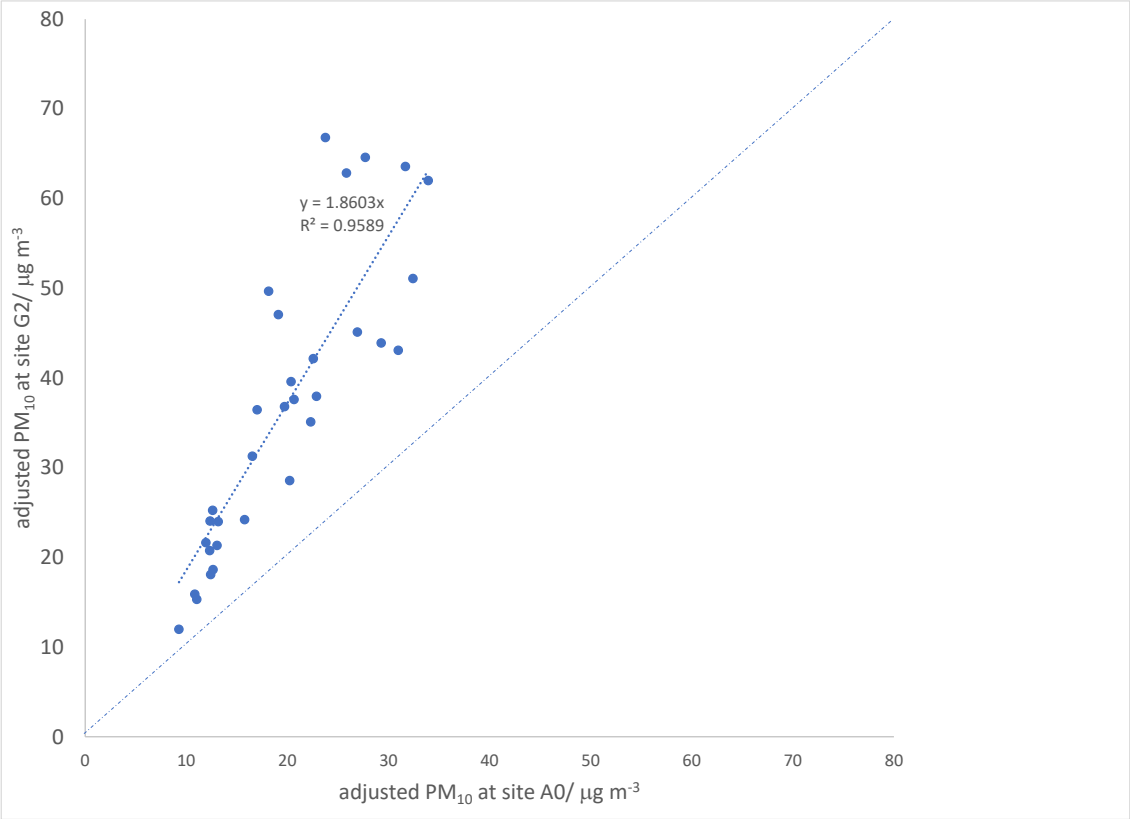


Figure 3-5: 24-hour average adjusted PM_{10} at the peak site (G2) and a peripheral site (A0).

3.3 What can we infer about air quality beyond the monitoring grid?

Figure 3-2 shows that the minimum adjusted PM_{10} concentration in our grid varied from 10 to 34 µg m^{-3} as a 24-hour average. Concentrations at site J3 varied from 12 to 57 µg m^{-3}, despite being at the far north-western edge of the town. These results strongly imply that elevated concentrations existed beyond the edge of our grid and beyond the urbanised area. This is consistent with observations made in 2022 in and outside Ashburton (currently unpublished). NIWA intend to look at this issue further in the future.

3.4 Relationship between current and previous ORC monitoring sites

Figure 3-6 shows that, compared to the precious ORC monitoring site, the new site has been reporting concentrations approximately 23 % lower. 24-hour PM_{10} concentrations from the new site could therefore be adjusted to create a "virtual" record for the previous site by multiplying concentrations by 1.295.

At the moment this relationship can only be verified for the period of monitoring, i.e., June 2023. However, we expect that this relationship is likely to hold for all seasons and all years. Outside of the winter period the concentrations generally get lower, which means the correction required is smaller and any errors in the correction becomes less critical. The correction factor is unlikely to change much over the year unless a very different emission source with a very different spatial pattern becomes significant, which we do not expect in Alexandra.

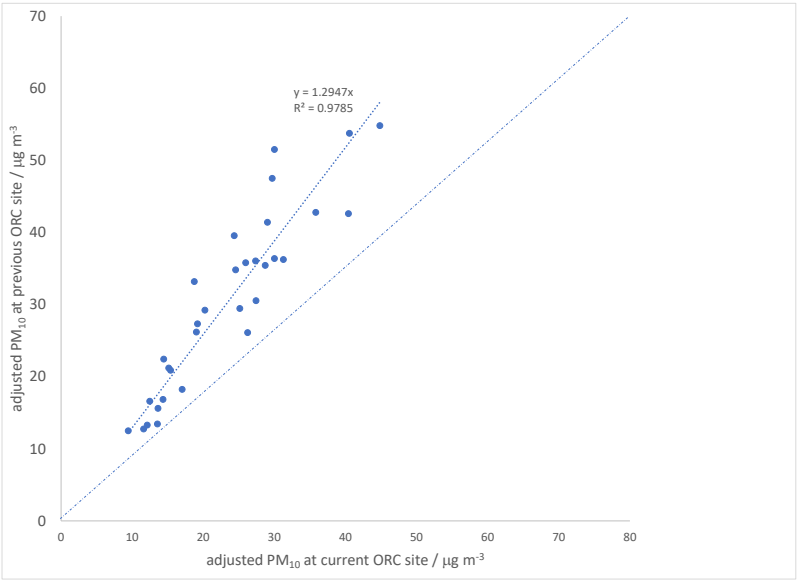


Figure 3-6: 24-hour average adjusted PM_{10} at the current and previous ORC monitoring sites.

3.5 Relationship between both current and previous ORC monitoring sites and town-wide median and maximum concentrations

Together, Figure 3-7 and Figure 3-8 show that the current ORC monitoring site reports concentrations very close to the town median, but that town maximum concentrations are approximately 63 % higher.

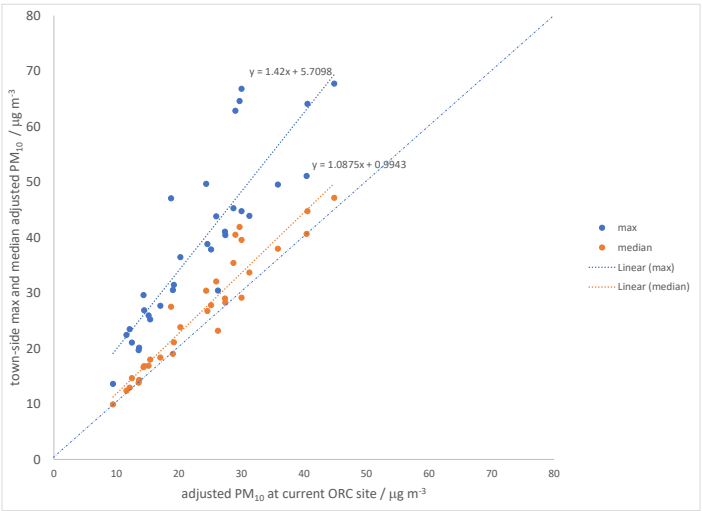


Figure 3-7: 24-hour average adjusted PM_{10} at the current ORC monitoring site and the town-wide median and maximum concentrations.

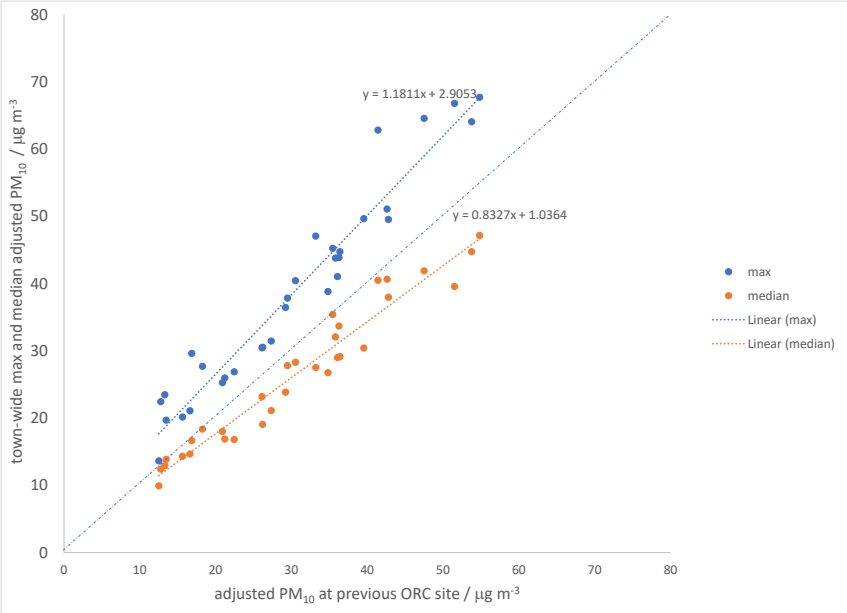


Figure 3-8: 24-hour average adjusted PM_{10} at the previous ORC monitoring site and the town-wide median and maximum concentrations.

3.6 Why is the hot spot where it is?

Explaining the spatial variation observed is beyond the scope of this report. However, this will be the subject of ongoing research by NIWA.

4 Conclusions and Recommendations

The monitoring conducted in this project clearly shows a large and consistent spatial variation in PM_{10} across Alexandra. Concentrations vary by an approximate factor of 2 with the highest concentrations being consistently found over a relatively small area between Ashworth Street and Simmonds Street, most frequently peaking around Table Top Park.

This spatial variation means that the representativeness of any single monitoring site is highly sensitive to its precise location. This work clearly shows that the "new" monitoring site adopted by ORC for regulatory monitoring in 2017 reports concentrations around 23 % lower than the previous site, despite it being only 720 m away along the same road (Ventry Street). The current site is fairly representative of median or average concentrations across the town, but both the current, and the previous site under-represent the maximum concentrations in the town.

Current guidance states that air quality monitoring for regulatory purposes should be conducted at the most polluted location within an airshed. However, in advance of highly spatially detailed monitoring such as this (which has only very recently become feasible), it is very difficult to ascertain where such a location is, and how large an area can be considered to qualify. This work has now revealed how localised this area is in Alexandra.

We make the following recommendations to ORC:

- To comply with current regulatory guidance, we recommend that ORC re-locate their monitoring station again closer to the "hot-spot" area identified in this work.
- We recommend that a "virtual" time series of PM_{10} be created both retrospectively and on an ongoing basis to estimate the concentrations at the previous ORC site to enable long-term analysis of trends. Compared to the precious ORC monitoring site, the new site has been reporting concentrations approximately 23 % lower. 24-hour PM10 concentrations from the new site could therefore be adjusted to create a "virtual" record for the previous site by multiplying concentrations by 1.295.
- Similar monitoring assessment of other towns should be considered.
- Work with MfE and other regional councils to promote a review of regulatory guidance and requirements regarding air monitoring sites to better enable a consistent approach to site representativeness, trend analysis and compliance reporting. This could be informed by additional monitoring of the type demonstrated in this work.

5 Acknowledgements

Permission to mount air quality monitors on power poles was provided by Aurora Energy.

Thanks to ORC for assistance with instrument deployment.

Appendix A Maps of observed and interpolated PM_{10}

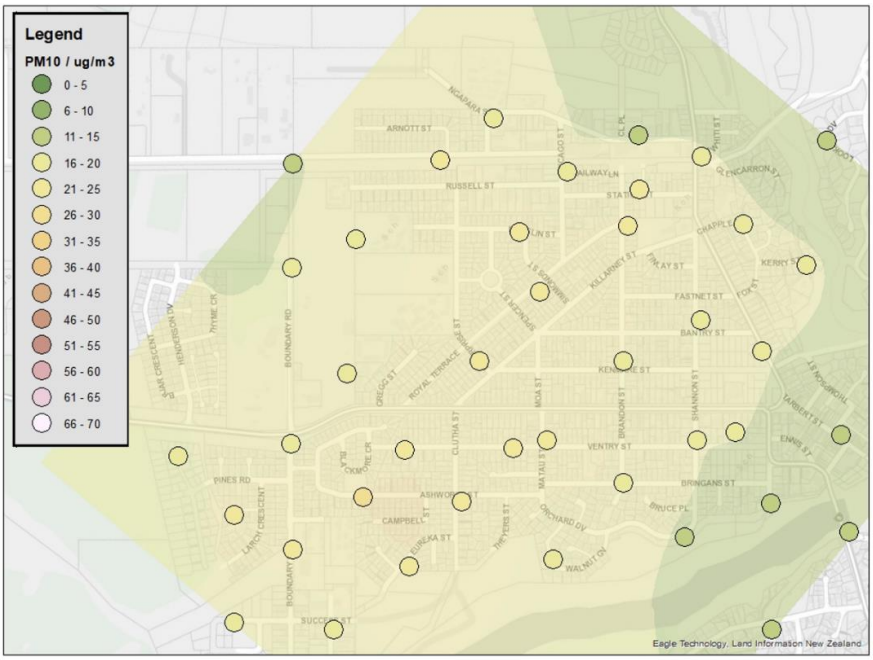


Figure A-1: 3rd June 2023.

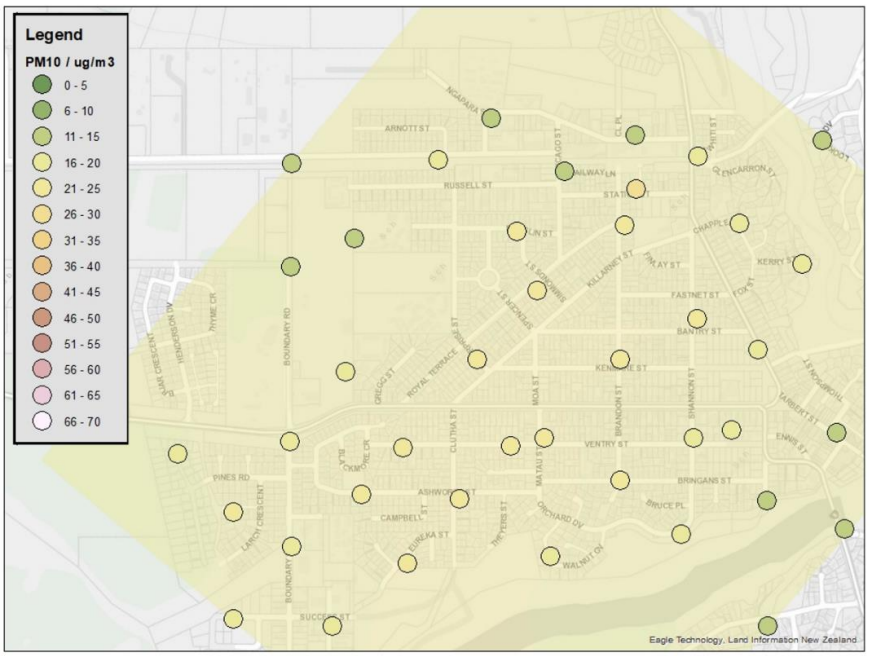


Figure A-2: 4th June 2023.

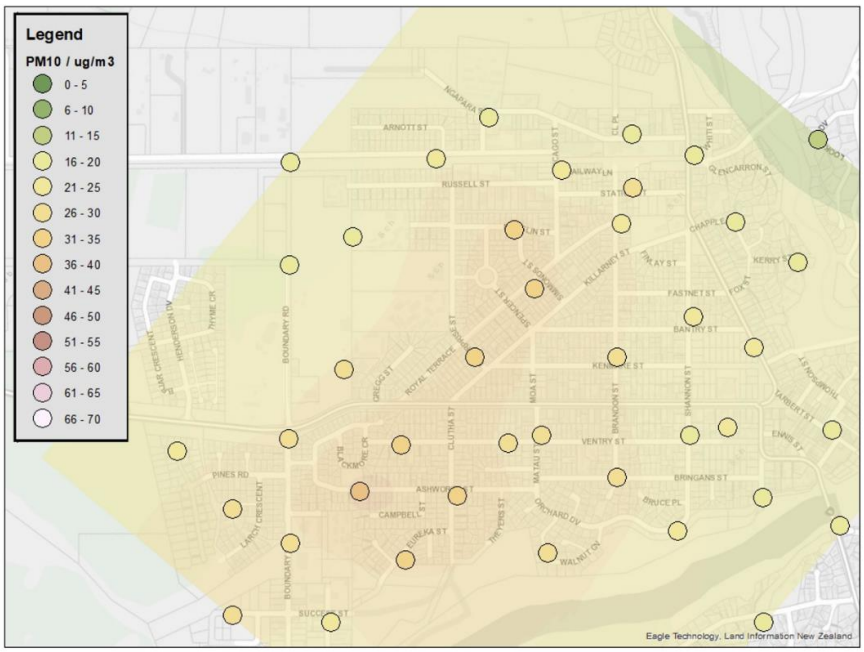


Figure A-3: 5th June 2023.

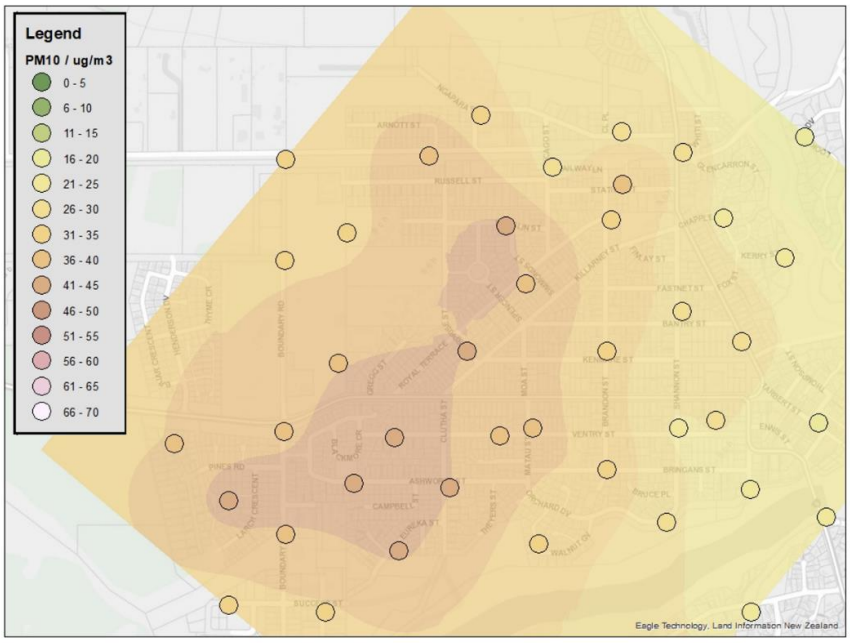


Figure A-4: 6th June 2023.

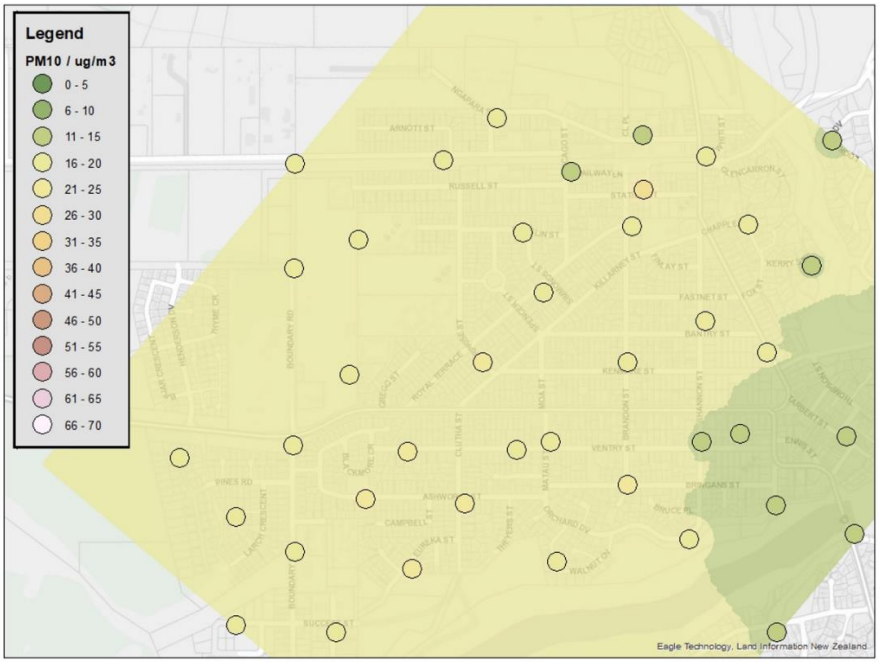


Figure A-5: 7th June 2023.

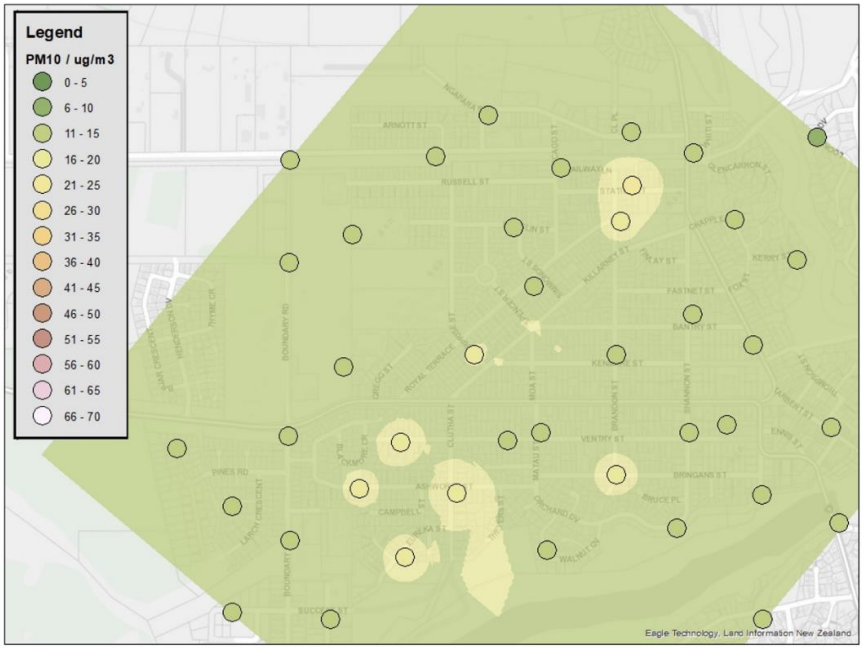


Figure A-6: 8th June 2023.

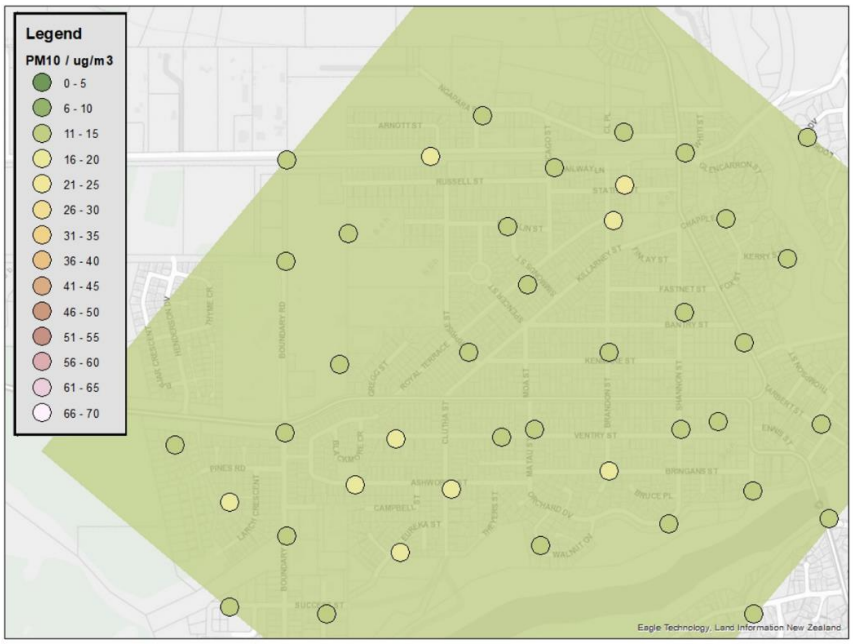


Figure A-7: 9th June 2023.

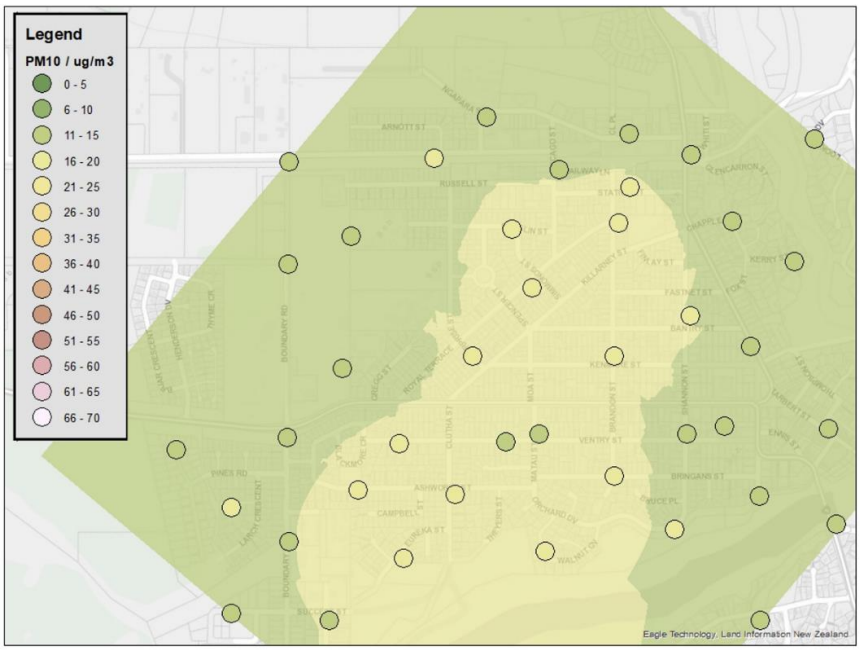


Figure A-8: 10th June 2023.

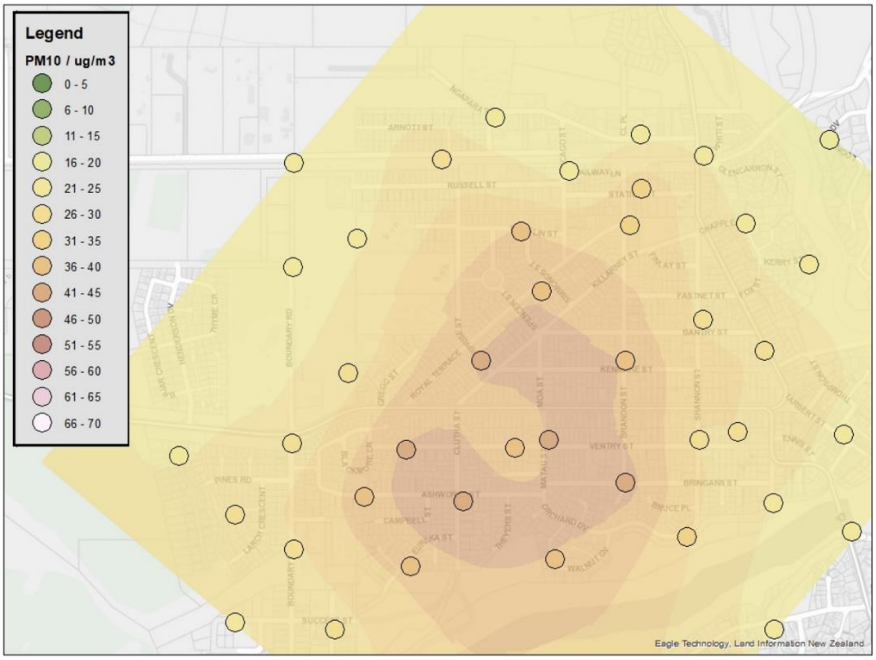


Figure A-9: 11th June 2023.

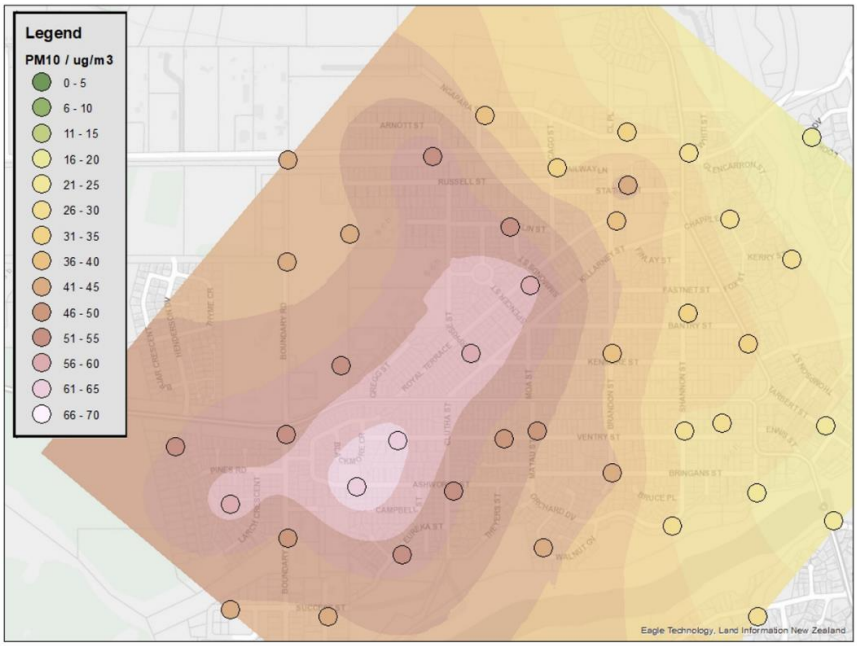


Figure A-10: 12th June 2023.

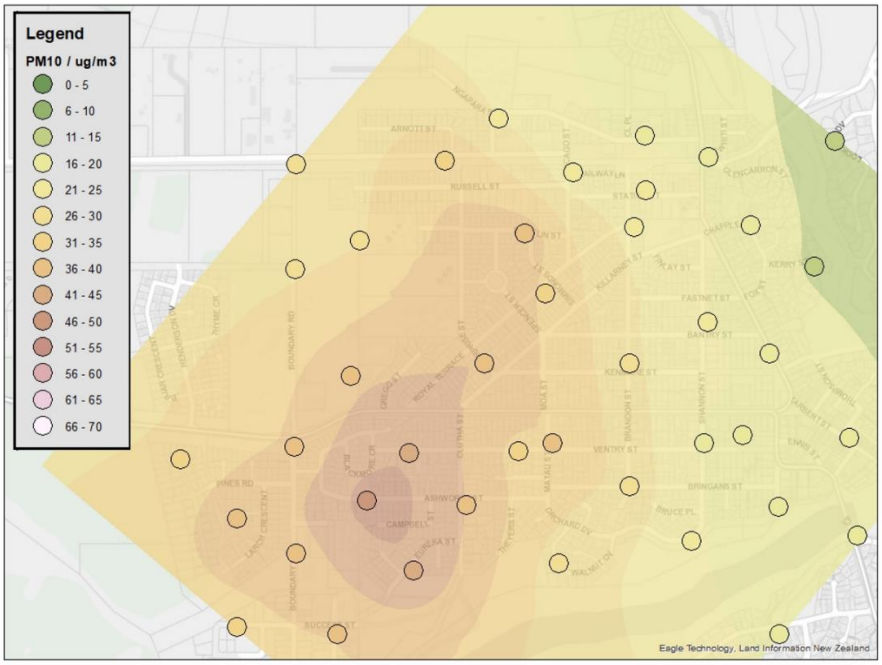


Figure A-11: 13th June 2023.

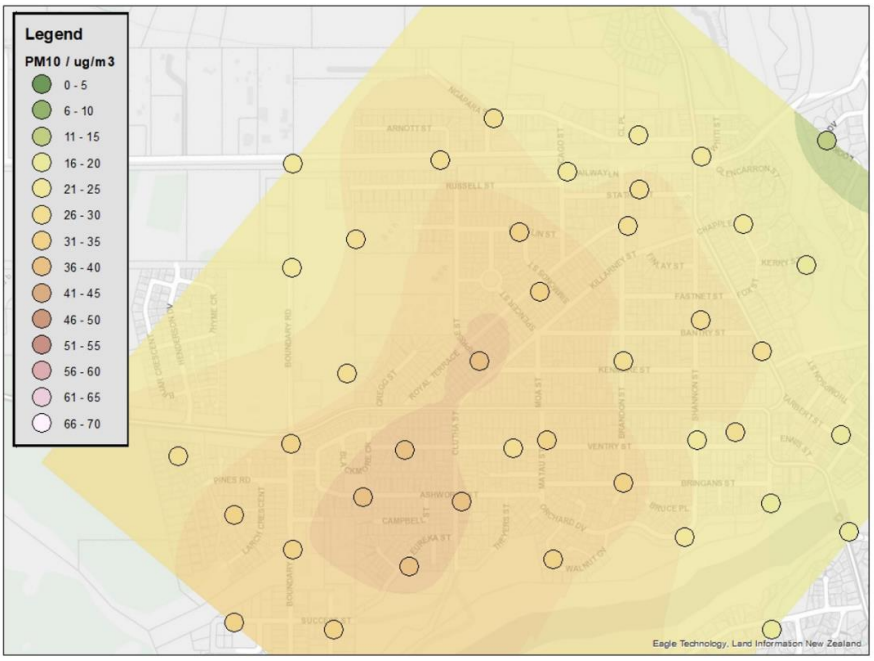


Figure A-12: 14th June 2023.

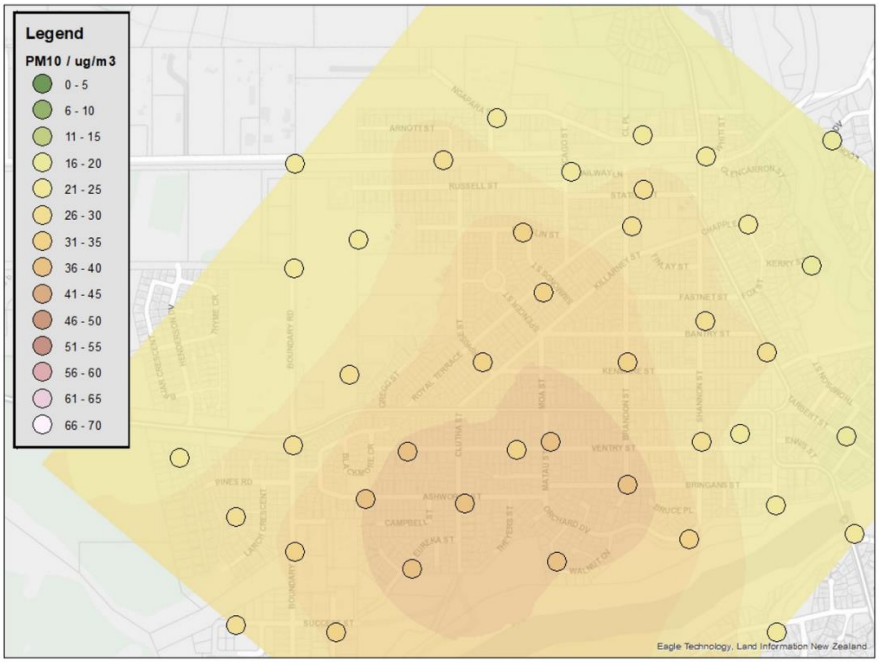


Figure A-13: 15th June 2023.

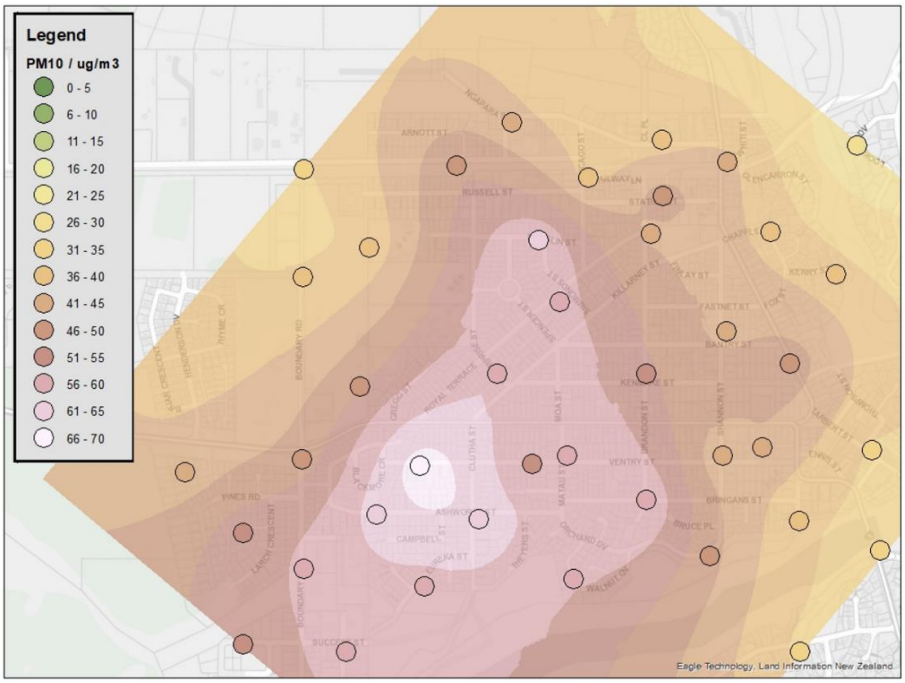


Figure A-14: 16th June 2023.

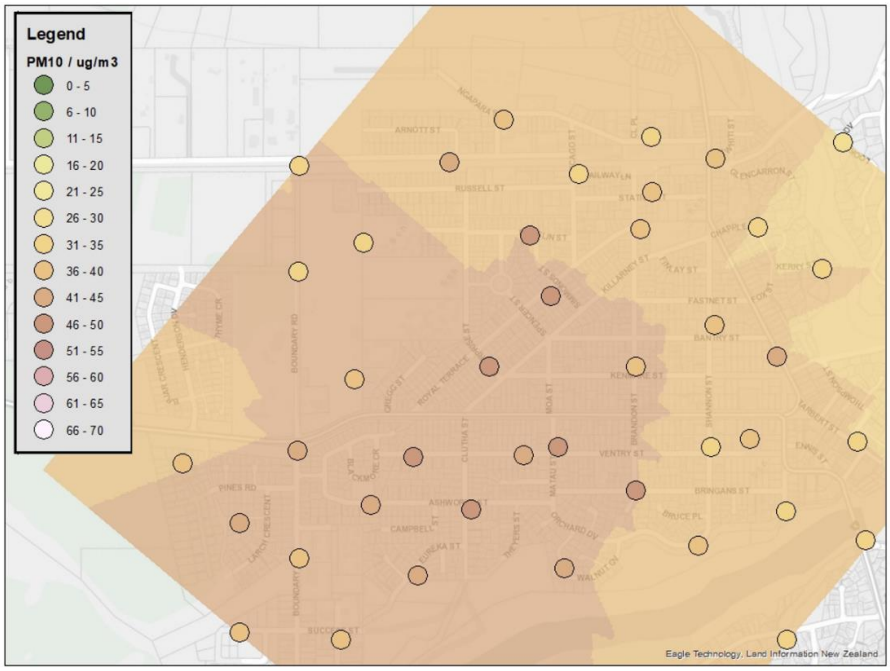


Figure A-15: 17th June 2023.

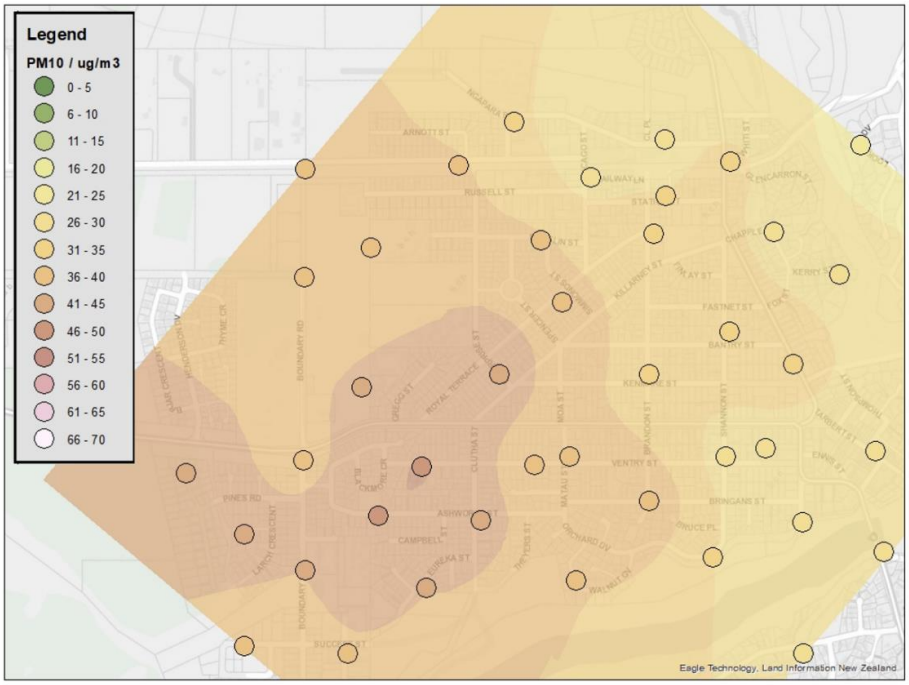


Figure A-16: 18th June 2023.

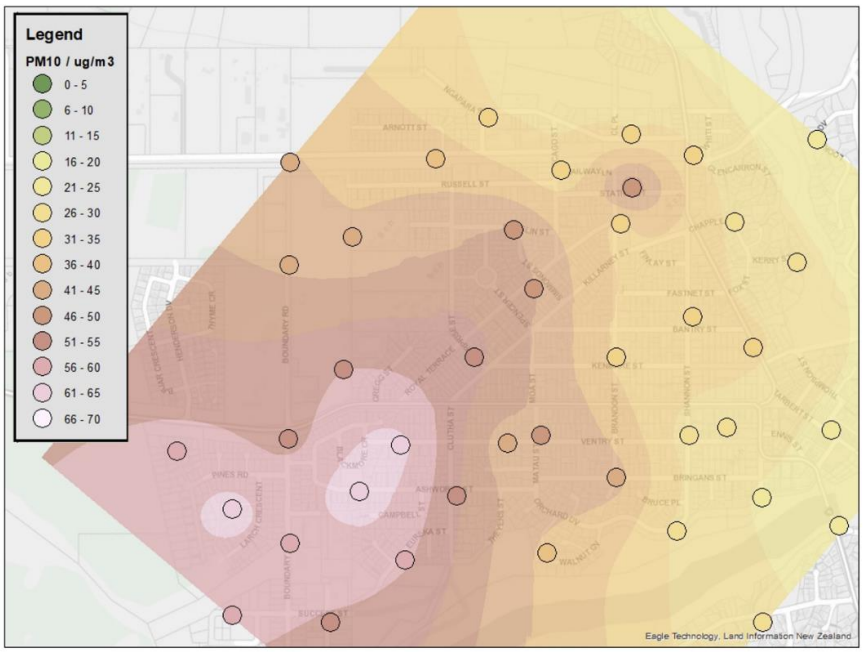


Figure A-17: 19th June 2023.

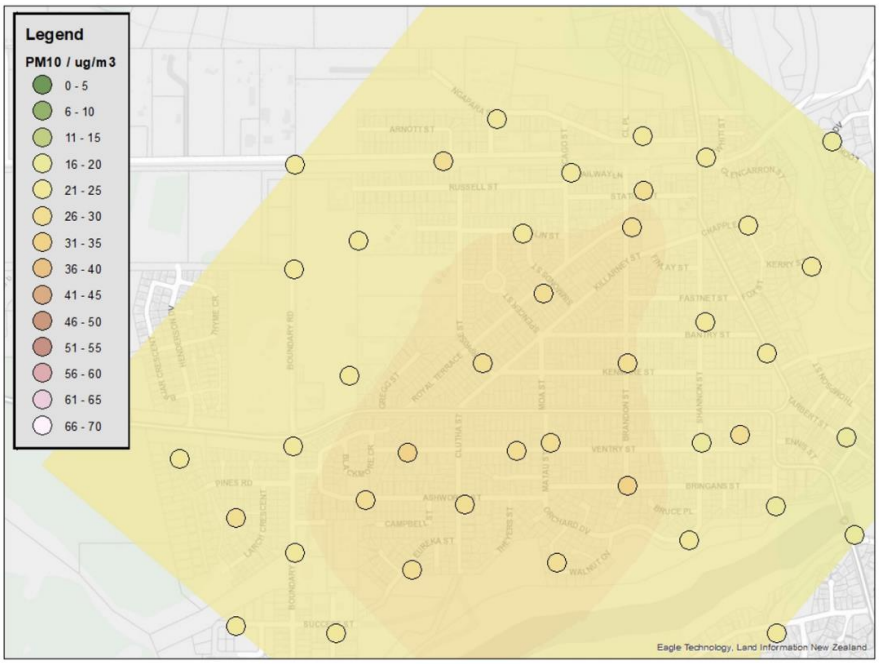


Figure A-18: 20th June 2023.

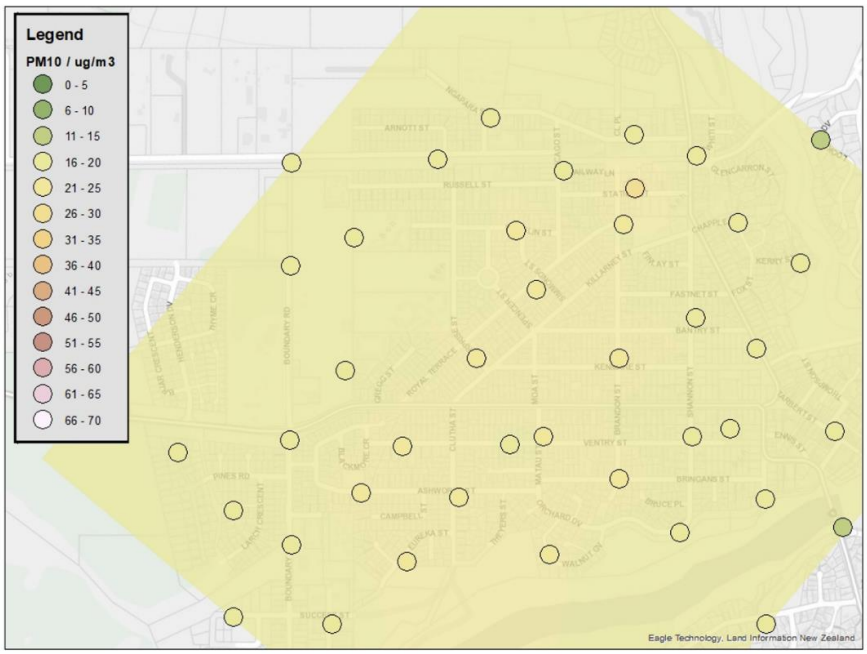


Figure A-19: 21st June 2023.

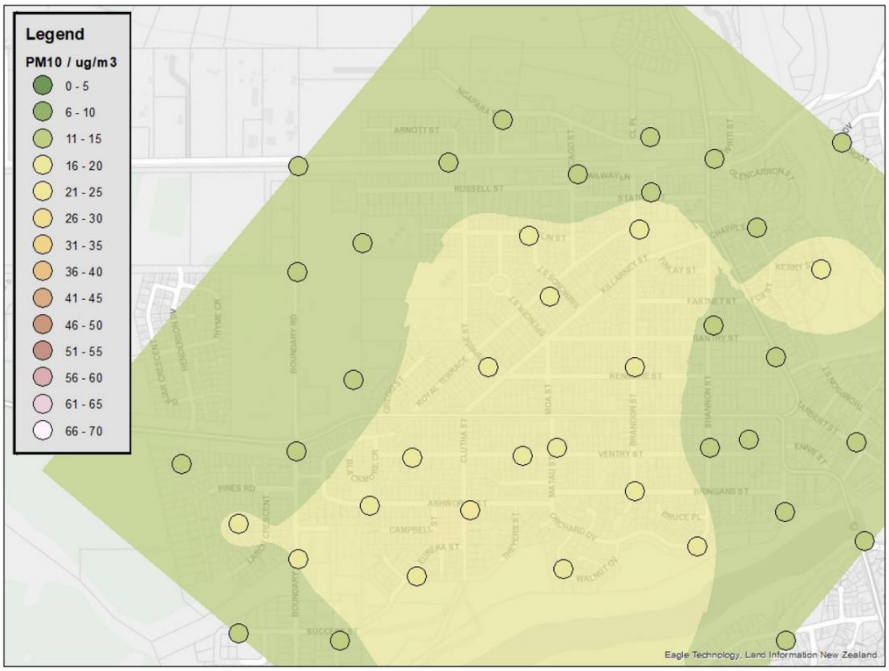


Figure A-20: 22nd June 2023.

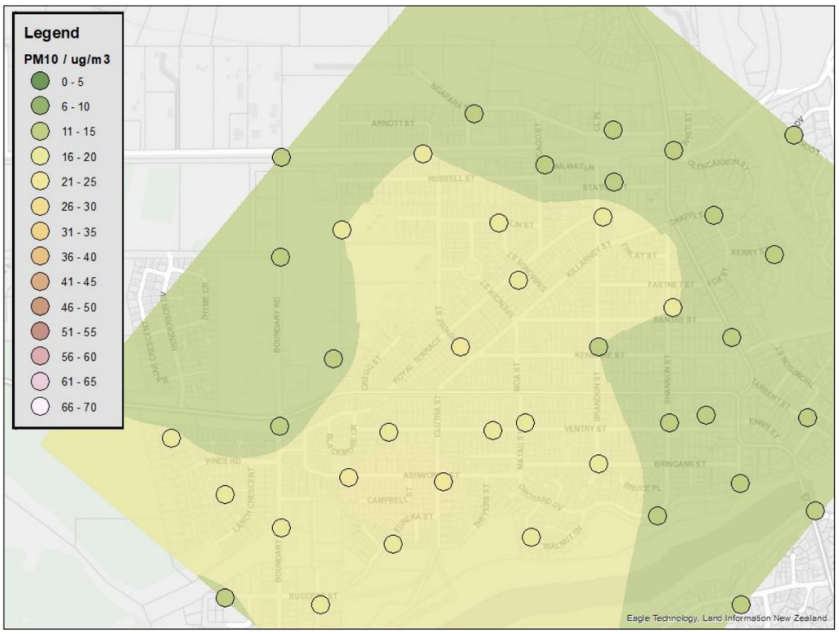


Figure A-21: 23rd June 2023.

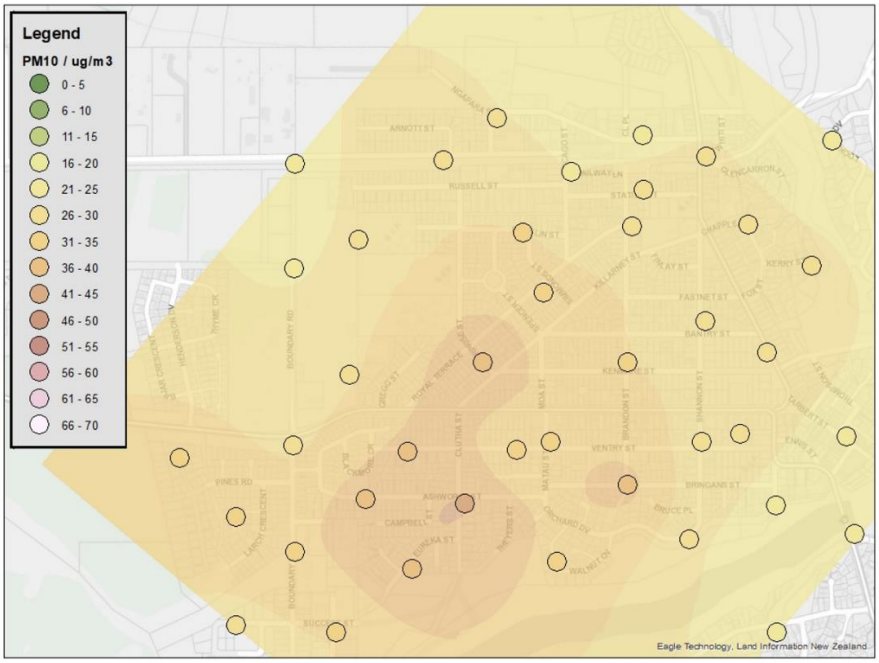


Figure A-22: 24th June 2023.

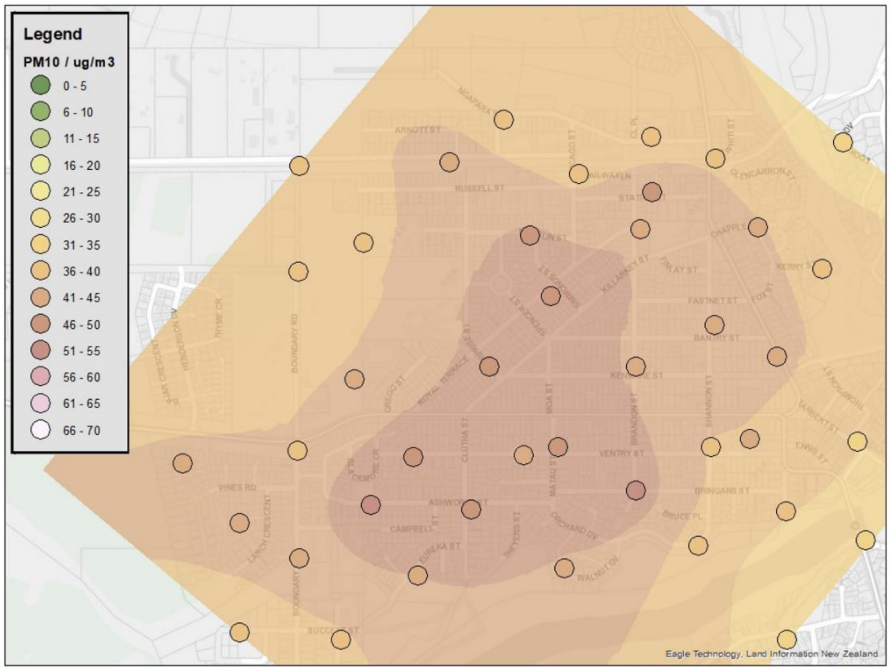


Figure A-23: 25th June 2023.

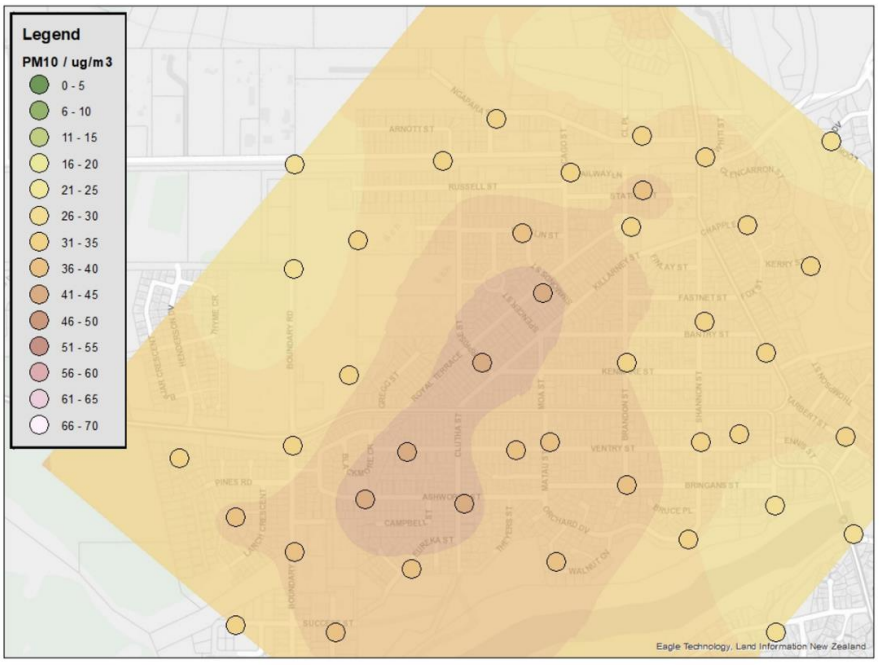


Figure A-24: 26th June 2023.

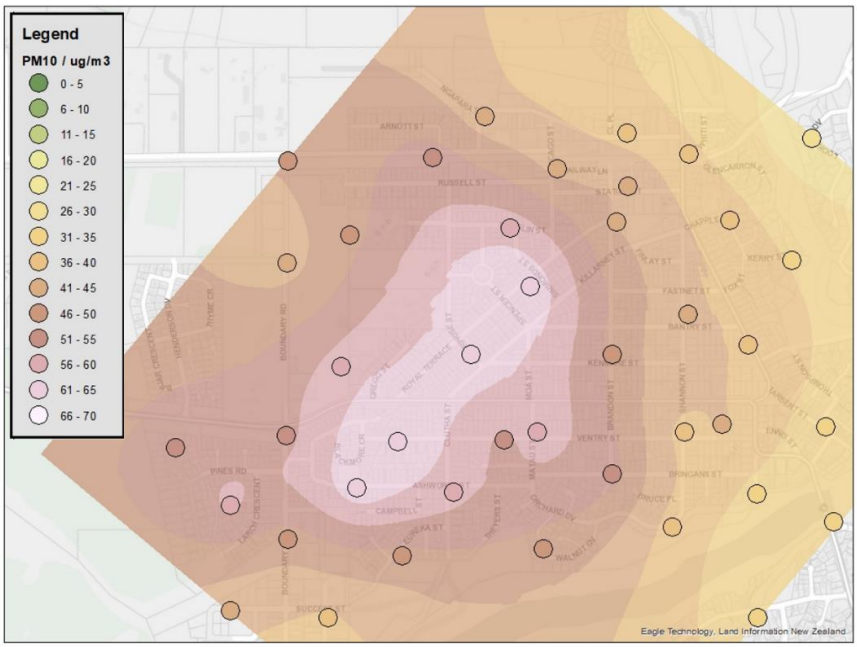


Figure A-25: 27th June 2023.

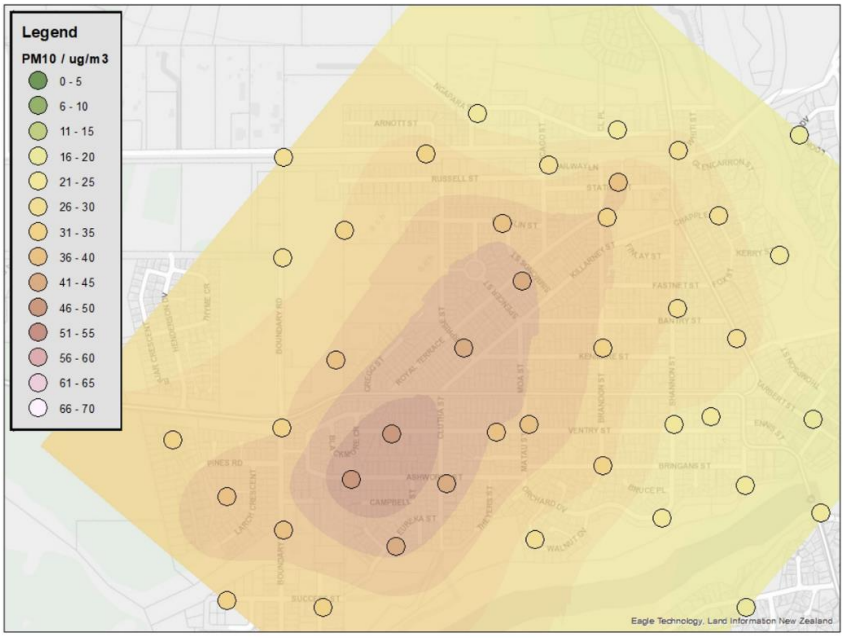


Figure A-26: 28th June 2023.

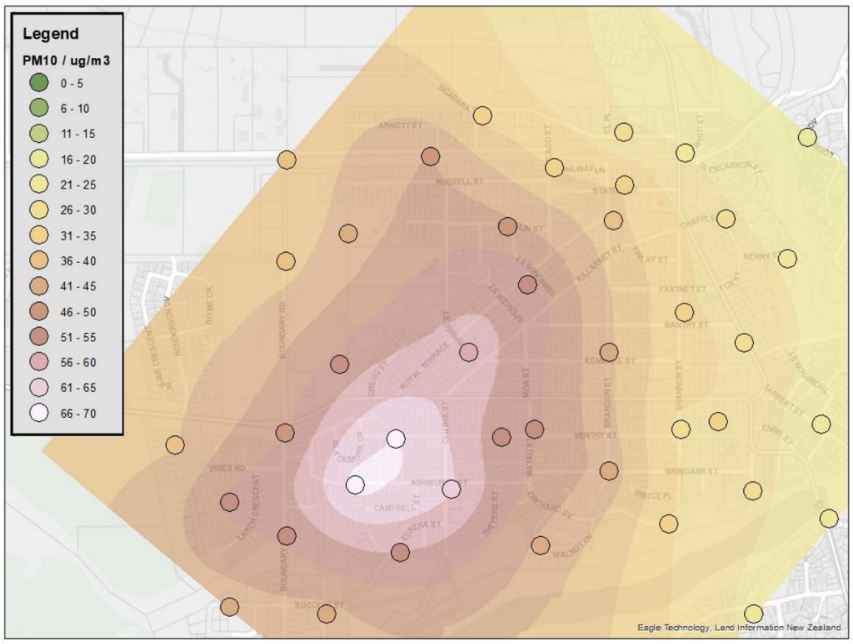


Figure A-27: 29th June 2023.

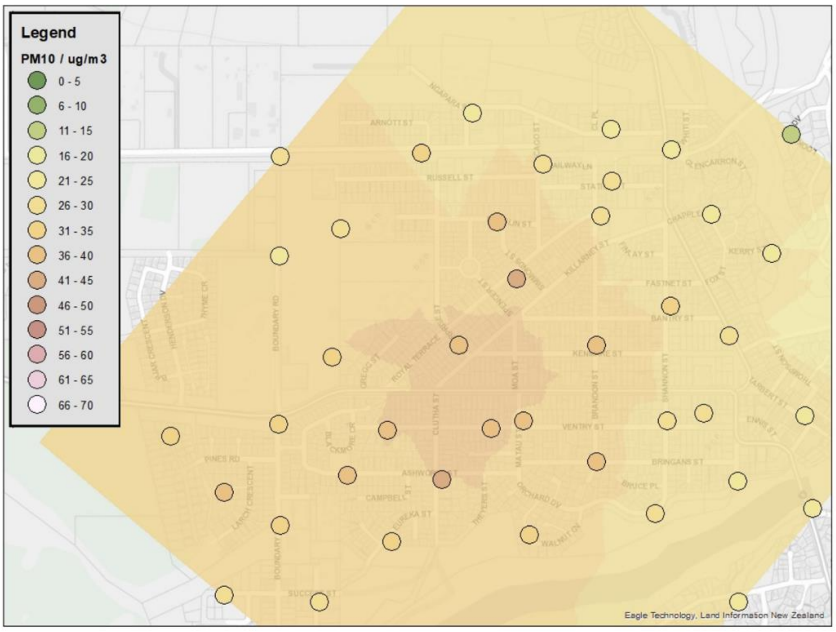


Figure A-28: 30th June 2023.

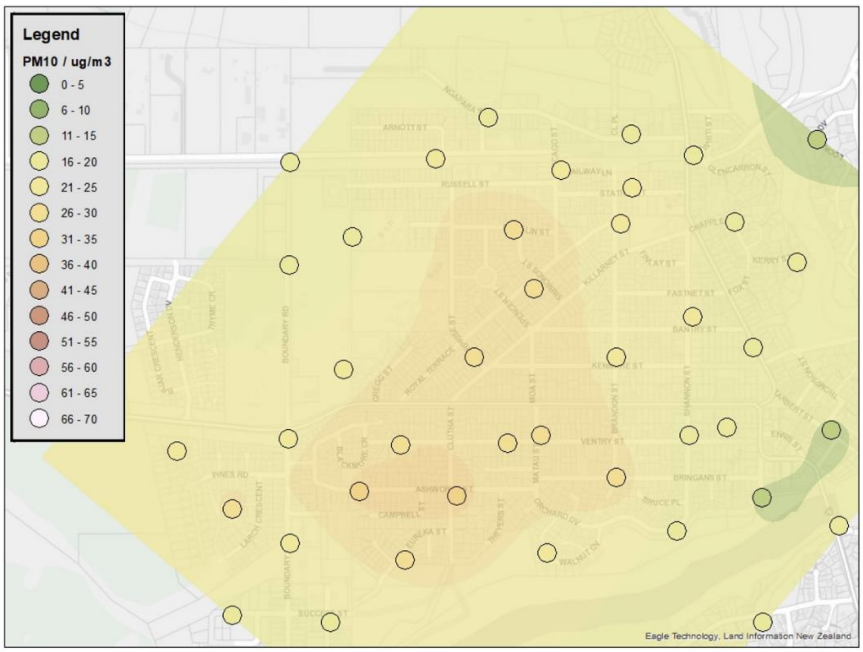


Figure A-29: 1st July 2023.

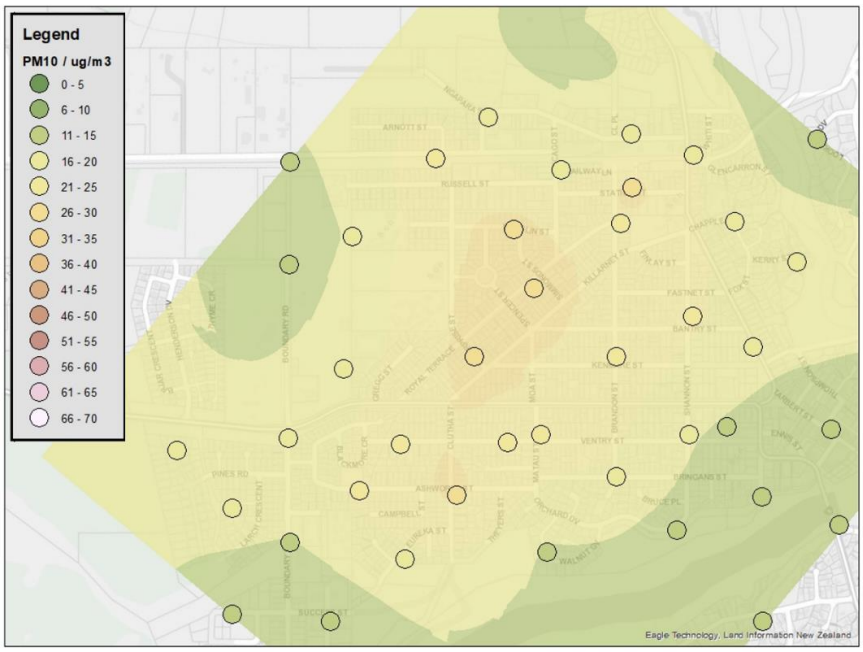


Figure A-30: 2nd July 2023.

9.2. Port Otago air quality screening study

Prepared for: Environmental Science and Policy Committee

Report No. SPS2401

Activity: Environmental: Air

Author: Sarah Harrison, Scientist – Air Quality

Endorsed by: Anita Dawe, General Manager Policy and Science

Date: 20 March 2024

PURPOSE

[1] This report presents the results of an air quality pilot study for sulphur dioxide (SO_2) undertaken at Port Otago during 2022-2023.

EXECUTIVE SUMMARY

[2] SO_2 is a colourless gas with a pungent odour that can cause both respiratory and cardiovascular health issues. It is produced by the combustion of sulphur-containing fuels such as coal and diesel and is a pollutant of concern in New Zealand near ports and industrial areas. Increased numbers of cruise ships to New Zealand ports in recent years has caused concern for air quality in some areas including Port Chalmers. Port Otago and ORC worked together to investigate SO_2 as a pilot study.

[3] Spatial monitoring for SO_2 was undertaken within and surrounding the Port Otago operational areas between 6 December 2022 and 3 August 2023. Many of the results were below the laboratory's limit of detection. The sites that most consistently recorded valid results were the Central Dunedin control site, followed by the T&U Berth. The highest concentration occurred at the T&U Berth (10.3 µg/m³ in December 2022). The results indicate that SO_2 is generally quite low in the Port Otago area and there was not enough information to identify any seasonal trends at many of the sites.

RECOMMENDATION

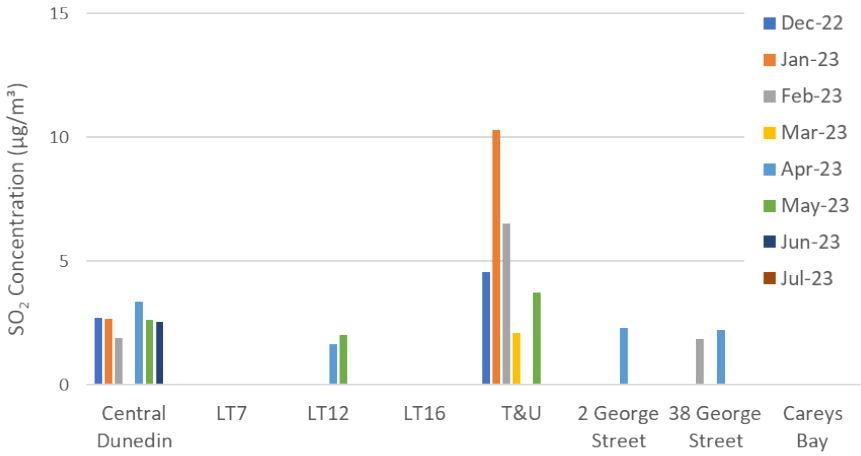
That the Committee:

1) ***Notes** this report.*
2) ***Notes** staff recommendation that further monitoring of SO_2 is not required at this time.*

DISCUSSION

[4] The below graph shows the SO_2 results from the screening study. All results are below 5 µg/m³ on a monthly average, except for January and February at the T&U Berth. Although the two highest concentrations occurred in the earliest part of the year, there is not enough information to infer seasonal trends. The full technical report is appended as Attachment 1 to this paper.

Figure 1 SO_2 results



[5] These results compare well with previous investigations and indicate that SO_2 concentrations are quite low in the Dunedin area including Port Otago.

[6] Monitoring for $PM_{2.5}$ and/or source apportionment analysis may be useful in the future. Further monitoring for SO_2 may only be required on a periodic basis.

CONSIDERATIONS

Strategic Framework and Policy Considerations

[7] Good air quality is an important part of the strategic direction: *An environment that supports healthy people and ecosystems, and A sustainable way of life for everyone in Otago.*

Financial Considerations

[8] The Port Otago air quality screening study was part of the air quality science and monitoring programme. The cost to undertake the study was approx. $3,700 + staff time.

Significance and Engagement

[9] This screening study does not trigger the Significance and Engagement requirements in *He Mahi Rau Rika*.

Legislative and Risk Considerations

[10] Managing air quality is a regional council function under the Resource Management Act.

Climate Change Considerations

[11] N/A

Communications Considerations

[12] Port Otago may wish to include these results in reports or do a media release. They have agreed to work with the ORC communications team if this is the case.

NEXT STEPS

[13] Based on the preliminary results, staff do not recommend further monitoring for SO_2 as necessary at this stage.

[14] It may be beneficial to further investigate sources of PM within the Port Chalmers airshed, as this is also produced by transport emissions, including those of shipping. It is known that elevated $PM_{2.5}$ concentrations occur in winter due to home heating and there may also be influences from Port activities or related vehicles such as cargo trucks.

ATTACHMENTS

1. Port Otago air quality screening study [**9.3.1** - 12 pages]

Port Otago air quality screening study 2023

February 2024

Otago Regional Council

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Published 20 March 2024

The author would like to thank Rebecca McGrouther and Jon Visser from Port Otago for their monitoring assistance and access to the light tower monitoring sites within the Port.

Otago Regional Council

Executive summary

Spatial monitoring for SO_2 was undertaken at and around Port Otago operational areas between 6 December 2022 and 3 August 2023. Many of the results were below the laboratory's limit of detection. The sites that most consistently recorded valid results were the Central Dunedin control site, followed by the T&U Berth. The highest concentration occurred at the T&U Berth (10.3 µg/m³ in December 2022).

The results indicate that SO_2 is generally quite low in the Port Otago area and there was not enough information to identify any seasonal trends at many of the sites. Further monitoring of SO_2 is not recommended in the near future but $PM_{2.5}$ monitoring and/or source apportionment analysis may be useful.

1. Introduction

Sulphur dioxide (SO_2) is produced by the combustion of sulphur-containing fuels such as coal and diesel. It is also produced by industries such as fertiliser and steel manufacture, and by natural sources such as geothermal activity. SO_2 is a pollutant of concern in New Zealand, especially around ports and industrial activities. The International Convention for the Prevention of Pollution from Ships (MARPOL) Annex VI sought to limit air pollution from ships while in port. From 1 January 2020, international ships coming to New Zealand and New Zealand ships travelling internationally were required to comply with Annex VI (Ministry of Transport, 2020). Annex VI requires that the limit for the sulphur content of fuel is reduced from 3.5% to 0.5%, either by using scrubbers to reduce emissions or by using higher grade fuel. New Zealand signed up to Annex VI in 2021 and compliance was implemented from the first quarter of 2022.

In recent years public concern for shipping emissions has increased in New Zealand. Cruise ships are just one source of emissions that occur at New Zealand ports, other sources include emissions from cargo ships and other vehicles such as trucks that transport cargo.

Previous monitoring of SO_2 undertaken by ORC in the late 1990's and early 2000's recorded annual averages of between 3 and 9 µg/m³ at North East Valley and between 16 and 26 µg/m³ at Central Dunedin (ORC, 2005). A three-month study in 2021[1] resulted in SO_2 monthly averages of between 5.7 and 7.0 µg/m³ at the Central Dunedin monitoring site (ORC, 2023). Table 1 shows the current relevant standards and guidelines for SO_2.

[1] Sampling was conducted using a continuous analyser as per AS 3580.4.1 – 2008 Determination of oxides of sulfur dioxide – Direct reading instrumental method.

Table 1 SO_2 limits and guidelines

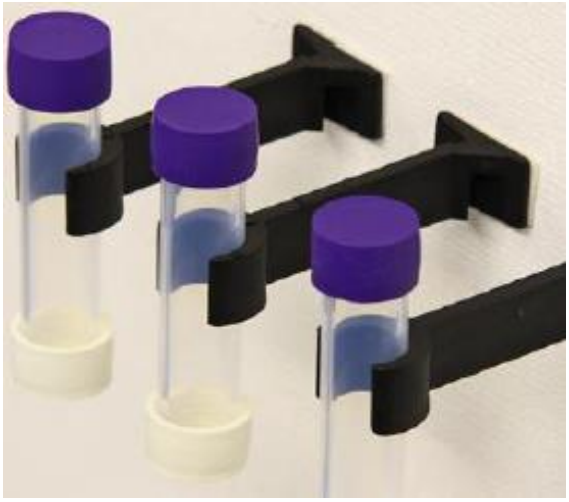
Averaging time	NESAQ 2004		AAQG 2002		WHO 2021	
	Limit	Allowable exceedances	Limit	Allowable exceedances	Limit	Allowable exceedances
1-hour	350	9				
1-hour	570	NA				
24-hours			120	NA	40	3-4*

*99th percentile

2. Methods

SO_2 was monitored using passive diffusion tubes[2] which were provided by Gradko Environmental in the UK and sent back for analysis. The tubes were made of plastic and are 7 cm long and 1.5 cm wide. They operate by the diffusion of pollutant molecules from the high-concentration ambient air into the low-concentration tube, where they were collected by an absorbent – a metal disc coated with an absorbent chemical reagent. The concentration of sulphate ions were determined by ion chromatography and the SO_2 concentration was accordingly calculated using this data, the rate of uptake and the exposure time. The tubes were attached to structures 2-3m above ground level and were exposed for monthly periods in duplicates. Field and travel blanks[3] were also undertaken each month. The laboratory provided the data in parts per billion (ppb) which were then blank corrected and converted into µg/m³ at 0° as per the New Zealand conversion factor (MfE, 2009).

Figure 1 Diffusion tubes for SO_2. Source, Gradko Environmental. The absorbent is located in the purple cap at the top of the tube, while the white cap contains a one-micron porosity filter to prevent particulates from entering the tube.



[2] Diffusion tubes are considered a low-cost option for monitoring and are best for spatial or temporal comparisons.

[3] A travel blank is a sealed tube that travels to and from the lab with the others but is never deployed. A field blank is a sealed tube that is deployed but not exposed to ambient air.

Figure 2 shows the locations of the monitoring sites. Four sites were located within the property boundary of Port Otago and were mounted on light towers (LT7, LT12 and LT16), and one was located at the T&U Berth in the Otago Harbour. Three additional locations were monitored around Port Chalmers - two sites on George Street, which is the main street southwest of the port, and one at Careys Bay to the northwest. One site served as a control site and was located in Central Dunedin at the permanent air quality station.

Figure 2 Map of SO_2 sampling locations

Figure 3 Site photos of SO_2 samplers

A Central Dunedin
B LT7
C LT12
D LT 16

Figure 3 continued **Site photos of SO_2 samplers**

E T&U Berth
F 2 George Street
G 38 George Street
H Careys Bay

3. Results

The dominant wind direction for most months during the sampling period was east-northeast at both high and low windspeeds. During the non-summer months, the west north-west is the next most frequent wind direction and this was the dominant direction during July 2023. Wind speeds were generally low, being under 6 m/s most of the time. It is possible that the wind was slightly different at different places within the Otago Harbour. The weather station at the Port is partially obstructed and therefore only provides a partial wind direction record. These data were not used in this study, so data was taken from the Central Dunedin air quality monitoring station instead.

Figure 4 **Wind roses showing wind speeds and direction at Central Dunedin for each month**

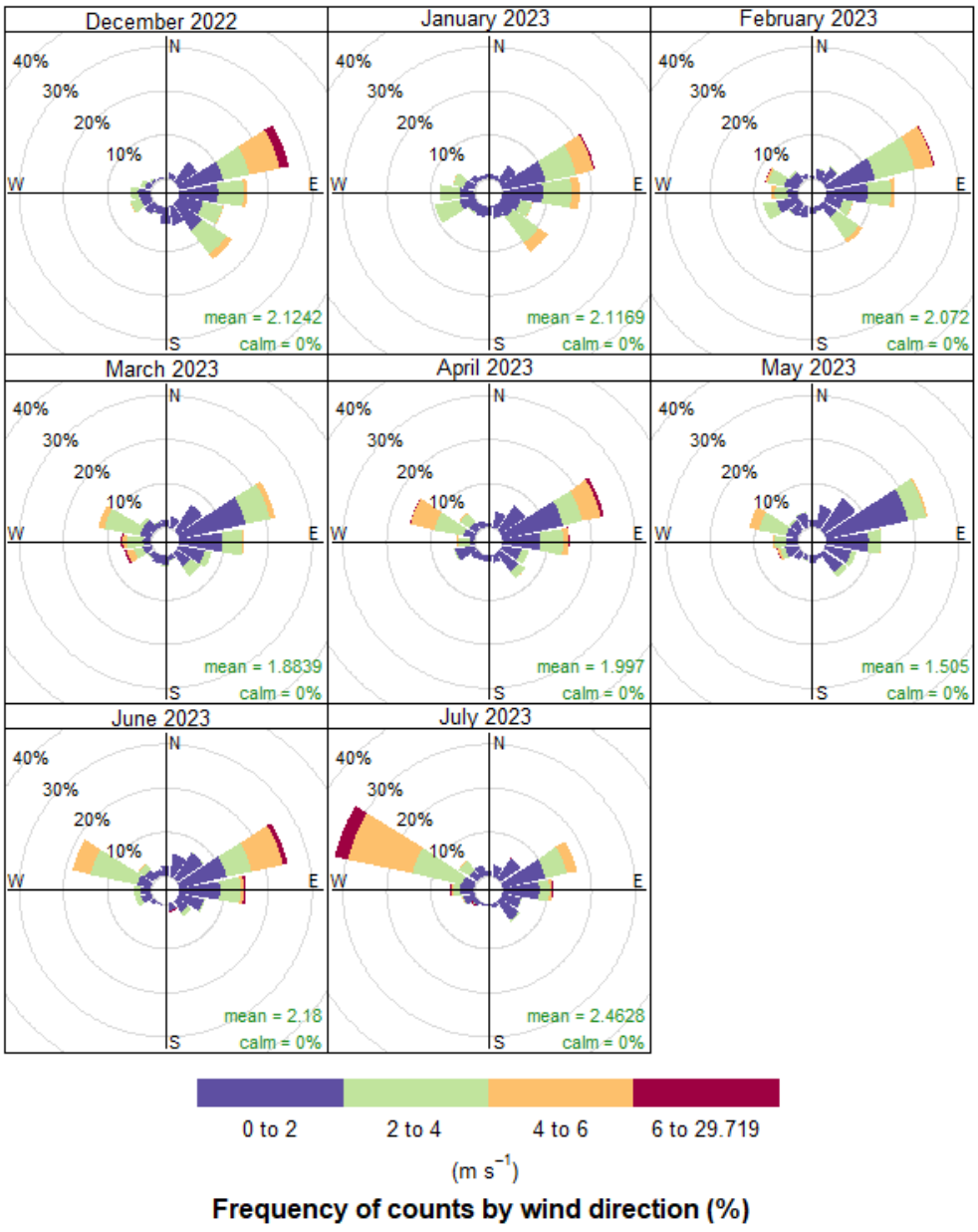


Table 2 displays the results of the averaged duplicates, including the inconclusive results. The results may be considered inconclusive if one of the duplicates is less than the limit of detection (<LOD) or if the difference between two duplicates exceeds 30%. One of the results for the T&U site was quite spurious and very high compared to its duplicate and all other results. Sometimes the laboratory noted that the sample tubes were dirty on the outside which may have influenced some results. In this case it is unknown why this result was spurious.

Table 2 Monthly SO_2 results (µg/m³)

	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23
Central Dunedin	2.7	2.7	1.9	<LOD	3.4	2.6	2.6	<LOD
LT7	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
LT12	6.7[a]	<LOD	<LOD	<LOD	1.6	2.0	<LOD	<LOD
LT16	30.5[a]	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
T&U	4.5	10.3	6.5	2.1	7.2[b]	3.7	274.8[b]	<LOD[c]
2 George Street	<LOD	N/A[d]	2.1[a]	<LOD	2.3	<LOD	<LOD	<LOD
38 George Street	4.2[a]	1.5[a]	1.8	<LOD	2.2	<LOD	<LOD	<LOD
Careys Bay	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

[a] One of the duplicates is less than the limit of detection <LOD

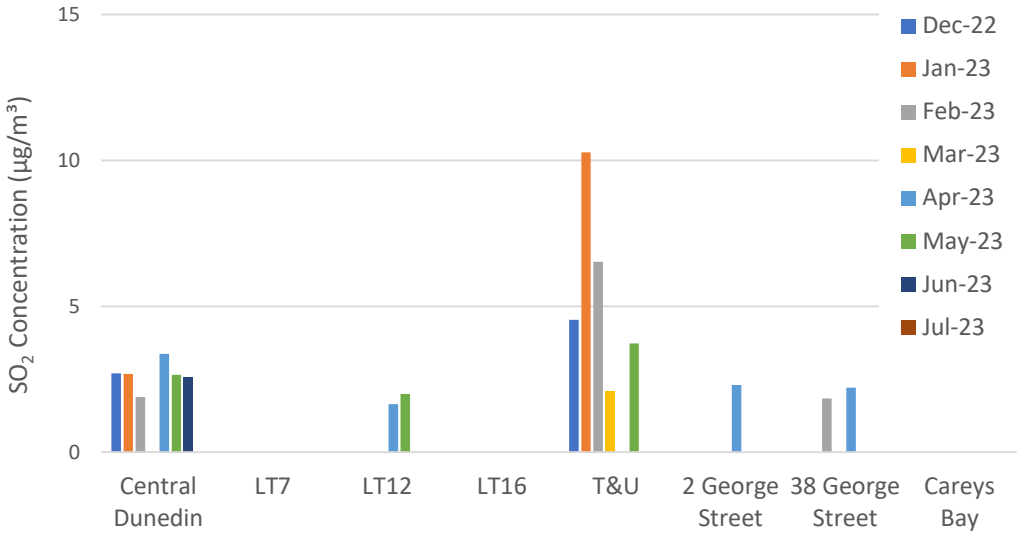
[b] The duplicates have a percentage difference greater than 30%

[c] One duplicate could not be tested

[d] Both tubes went missing due to road works and removal of the lamppost they were on

The majority of the results came back as lower than the limit of detection, most notably at LT7 within the Port boundary, and at Careys Bay to the northwest. The highest concentrations were recorded at the T&U berth. The highest valid result was 10.3 µg/m³ for the month of January, followed by 6.5 µg/m³ for February, both at the T&U Berth. The other site with consistent detectable results was Central Dunedin, with the highest concentration of 3.4 µg/m³ occurring in April. Figure 5 below displays the valid results.

Figure 5 Valid monthly SO_2 results



4. Discussion

This study identified that the T&U Berth had the highest concentration of SO_2, which occurred in January 2023. There is not enough data to identify any seasonal or spatial trends. As these SO_2 samples are measured as a monthly average, they do not provide information on the hourly or daily concentrations of SO_2, consequently they cannot be compared to current standards or guidelines. However, the monthly results are very low, which indicates that the standards are likely to be met. The results for Central Dunedin are a bit lower than those recorded in 2021, but within the same ballpark (1.9 to 3.6 µg/m³ compared to 5.7 to 7.0 µg/m³). The difference in results may be attributable to the difference in methods.

As this is the first SO_2 monitoring project to be undertaken at Port Otago, it is unknown whether changes to shipping emissions under MARPOL Annex VI has had an impact on the ambient air quality, but SO_2 monitoring undertaken at Port Tauranga has shown significant decreases from January 2020, after the adoption of Annex VI by international ships (BPRC, 2023).

It may be beneficial to further investigate sources of PM within the Port Chalmers airshed. It is known that elevated $PM_{2.5}$ concentrations occur in winter due to home heating (ORC, 2022); there may also be influences from Port activities or related vehicles such as cargo trucks, as has been found at CentrePort in Wellington (Mitchell, 2022).

5. References

Bay of Plenty Regional Council, 2023. *Ambient Air Quality Data Update 2023.* https://atlas.boprc.govt.nz/api/v1/edms/document/A4428391/content

Mitchell, T.A., 2022. *Pilot study: air quality monitoring CentrePort, Wellington*. Greater Wellington Regional Council, Publication No. GW/ESCI-T-22/01, Wellington. https://www.gw.govt.nz/assets/Documents/2022/02/Pilot-Air-Quality-Study-CentrePort.pdf

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ORC, 2022. *$PM_{2.5}$ investigation in Otago 2021.* Data and Information Committee Paper, 14 September 2022. https://www.orc.govt.nz/media/12900/pm2-5-investigation-in-otago-2021.pdf

ORC, 2023. *Air Quality Projects – NO2 & SO2 Monitoring and ULEB testing*. Data and Information Committee Paper, 26 April 2023. https://www.orc.govt.nz/media/14410/no2-and-so2-mo

6. Appendix

SO_2 duplicate results (µg/m³)

	Dec-22	Jan-23	Feb-23	Mar-23	Apr-23	May-23	Jun-23	Jul-23
Central Dunedin	3.0	2.5	1.8	<LOD	2.9	2.7	2.4	<LOD
Central Dunedin	2.4	2.8	2.0	<LOD	3.9	2.6	2.7	<LOD
LT7	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
LT7	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
LT12	<LOD	<LOD	<LOD	<LOD	1.7	2.0	<LOD	<LOD
LT12	6.7	<LOD	<LOD	<LOD	1.6	2.0	<LOD	<LOD
LT16	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
LT16	30.5	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
T&U	4.3	8.6	6.2	2.1	3.4	3.6	545.7	<LOD
T&U	4.8	11.9	6.9	<LOD	11.0	3.9	3.9	NA
2 George Street	<LOD	Missing	2.2	<LOD	2.4	<LOD	<LOD	<LOD
2 George Street	<LOD	Missing	1.9	<LOD	2.2	<LOD	<LOD	<LOD
38 George Street	4.2	1.5	1.8	<LOD	2.3	<LOD	<LOD	<LOD
38 George Street	<LOD	<LOD	1.8	<LOD	2.2	<LOD	<LOD	<LOD
Careys Bay	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD
Careys Bay	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD	<LOD

9.3. Annual Air Quality Report 2023

Prepared for: Environmental Science and Policy Committee

Report No. ENV2401

Activity: Environmental: Air

Author: Sarah Harrison, Scientist – Air Quality

Endorsed by: Anita Dawe, General Manager Policy and Science

Date: 20 March 2024

PURPOSE

[1] This annual report discusses the results of the State of the Environment (SOE) monitoring for air quality for the year 2023.

EXECUTIVE SUMMARY

[2] Monitoring of PM_{10} (particulate matter with a diameter of less than 10 micrometres) was undertaken in the Alexandra, Arrowtown, Central Dunedin and Mosgiel airsheds during 2023.

[3] Alexandra, Arrowtown and Mosgiel recorded exceedances of the NESAQ (National Environmental Standards for Air Quality) during the winter months. The limit for PM_{10} is 50 µg/m³ over a 24-hour average and there were a total of 17 exceedances. These results are consistent with the results reported in previous years.

[4] $PM_{2.5}$ (particulate matter with a diameter of less than 2.5 micrometres) was monitored at Arrowtown, Central Dunedin, Clyde, Cromwell, Milton and Wanaka. Arrowtown followed by Milton had the highest annual and winter average concentrations. This data cannot currently be compared to existing guidelines or the proposed NESAQ for $PM_{2.5,}$ due to the following: Arrowtown and Central Dunedin need to be tested for equivalence (currently ongoing), the other four sites' monitoring methods are not suitable under the NESAQ to compare with limits.

RECOMMENDATION

That the Council:

1) ***Notes** this report.*

BACKGROUND

[5] Otago has several towns where air quality is considered degraded during winter, namely Alexandra, Arrowtown, Clyde, Cromwell and Milton. Under the Resource Management Act (RMA), regional councils are required to monitor air quality, and to improve it where necessary. The main pollutant of concern is particulate matter (PM) which is a product of combustion. In Otago the main source of PM is home heating emissions in winter (Wilton, 2019). Long term exposure to PM_{10} and $PM_{2.5}$ contribute to the risks of developing and exacerbating existing cardiovascular and respiratory conditions, which

makes fine particulates a serious threat to human health. Furthermore, recent research provides evidence that air pollution is dangerous at lower concentrations than previously thought, and supports the lowering of existing guidelines (WHO, 2021).

[6] ORC operates an SOE monitoring network for PM_{10} and is required to report[1] exceedances of the NESAQ (50 µg/m³, 24-hour average). The SOE network is currently being upgraded to include monitoring for $PM_{2.5}$. The upgrade process includes a period of co-location and subsequent equivalence testing of the new instruments compared to the existing ones. Further comparison data is still required to be able to correct for the new instruments and accurately report some of their data.

AIR QUALITY ASSESSMENT FRAMEWORK

[7] Under the RMA, councils are required to monitor air quality and work towards meeting the standards of the NESAQ. The NESAQ is currently being updated to include limits for $PM_{2.5}$, and proposed limits were released in 2020. In 2021 the World Health Organization (WHO) released updated guidelines which recommend new and stricter limits for pollutants (WHO 2021). The standard that ORC must report against is the NESAQ; for context, other guidelines are given below (Table 1).

Table 1 Standards and guidelines for PM_{10} and $PM_{2.5}$

Pollutant	Averaging Time	NESAQ 2004		Proposed NESAQ 2020		WHO 2021	
		Value (µg/m³)	Allowable exceedances	Value (µg/m³)	Allowable exceedances	Value (µg/m³)	Allowable exceedances
PM_{10}	24-hour	50	1 per annum	50	1 per annum	45	3-4[b]
	Annual	20[a]	NA	NA	NA	15	NA
$PM_{2.5}$	24-hour			25	3 per annum	15	3-4[b]
	Annual			10	NA	5	NA

[a]AAQG (Ambient Air Quality Guideline, 2002) limit and NESAQ Guideline

[b]99th percentile, there can be 3-4 exceedances per year

[8] The air quality results can also be categorised according to the MfE (Ministry for Environment) Environmental Performance Indicators (EPI), outlined in the Ambient Air Quality Guidelines (AAQG) (2002). The EPI categories indicate an appropriate action according to the concentrations (Table 2). How the results measure against the MfE EPI is set out below in paragraph 10.

[1] Currently ORC reports exceedances by way of public notice in the ODT, as well as on the ORC website every month exceedances occur.

Table 2 MfE Environmental Performance Indicators for air quality

Category	Monitoring result compared to guideline	Description
Action	Exceeds the guideline	Unacceptable and action is required to reduce emissions
Alert	66-100%	Warning level which could lead to exceedances if trends are not curbed
Acceptable	33-66%	Maximum values might be a concern in sensitive locations, urgent action is not warranted
Good	10-33%	Peak measurements not likely to affect air quality
Excellent	0-10%	Not recommended for PM_{10} monitoring, PM_{10} in this range is classified as good instead

SOE MONITORING RESULTS: PM_{10}

[9] PM_{10} was monitored continuously at four sites across the region in 2023: Alexandra, Arrowtown, Central Dunedin and Mosgiel. A summary of the key PM_{10} monitoring indicators for 2023 are given in Table 3, with a detailed table of the NESAQ exceedances in Appendix 1. Arrowtown had the most exceedances, with ten, as well as the highest maximum daily concentration of 81 µg/m³. The highest annual mean occurred at Mosgiel, followed by Alexandra with 17 and 16 µg/m³ respectively. These annual means are compliant with the NESAQ, but not with the WHO guideline of 15 µg/m³.

Table 3 Key PM_{10} indicators for 2023

Site	Annual mean (µg/m³)	Winter mean (µg/m³)	Maximum daily concentration (µg/m³)	2nd highest daily concentration (µg/m³)	Number of NESAQ exceedances	Data capture (%)
Alexandra	16	24	51	51	3	94
Arrowtown	13	24	81	80	10	95
Central Dunedin	15	16	39	39	0	99
Mosgiel	17	21	58	56	4	83

Figure 1 PM_{10} concentrations for 2023 (24-hour average)

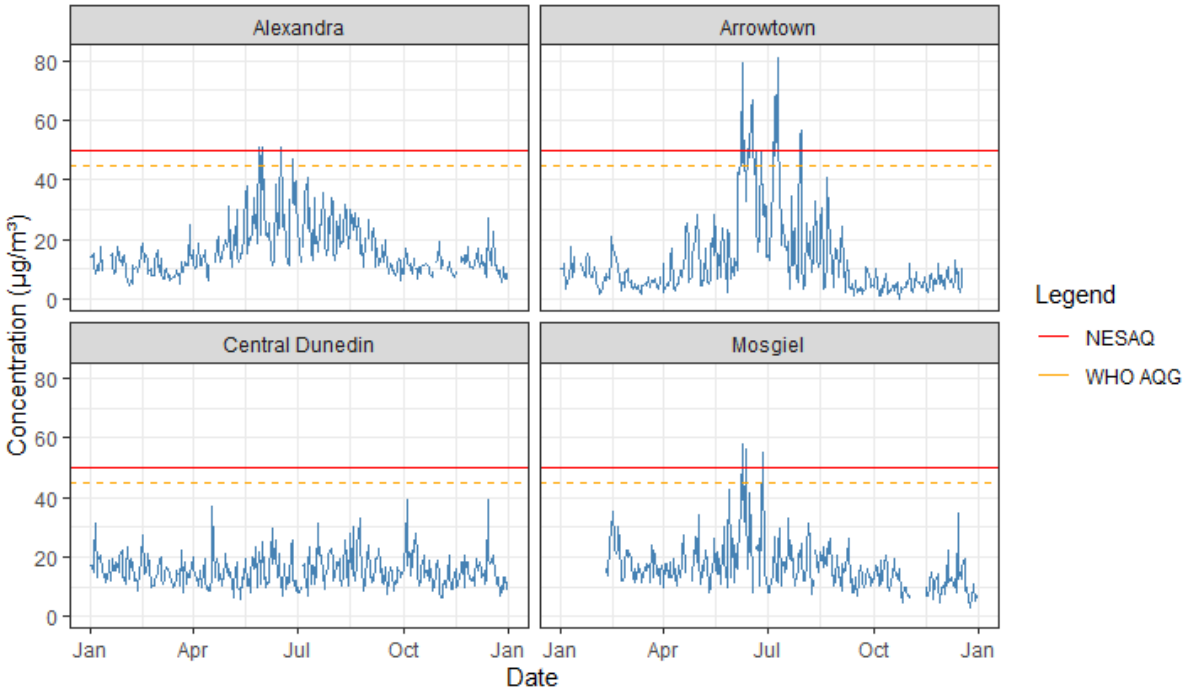
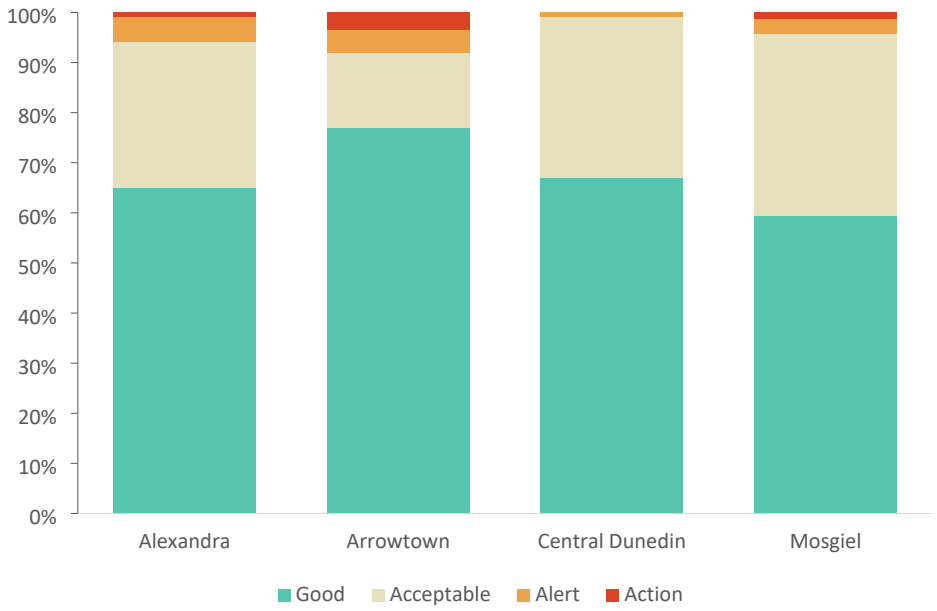


Figure 2 PM_{10} concentrations as air quality indicator categories for 2023 (24-hour average)



[10] When the PM_{10} data is sorted into the MfE indicator categories, all sites have over 60% data in the "good" category, with much of the rest of it within the "acceptable" category. All sites have less than 10% of their data in the "alert" category (Figure 2). The seasonality of Arrowtown's air quality is shown in this graph in particular,

highlighting both very low concentrations along with the most extreme high pollution days.

SOE MONITORING RESULTS: $PM_{2.5}$

[11] $PM_{2.5}$ was monitored continuously at six locations across the region in 2023: Arrowtown, Central Dunedin, Clyde, Cromwell, Milton and a new site that was installed in Wanaka at the beginning of winter. $PM_{2.5}$ was monitored using non-reference methods[2] at Clyde, Cromwell, Milton, and Wanaka. The instruments at Arrowtown and Central Dunedin are considered equivalent to reference methods and as such, can be compared to the proposed NESAQ, however a twelve-month period of co-location needs to be undertaken in order to establish a correction factor. As this has not been undertaken yet, none of the $PM_{2.5}$ data have been compared to limits or guidelines.

[12] A summary of the key $PM_{2.5}$ monitoring indicators for 2023 are given in Table 4. Central Dunedin recorded the lowest annual and winter means for 2023, and the Wanaka site recorded the second lowest winter mean. Unlike the other four monitoring locations these two appear to have the least seasonal variation. The sites with the highest concentrations were Milton (126 µg/m³ maximum daily concentration) followed by Arrowtown (116 µg/m³ maximum daily concentration).

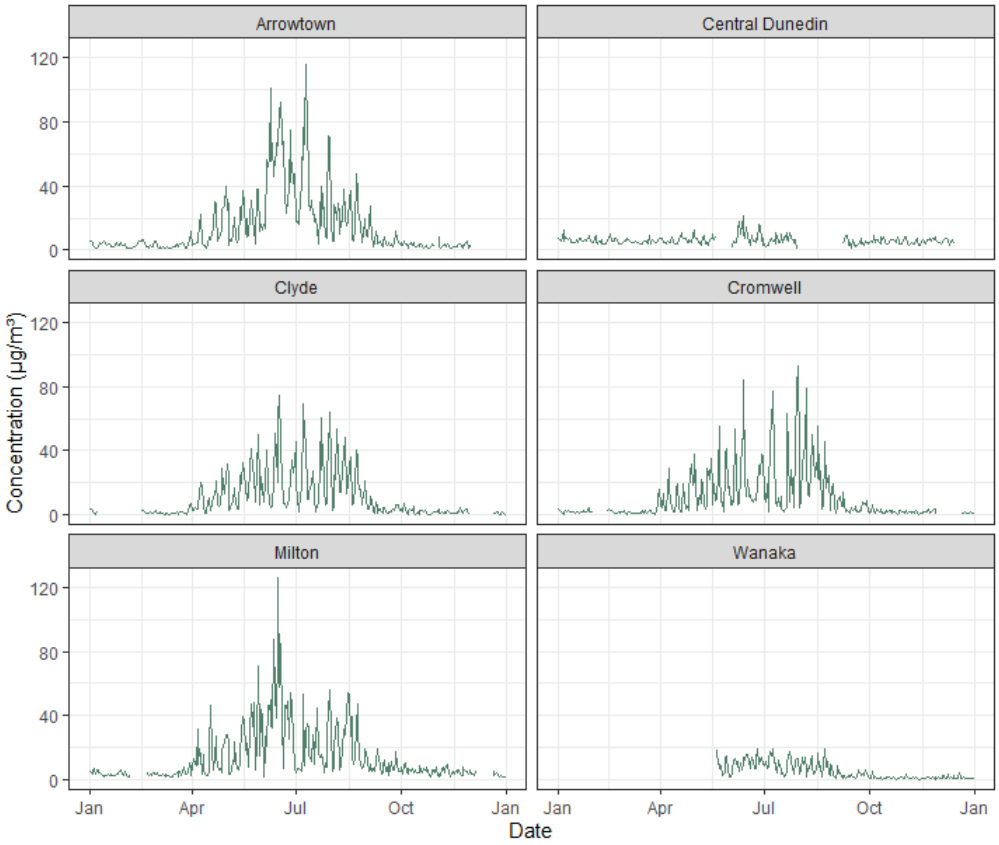
[13] For the Arrowtown site, all key indicators for $PM_{2.5}$ are higher than the ones for PM_{10}, which should not be possible. This is an example of why this data needs a correction factor.

Table 4 Key $PM_{2.5}$ indicators for 2023

Site	Annual mean (µg/m³)	Winter (May to August) mean (µg/m³)	Maximum daily concentration (µg/m³)	2nd highest daily concentration (µg/m³)	Data capture (%)
Arrowtown	15	31	116	101	91
Central Dunedin	6	7	21	18	81
Clyde	11	23	74	69	83
Cromwell	11	23	92	84	90
Milton	14	27	126	88	92
Wanaka	-	9	20	19	61

[2] Under the NESAQ only reference method instruments may be compared to standard limits

Figure 3 $PM_{2.5}$ concentrations for 2023 (24-hour average)



CONSIDERATIONS

Strategic Framework and Policy Considerations

[14] The work outlined in this paper contributes to the following elements of ORC's Strategic Direction:

- Monitoring air quality in the region and investigate pollution sources
- Provide best available information on Otago's air quality

Financial Considerations

[15] The air quality monitoring is a funded activity in both the Science and Environmental Monitoring areas.

Significance and Engagement

[16] N/A

Legislative and Risk Considerations

[17] Managing air quality is a regional council requirement in accordance with the NESAQ.

Climate Change Considerations

[18] N/A

Communications Considerations

[19] Air quality communications will continue during 2024.

NEXT STEPS

[20] Monitoring network upgrades will continue in 2024.

[21] This information will be used to inform the Air Plan review as it continues to be developed.

REFERENCES

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APPENDIX: PM_{10} Exceedance table for 2023

Site	Alexandra	Arrowtown	Central Dunedin	Mosgiel
Date	**Concentration (µg/m³) 24-hour average**			
28/05/2023	51			
31/05/2023	51			
8/06/2023		80		58
10/06/2023		54		
11/06/2023				56
14/06/2023		56		
16/06/2023	51	64		
26/06/2023				55
27/06/2023				55
6/07/2023		68		
8/07/2023		56		
9/07/2023		81		
10/07/2023		55		
29/07/2023		55		
30/07/2023		57		
Total number of exceedances	**3**	**10**	**0**	**4**

ATTACHMENTS

Nil