

{title-will-be-inserted-by-system-do-not-remove}

{remove-from-minutes-start}

Prepared for: Council
Report No. P&S1852
Activity: Environmental: Air
Author: Sarah Harrison, Air Quality Scientist
Endorsed by: Gwyneth Elsum, General Manager Strategy, Policy and Science
Date: 29 June 2020

PURPOSE

- [1] This is the annual report for the Air Quality Programme. The report provides a summary of State of the Environment (SOE) air quality monitoring, SOE network upgrades, implementation of ORC's Air Quality Strategy and compliance of the ORC Air Plan.

RECOMMENDATION

{remove-from-minutes-end}

{recommendation-start}

That the Council:

- 1) **Receives** this report.

{recommendation-end}

{remove-from-minutes-start}

EXECUTIVE SUMMARY

- [2] Otago has several towns – Alexandra, Arrowtown, Cromwell, Clyde and Milton - where air quality is considered degraded during winter. Under the Resource Management Act (RMA, 1991) and the National Environmental Standards for Air Quality (NESAQ, 2004, revised 2011) regional councils are required to monitor and improve air quality where necessary.
- [3] The main pollutant of concern in Otago is particulate matter, a product of combustion. In some Otago towns in excess of 90% of PM₁₀ (particulate matter with a diameter of less than 10 microns) is produced by home heating emissions from solid fuel burners (Environet, 2019). Long term exposure to PM₁₀ and PM_{2.5} (particulate matter with a diameter of less than 2.5 microns), contribute to the risks of developing, and exacerbate existing, cardiovascular and respiratory conditions, which makes them a serious threat to human health (WHO, 2006).
- [4] ORC has a State of the Environment (SOE) monitoring network to monitor PM₁₀, to report exceedances of the NESAQ (50 µg/m³, 24-hour average), and provide direction for the development of implementation of air quality improvements. This network is currently being upgraded to include the monitoring of PM_{2.5}, in preparation for the updated NESAQ which will include limits for PM_{2.5}. Accordingly, a spatial study was conducted in Wanaka to prepare for a new PM_{2.5} monitor. Additionally, the monitoring site in Dunedin is running the existing and new instruments concurrently for comparison.

- [5] In 2018 the ORC Air Quality Strategy was reviewed, and an Implementation Plan was made to continue the wood-burner replacement programme that was begun in 2008. In 2019 a pilot study for community engagement and the replacement of wood burners was undertaken in Arrowtown. Monitoring methods for compliance/enforcement of the ORC Air Plan rules were also trialled during this project, to help inform future enforcement plans. During 2019, an emissions inventory was conducted in Wanaka, Cromwell and Clyde to gather information on types of heating used in these communities, which will aid ORC's air quality implementation.

STATE OF THE ENVIRONMENT

- [6] Otago has a network of seven monitoring stations in the following locations: Alexandra, Arrowtown, Clyde, Cromwell, Central Dunedin, Mosgiel and Milton. All of these sites monitor PM₁₀, and Central Dunedin also monitors PM_{2.5}.
- [7] Under the RMA, regional councils are required to monitor air quality and work towards meeting the standards of the NESAQ. The NESAQ is currently under review to include PM_{2.5}, however the World Health Organisation have recommended guidelines for PM_{2.5}. The relevant standards and guidelines are given below (Table 1).
- [8] *Table 1. Standards and guidelines for PM₁₀ and PM_{2.5}*

| Pollutant | Averaging Time | NESAQ Standard | | NESAQ Guideline | | WHO Guideline | |
|-------------------|----------------|----------------------------|-----------------------|----------------------------|-----------------------|----------------------------|-----------------------|
| | | Value (µg/m ³) | Allowable exceedances | Value (µg/m ³) | Allowable exceedances | Value (µg/m ³) | Allowable exceedances |
| PM ₁₀ | 24-hour | 50 | 1 per year | | | 50 | NA |
| | Annual | | | 20 | NA | 20 | NA |
| PM _{2.5} | 24-hour | | | | | 25 | 3 |
| | Annual | | | | | 10 | NA |

- [9] A summary of the key SOE monitoring indicators for 2019 are given below (Table 2).

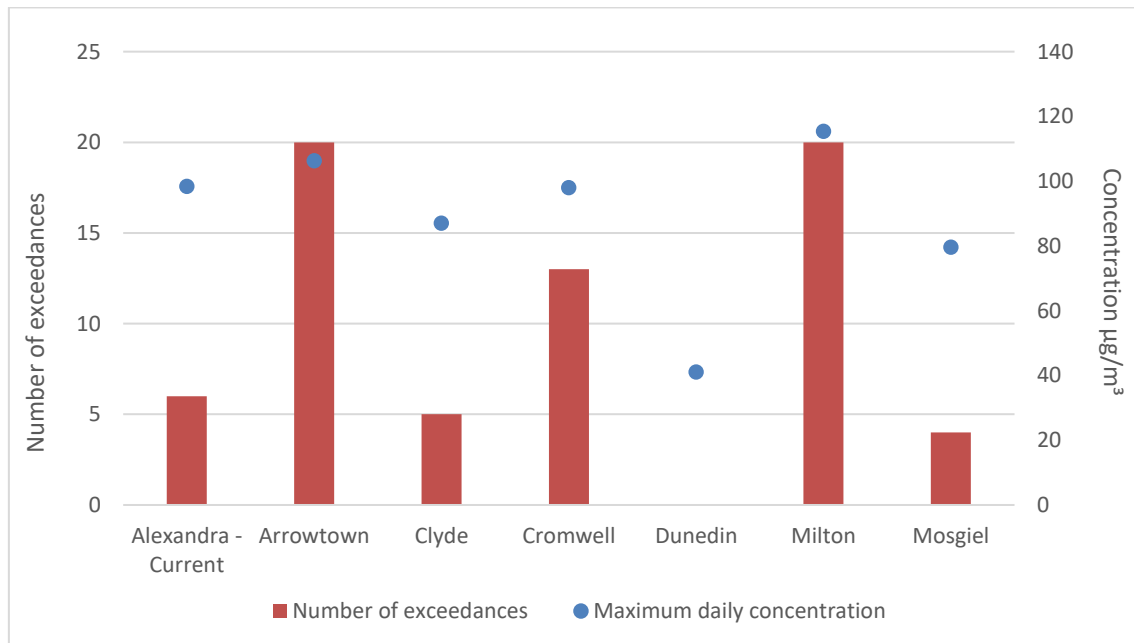
Table 2. Key PM₁₀ indicators for 2019

| Site | Maximum daily concentration (µg/m ³) | Winter Mean (µg/m ³) | Average highest 10 days (µg/m ³) | Number of exceedances (n) | Annual average (µg/m ³) |
|-----------------------------------|--|----------------------------------|--|---------------------------|-------------------------------------|
| Alexandra - Original ¹ | 185 | 42 | 118 | 35 | 25 |
| Alexandra - Current | 98 | 23 | 63 | 6 | 14 |
| Arrowtown | 106 | 31 | 78 | 20 | 16 |
| Clyde | 87 | 22 | 56 | 5 | |
| Cromwell | 98 | 26 | 66 | 13 | |
| Dunedin | 41 | 12 | 29 | 0 | 14 |
| Milton | 115 | 29 | 75 | 20 | |
| Mosgiel | 80 | 25 | 56 | 4 | 16 |

¹ Original site data is calculated using the following equation from the 2016 co-location study:
 $PM_{10}(\text{original site}) = 1.886 (PM_{10}(\text{current site}) - 0.49)$

[10] With the exception of the Dunedin site, all sites exceeded the NESAQ limit for PM₁₀ several times during 2019. All monitored sites met the WHO and NESAQ annual guideline for PM₁₀, the estimation is that the original Alexandra site would have exceeded this. Arrowtown and Milton each had 20 exceedances, as well as similar winter means and daily maximum for the winter (Figure 1).

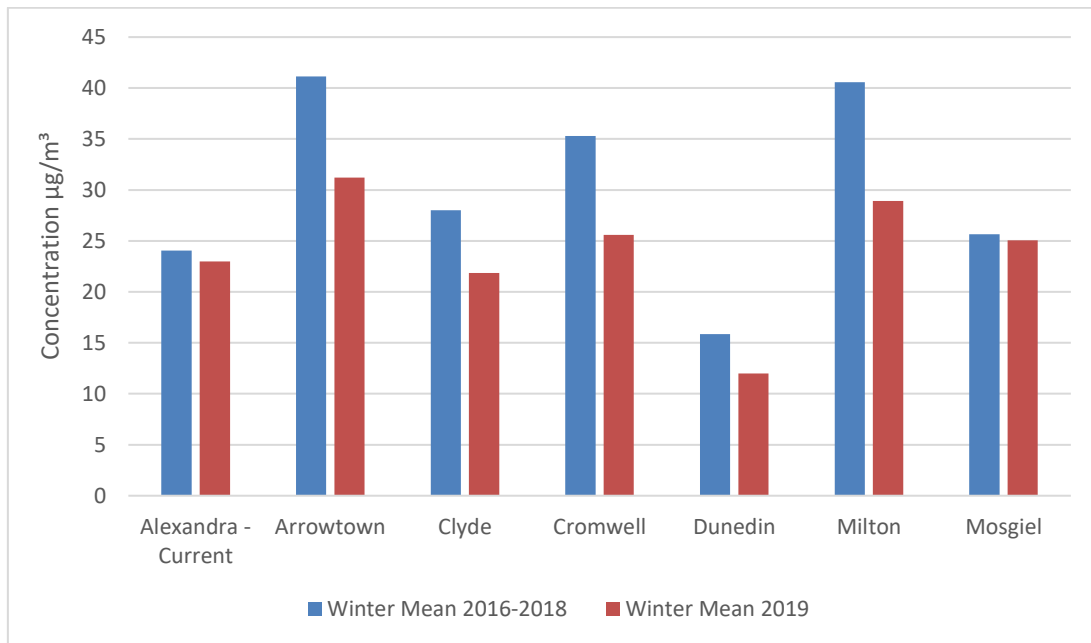
[11] *Figure 1. Number of exceedances and maximum daily concentrations for 2019*



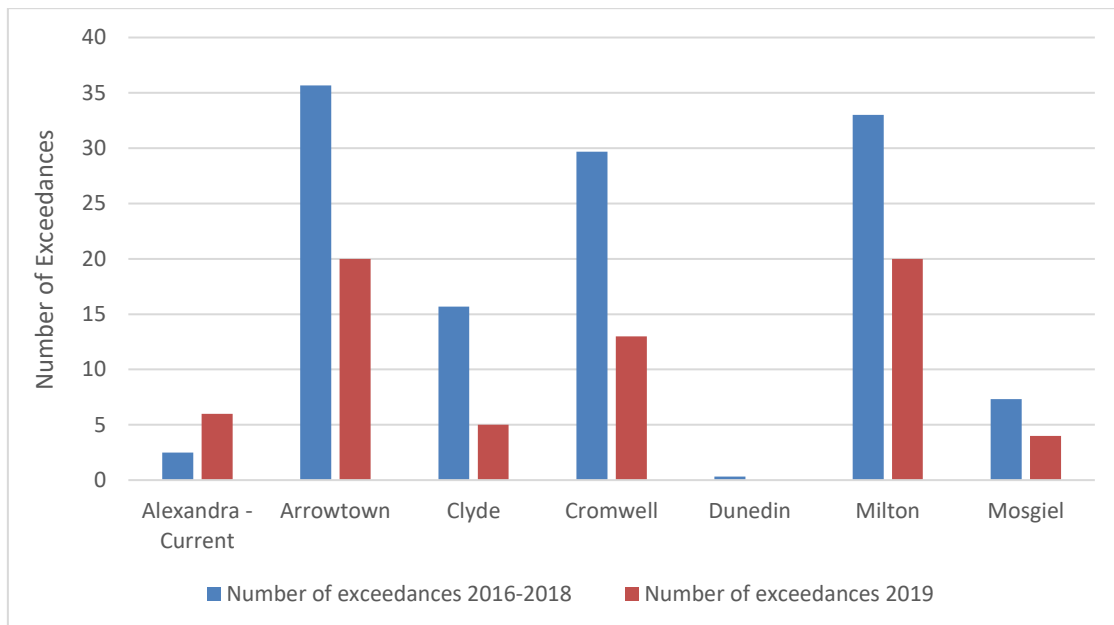
[12] When comparing data to previous years, the winter mean is a more appropriate indicator as exceedances only occur in winter. The below graphs show how 2019 compares with the average of the previous three years (Figures 2 and 3). At all monitored sites, except for Alexandra, the mean winter concentrations and number of exceedances has shown improvement. This improvement may be attributed to the replacement of non-compliant wood burners, but also the climate characteristics for the winter.

[13] The NIWA climate summary for 2019 details the fourth warmest year on record due to El Niño. The year was characterised by warm, drought inducing conditions, interspersed by storms and high rainfall. Outside the storm events, the winter in parts of Otago was relatively mild and dry. The Central Otago sites still experienced several days with average temperatures below 0°C during June 2019, which is a strong predictor of inversion layers and consequently NESAQ PM₁₀ exceedances.

[14] Figure 2. Mean winter concentrations comparison

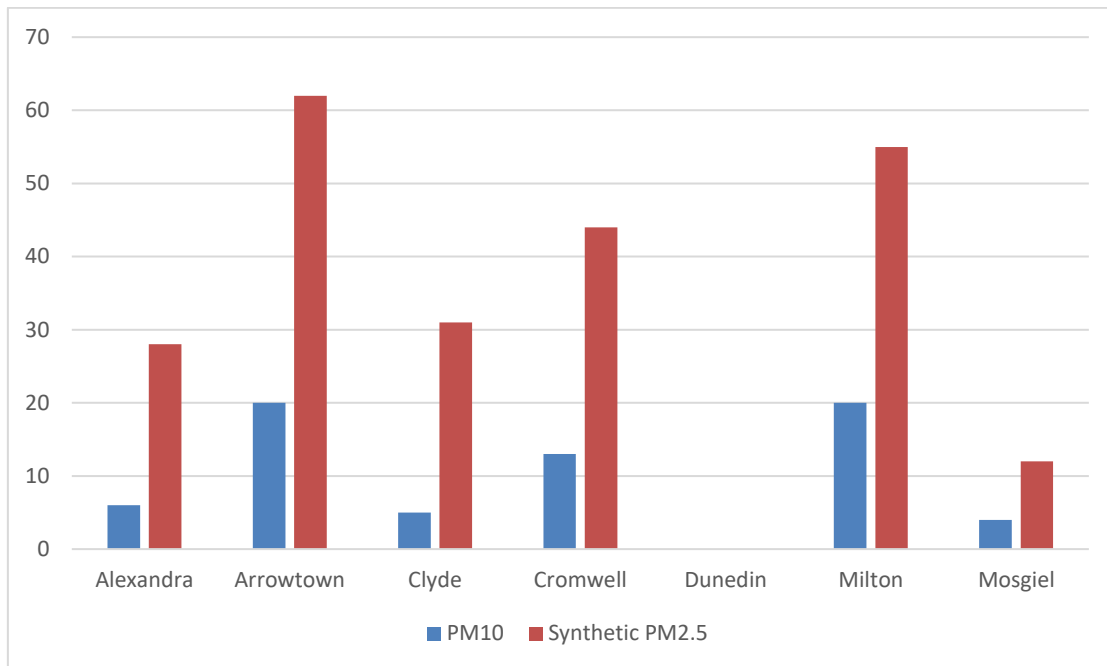


[15] Figure 3. Number of exceedances comparison



[16] The proposal of the NESAQ to include PM_{2.5} has been released, and details annual and 24-hour limits which are the same as the WHO guidelines (10 µg/m³ and 25 µg/m³, respectively). The potential exceedances Otago might experience can be calculated using PM_{2.5} to PM₁₀ ratio estimations. The following graph shows that the number of PM_{2.5} exceedances per year would be at least doubled in all monitored towns (ORC, 2020b).

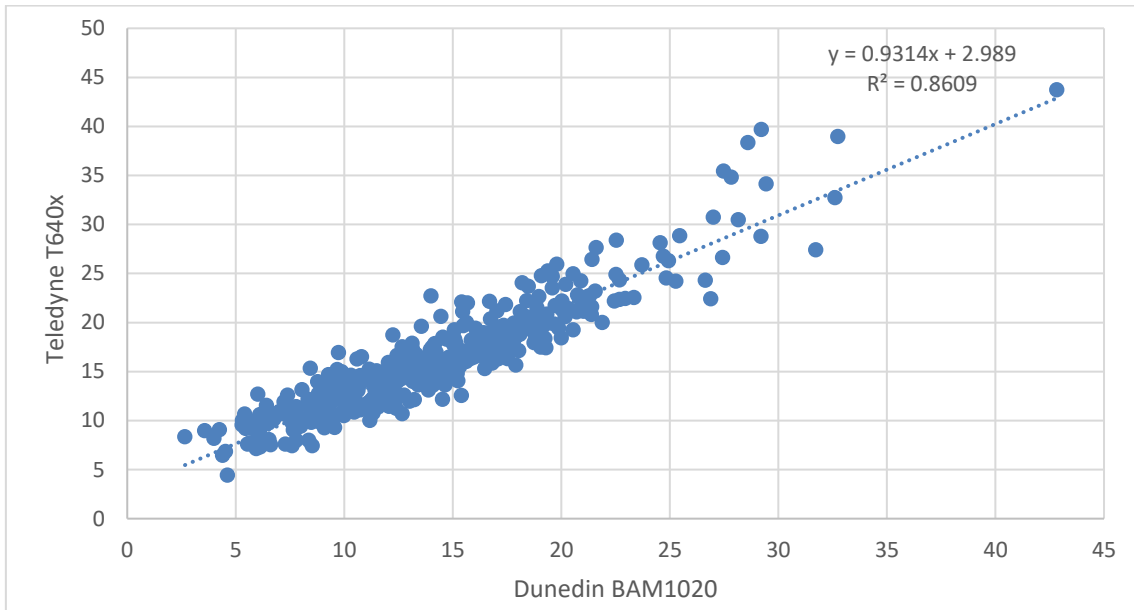
[17] Figure 4: Predicted number of exceedances for the proposed NESAQ for PM_{2.5} compared to PM₁₀ for 2019



MONITORING NETWORK UPDATES

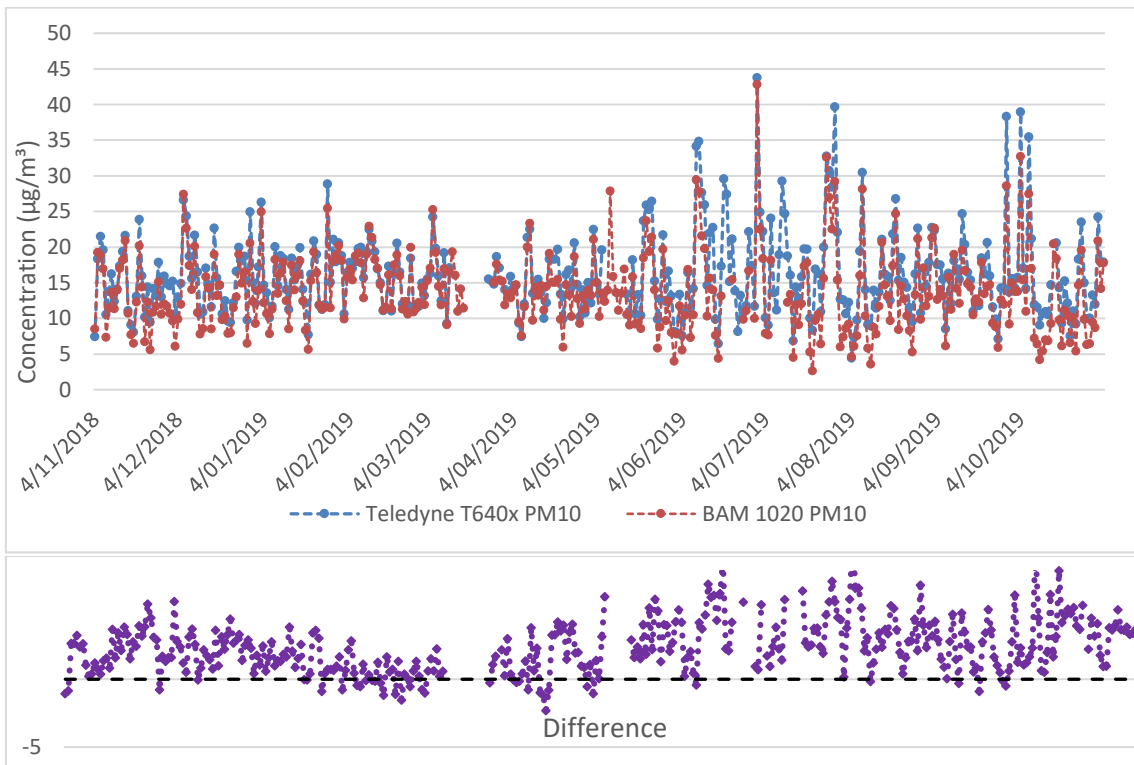
- [18] In anticipation to the NESAQ update to include standards for PM_{2.5}, two new monitors are scheduled to be installed in Arrowtown and Wanaka during 2020. These new monitors are different examples of optical technology (measure particulate matter in real time using light scatter), as opposed to the current method of monitoring using BAMs (beta-attenuation monitor, particles are measured by how much beta radiation is absorbed on a filter tape every hour). Optical technology is not necessarily newer than BAM technology, but the ORC instruments are becoming outdated, and the Teledyne model was chosen because it is able to measure PM₁₀ and PM_{2.5} at the same time.
- [19] The instrument for Wanaka (MetOne ES642) will be the first permanent monitoring to be undertaken in this town, and a spatial study was carried out during August 2019 to confirm the most appropriate monitoring location (ORC, 2020a). The Arrowtown instrument (Teledyne T640x) will be co-located with the existing monitor.
- [20] The first Teledyne T640x was installed in Dunedin in 2018 and we now have a full years' worth of comparison data between it and the existing BAM1020. Figure 5 shows the close relationship between the two instruments' 24-hour average PM₁₀ concentrations.

[21] Figure 5. Comparison of daily concentrations ($\mu\text{g}/\text{m}^3$) of two different instruments in Central Dunedin



[22] The average difference between the two sets of daily values is $2.4 \mu\text{g}/\text{m}^3$, with the Teledyne T640x consistently over-reporting compared to the BAM1020 (Figure 6). The annual PM_{10} and $\text{PM}_{2.5}$ values for 2019¹ were 16 and $7 \mu\text{g}/\text{m}^3$ respectively, both of which are compliant with the WHO guidelines. (¹Data after 4 November 2019 was unavailable for collection at time of writing due to COVID-19 levels 3 and 4).

[23] Figure 6. PM_{10} time series at Dunedin for 2018-2019

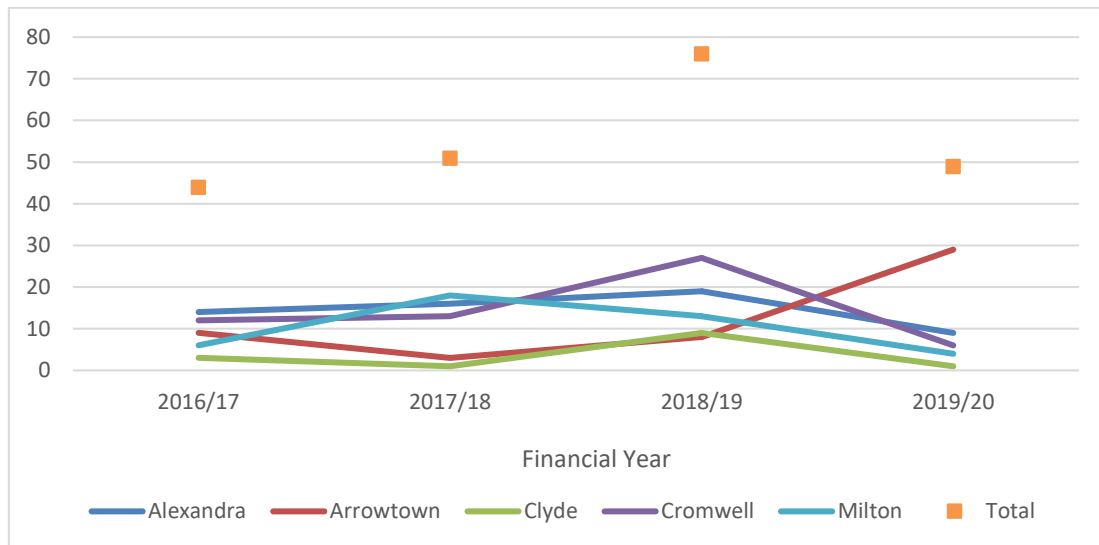


- [24] PM₁₀ at the Dunedin site has not exceeded the NESAQ for two years, and with only the one exceedance over the last five years, this is considered a non-polluted airshed. Central Dunedin is in Air Zone 2, and is characterised by industrial emissions, with coastal and port influences and a proximity to SH1 traffic, these factors set it apart from the other monitored towns that have high residential heating influences. For these reasons, it is expected that the Teledyne T640x may have a different relationship to the BAM1020 data in Arrowtown.
- [25] These instrument replacements have been taking place as part of a three-year plan for the SOE monitoring network. Following years will see this continue until the entire network consists of the two new types of instrument, with expansion of the network into at least two new towns: Queenstown along with Wanaka. Further expansion beyond this will be directed by the future Air Plan review.

AIR QUALITY STRATEGY IMPLEMENTATION

- [26] During 2019 a winter monitoring and communications programme was undertaken in Arrowtown, as a pilot to further work in Air Zone 1 towns. This work was guided by the air quality strategy implementation plan ([ORC, 2018](#)), which recommended collaborative and community inclusive efforts. ORC worked with stakeholders such as the Arrowtown community, Cosy Homes Trust (CHT), Southern DHB and NIWA to establish an educational approach that ORC could contribute to with communications work and attending community events.
- [27] The ORC Clean Heat Clean Air (CHCA) subsidy was promoted throughout this project, as a way for residents to replace their older wood burners at a lower cost, with the view to help reduce overall emissions in Air Zone 1. The CHCA subsidy was available to all Air Zone 1 towns and Milton and could be used for ultra-low emission wood burners, pellet fires or heat pumps.
- [28] Burner replacements using the CHCA subsidy in Arrowtown increased during and after this programme (Figure 7). Of the 49 allocated burner replacements, 29 of these were for Arrowtown properties.
- [29] The start of the COVID-19 pandemic response meant that much of this work could not be replicated this year prior to winter starting, so a plan to continue to conduct communications and monitoring work is being developed for the remainder of 2020.

[30] Figure 7: Allocated CHCA subsidies for recent financial years.



COMPLIANCE AND ENFORCEMENT FOR DOMESTIC BURNERS

- [31] The ORC Air Plan outlines the rules for the three Air Zones in terms of the emissions standards domestic burners must meet (rule 16.3.1), and also states that no domestic burner may discharge offensive or objectionable smoke or odour beyond the boundary of the property in any Air Zone. There are many difficulties associated with enforcing these rules and investigating complaints.
- [32] ORC is technically able to undertake enforcement action where non-compliant burners are being used, however this has not been utilised in the past because it requires a different approach than the existing compliance framework, which is based around resource consents and permitted activities held by and undertaken by individuals or organisations. Domestic burners require a building consent from the local authority and many residents are not aware that ORC has rules for wood burners. Additionally, this is an extremely sensitive topic to broach with the community, as Otago experiences very cold winters and many residents have concerns around the cost and risk of relying solely on electricity. It is difficult to track down the non-compliant burners because the information ORC receives from local council building consents databases is not always complete, especially for older burners. It is also not possible to enter properties to check a burner age/type unless invited.
- [33] In terms of responding to offensive or objectionable smoke, by nature this can change over the course of an evening or morning due to wind dispersion and the characteristics of the smoke changing as the fire heats up or is dampened down. It can be very difficult to prove the source of smoke if many chimneys are contributing to a visible layer of smoke.
- [34] Decisions for the 2020/2021 year will need to be carefully considered due to the financial impacts of COVID-19, which are disproportionately affecting Queenstown-Lakes and Central Otago. The Energy Efficiency and Conservation Authority (EECA) currently have financial incentives for owner-occupied residences only, subject to eligibility criteria. ORC may be able to compliment this by concentrating efforts toward rental properties with non-compliant burners, which would induce landlords to meet the Healthy Homes

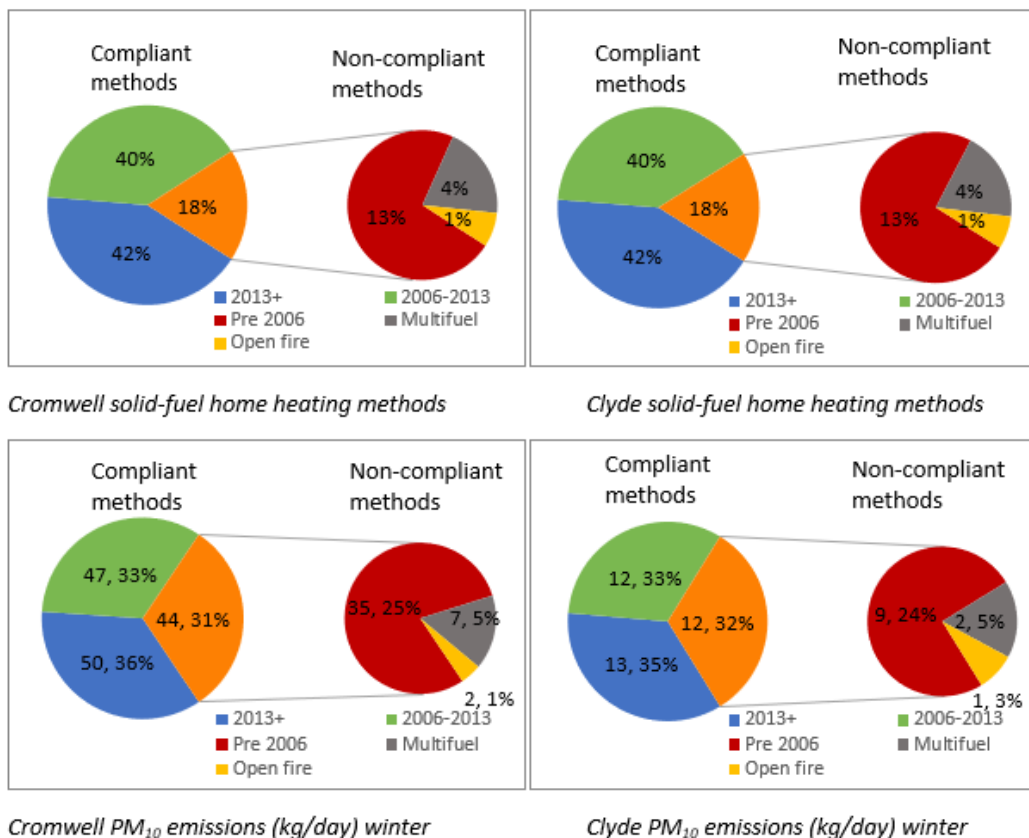
Standards (must be met by all rental properties by 2024). This would be undertaken by working more closely with the local authorities to obtain correct building consent data, establishing a database, and following an approach similar to the Arrowtown project pilot study for sending letters. In the meantime, ORC will continue to respond to any complaints as per normal procedures.

EMISSIONS INVENTORY

[35] An emissions inventory was undertaken in Cromwell, Clyde and Wanaka by Environet during winter 2019. Results showed that between 95% and 98% of particulate matter (PM) emissions come from domestic heating in the three towns in winter.

[36] Cromwell and Clyde have very similar percentages of home heating methods when using solid fuel. The data from both towns suggest 18% of non-compliant heating accounts for 32% of PM₁₀ emissions over a winter’s day (12 kg/day in Clyde and 44 kg/day in Cromwell). Compliant wood-fire burners from 2006 onwards contribute up to 68% of particulate matter, from 82% usage.

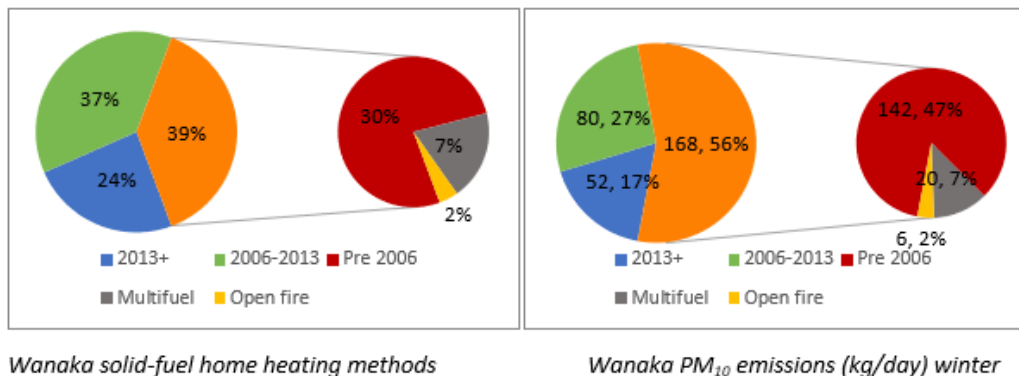
[37] *Figure 8. Cromwell and Clyde heating methods and PM₁₀ emissions*



[38] Wanaka is an Air Zone 2 town and has not had the same history of CHCA subsidy promotion as Air Zone 1 towns like Cromwell and Clyde. Wanaka has more relaxed rules, and is a slightly newer, rapidly growing town. The emissions inventory shows that Wanaka has a much higher percentage of the types of burners that are non-compliant in Air Zone 1 than Cromwell and Clyde (Figures 8 and 9), 39% compared to 18%. This could be because not as many burners have been replaced over recent years, and there may have

been less concern about air quality in Wanaka due to the lower occurrence of high pollution days.

[39] Figure 9. Wanaka heating methods and PM₁₀ emissions



CONSIDERATIONS

[40] A full air programme review, incorporating an integrated framework to improve air quality in Otago towns in winter months, warrants consideration. The situation is complex, requiring consideration of social, economic, human health and regulatory levers. Improving Otago air quality will likely require significant investment. Provisions have been in the 2020/21 budget to undertake a review of the ORC's air implementation programme.

NEXT STEPS

- [41] The monitoring network will continue to be upgraded and expanded in 2020.
- [42] The air quality implementation will continue during 2020, with the communications campaign and community engagement continued where possible. Cromwell and Clyde are the two remaining towns to receive engagement work. Monitoring will be considered due to the financial impacts of COVID-19.
- [43] The compliance and enforcement will continue in response to complaints for domestic burners.

REFERENCES

NIWA National Climate Centre. *New Zealand Climate Summary: 2019*. Issued 9 January 2020. NIWA Ltd

ORC Committee Paper, 2018. *Air Quality Strategy and Implementation Plan*. Policy Committee Report, 25 September 2018.

ORC Council report, 2020 (a). *Spatial variation of air quality in Wanaka*. Council report 27 May 2020.

ORC, 2020 (b). *Technical Implications of the 2020 NESAQ Proposal*. Internal file note, May 2020. Internal reference A1334295

Wilton, E. 2019. *Wanaka, Cromwell and Clyde Air Emission Inventory – 2019*. Environet Limited, Internal Objective ID A1344874.

World Health Organisation, 2006. *Air quality guidelines for particulate matter, ozone, nitrogen dioxide and sulfur dioxide: Global update 2005: Summary of risk assessment*. Retrieved from <https://www.who.int/airpollution/publications/aqg2005/en/>

ATTACHMENTS

{attachment-list}

{remove-from-minutes-end}