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PREPARED FOR
Nelson City Council

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Assessment of the potential
disaggregation of Airshed C
and implications for air
quality management

Envirolink Report NLCC95

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EXECUTIVE SUMMARY

As part of a review of the current Air Plan the Nelson City Council is considering issues relating to the location of the boundary for the current Airshed C. This report evaluates issues around the location of the northern boundary for Airshed C and considers the implications of a boundary change on air quality management.

The poorest air quality in Nelson has occurred historically within Airshed A which comprises the Washington Valley, Hospital and Toi Toi area. Airsheds B1 and B2 comprise Tahunaunui and Stoke respectively. Airshed C includes central Nelson, the Maitai and Brook valleys as well as Atawhai and other areas north of Nelson. The purpose of this report is to evaluate the scientific basis for separating the airshed into two areas, one of which could be subject to less stringent regulations, and the implications for air quality management of doing so.

Air quality monitoring data indicates lower PM₁₀ concentrations in Airshed C relative to Airsheds A and B1. Within Airshed C highest concentrations are likely around the Brook Street monitoring site and in Britannia. Limited monitoring carried out in Dodson Valley in 2004 showed a maximum concentration of PM₁₀ just within the "acceptable" air quality category.

The Nelson North area comprising the Atawhai and Clifton CAUs was found to only have minimal contribution to PM₁₀ concentrations in other parts of Airshed C or in other airsheds. This was considered reasonable justification for segregation of this area from the current Airshed. Further monitoring is required to assess the extent to which air quality management in this area could differ from that in Airshed C.

The assessment found that removal of Atawhai and Clifton from Airshed C would require a reduction in the number of allowable ultra low emission burners (ULEB) in new dwellings or existing dwellings using other heating methods as permitted under Plan Change A3. The ULEB installations would need to reduce from 600 for Airshed C to 420.

Recommendations

1. That the Atawhai and Clifton areas north of Nelson be separated from Airshed C for the purposes of air quality management.
2. That the new northern boundary for Airshed C be located along the ridgeline south of Wakapuaka cemetery as shown in Figure 4.3 of this report (blue line).
3. That monitoring of PM₁₀ be carried out in Dodson Valley during 2017 and that data be used relative to Air Plan PM₁₀ targets to determine if unlimited ULEB installations within the new area are able to be permitted.
4. That the number of allowable ULEB in Atawhai and Clifton be limited to 120 until results of 2017 PM₁₀ monitoring are available.
5. That the number of ULEB installations permitted within Airshed C be revised from 600 down to 420.

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1 INTRODUCTION

The gazettement of Airsheds is a requirement under the National Environmental Standards for Air Quality (NESAQ). Nelson has been split into four urban air catchment areas referred to as airsheds for the purposes of air quality management and in accordance with the NESAQ. Figure 1.1 shows the four airsheds referred to as “A”, “B1”, “B2” and “C”.



Figure 1-1: Airshed areas for Nelson

Historically the poorest air quality in Nelson has been measured in Airshed A (Nelson South, Washington Valley and Toi Toi area). The National Environmental Standard (NES) for PM₁₀ is set at 50 µg/m³ (24-hour average) and may be exceeded on one occasion per year (Ministry for the Environment, 2004). In 2001 there were 81 days when concentrations of PM₁₀ exceeded 50 µg/m³ in Airshed A. Airshed B1 was also regularly in breach of the NES. Limited historical monitoring carried out in Airsheds B2 and C suggested concentrations were lower than airsheds A and B1 with less frequent exceedences of the NES for PM₁₀.

An Air Plan was developed for Nelson to reduce PM₁₀ concentrations and became operative in 2008. The Plan included management measures primarily targeting domestic home heating as the main source of winter time breaches of the National Environmental Standard (NES) for PM₁₀. Reductions in industrial emissions were also targeted. The plan aimed to reduce PM₁₀ concentrations in Nelson’s Airshed A by 70% and in other Airsheds by lesser amounts. The measures included in the Air Plan were:

- i. A ban on outdoor rubbish burning from 2003.
- ii. Emission limits for new installations of solid fuel burners of 1.5 g/kg and an energy efficiency of 65% (when tested to NZS 4013).
- iii. A ban on the use of open fires from January 2008.

- iv. A ban on the installation of solid fuel burners in new dwellings or existing dwellings using other heating methods from November 2008.
- v. Airshed A and B1 - staged phase out of older burners from 2010, 2011 and 2013. The latter phase out date of wood burners installed between 2000 and 2003 was withdrawn following 2011 revisions to the NES. This resulted in approximately 120 burners in Airshed A which did not get phased out and for which no legislative replacement date currently exists.
- vi. Airshed B2 – staged phase out of older (pre 1990s burners) by 2010 and pre 1995 burners by 2012.

An evaluation of the effectiveness of the Air Plan in reducing PM₁₀ concentrations in Nelson to meet the NES was carried out in 2014 (Wilton, 2014). Results suggested significant reductions in concentrations in Airshed A and B1 where concentrations in breach of the NES historically occurred (Figures 1.2 and 1.3). Airshed B1 is likely to be in compliance with the NES for PM₁₀ and additional reductions in 2014 levels of around 14% are likely to be required for ongoing compliance with the NES in Airshed A (Wilton & Zawar Reza, 2014).

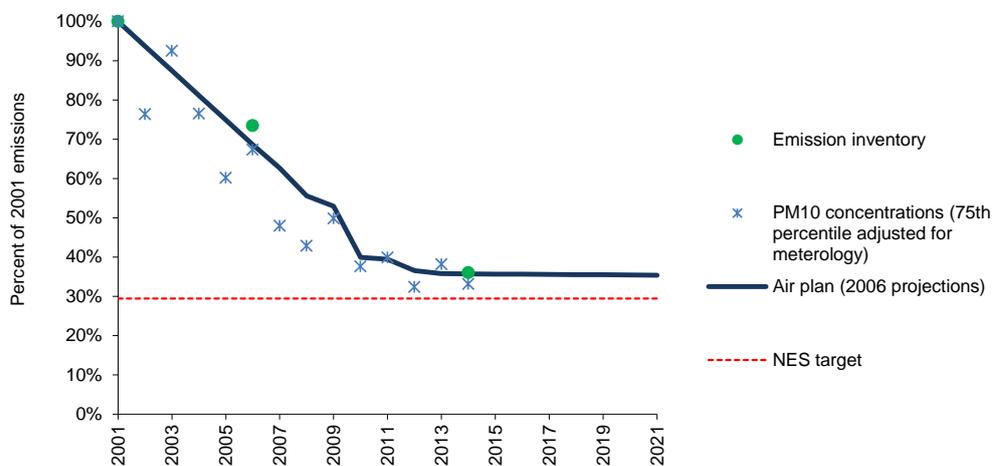


Figure 1-2: Trends in PM₁₀ concentrations and emissions in Airshed A – 2001 to 2014.

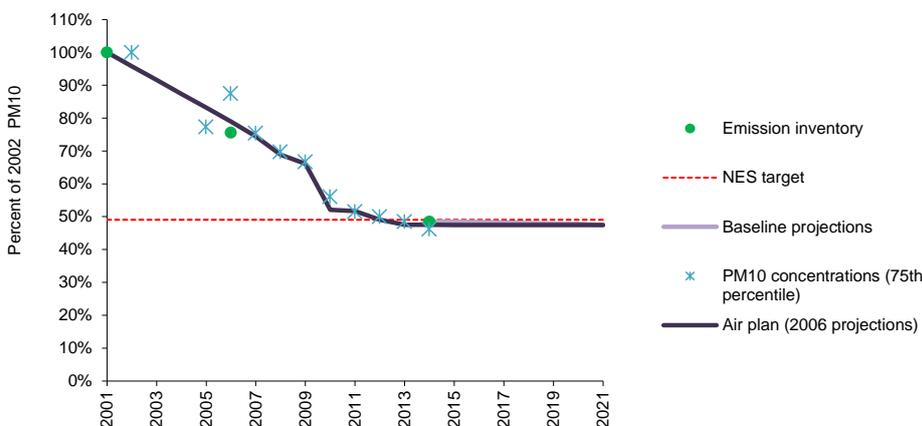


Figure 1-3: Trends in PM₁₀ concentrations and emissions in Airshed B1 – 2001 to 2014.

Airsheds B2 and C are compliant with the NES for PM₁₀. In 2016, Plan Change A3 was implemented to enable the installation of up to 1000 new ultra low emission burners (ULEB) in Airshed B2 and up to 600 ULEB in Airshed C. Under this change, any potential degradation in PM₁₀ concentrations associated with the installation of new burners was to be offset by a behaviour change programme aimed at reducing emissions from existing solid fuel burners through improved operation.

The Nelson City Council is now carrying out a thorough review of the Air Plan. As part of that review an evaluation of whether the current Airshed C should be split and the potential for an area to the north which has fewer restrictions on wood burners. Airshed C refers includes central Nelson, the Maitai and Brook valleys as well as Atawhai and other areas north of Nelson. The air quality monitoring site is located in the Brook area as this area has shown higher concentrations than other monitoring carried out in Airshed C. Monitoring in the CBD and up Dodson Valley has indicated lower concentrations in these areas.

2 MONITORING IN AIRSHED C

Air quality monitoring for PM₁₀ in Airshed C includes monitoring at the Cawthron Institute in Halifax Street (the Wood) during 2003, Dodson Valley (Nelson North) in 2004, Sowman Street in the Brook in 2003 and at the Brook Street monitoring site in 2008, 2009, 2015 and 2016 (the Brook). Prior to this, smoke measurements carried out at a central location (Nelson City Council) were significantly lower than concentrations measured at Vanguard Street and Quarantine Road.

The above data provides a snapshot of variations in PM₁₀ concentrations in three locations across Airshed C around the early and mid-2000s. Data suggest that PM₁₀ concentrations were highest in the Brook with a maximum concentration of 59 µg/m³ recorded during 2003. A maximum of 26 µg/m³ was recorded at the Cawthron monitoring site during 2003 and the Dodson Valley a maximum of 32 µg/m³ was measured during 2004.

The NESAQ requires that monitoring be carried out in the location within an airshed where concentrations are likely to be highest or exceed the NES most frequently. Consequently, ongoing monitoring of PM₁₀ in Airshed C has been carried out at the Brook. Data for 2008-2009 and 2015-2016 indicates maximum concentrations are around 40 µg/m³.

Figure 2.1 compares data from smoke monitoring carried out during June 1998. It should also be noted that the measure is “smoke” rather than particulate and that this is not accurate as a measurement of mass but does provide an indication of the relative air pollution between the three locations. Note also that indicators for reporting of low, moderate and high concentrations are outdated, with the moderate line representing a level that the NES for PM₁₀ has been set.

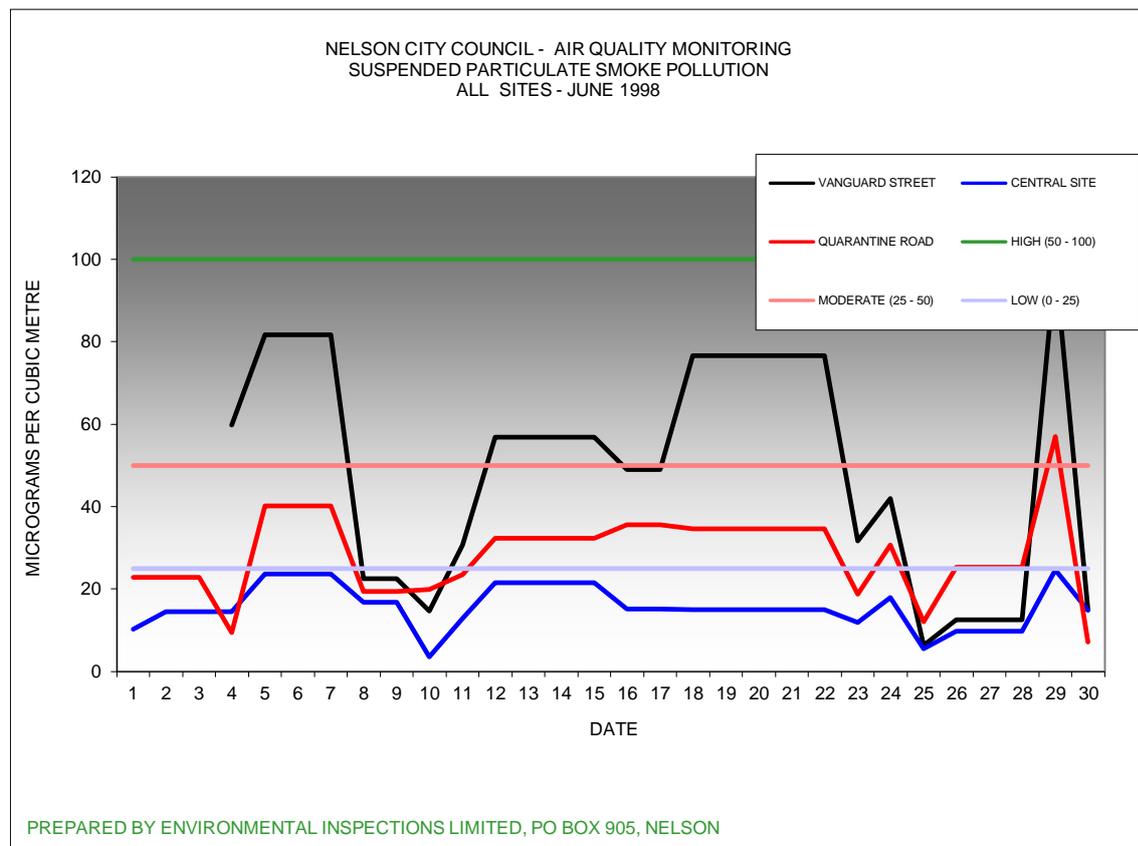


Figure 2-1: Comparison of smoke monitoring results for central Nelson to Vanguard Street and Quarantine Road for June 1998.

3 AIR DISPERSION MODELLING AND MOBILE MONITORING

3.1 Air dispersion modelling results

The origin of PM₁₀ concentrations measured at different receptor locations in Airshed C was evaluated in Gimson, (2015). Receptors were located in The Wood, Maitai, Brook Street, Trafalgar and Britannia. The Wood and Britannia were identified through the dispersion modelling as the two areas of peak PM₁₀ concentrations in Airshed C.

Concentrations of anthropogenic PM₁₀ in The Wood were found to originate from the census area unit of the Wood itself (around 50%) with Maitai, Brook and Airshed A each contributing just over 10%. The Nelson north area (Atawhai) was found to likely contribute less than 1% of the PM₁₀ concentrations in the Wood for a winter average and around 1% for the top ten high pollution days (Gimson, 2015).

The modelling indicates that the Britannia area is primarily influenced by emissions from Airshed A and the report suggests that the ridgeline separating the areas does not appear to block the flow from Airshed A to Britannia Heights. Around 50% of the PM₁₀ concentrations in Britannia are estimated to originate in Airshed A with around 20% from Britannia itself and around 15% from Airshed B (Gimson, 2015).

Emissions from the Brook area also contribute 25% of the winter average PM₁₀ concentrations in Trafalgar and around 12% of concentrations in the Maitai receptor area (entrance to Maitai Valley). The Brook itself is dominated by emissions within the Brook area (81%) with 5% from Airshed A and 4% from Maitai.

The modelling indicates that the Nelson North area (Atawhai) has only a minimal contribution to PM₁₀ concentrations measured in the Wood, Britannia, Maitai or the Brook (around 1% at the Wood) and does not contribute significantly to any other airshed (less than 1% contribution).

3.2 Mobile monitoring around Nelson

The purpose of evaluating the results of the mobile monitoring conducted across Nelson during winter 2008 is to assess how concentrations in the Atawhai north area compare with those in other areas of Airshed C.

Results of the mobile monitoring for Nelson, Richmond and Christchurch are presented in Olivares, Smith, & Bluett, (2010). Figure 4.6 of that report illustrates spatial variability in PM₁₀ concentrations across Nelson on 21 July and 25th July 2008. The study is limited in that it only includes two days of mobile monitoring. However, data are consistent with air quality monitoring results with highest concentrations occurring in Airsheds A and B1 and is indicative of spatial variability in PM₁₀ concentrations in the Nelson area.

Mobile monitoring results suggest PM₁₀ concentrations are low in most areas of Airshed C. Areas that may have higher concentrations based on the results of mobile monitoring would be the Britannia/ Nelson Port area between Airshed A and the coastline, the area in the vicinity of and slightly to the west of the current monitoring site at 26 Brook Street. The mobile monitoring extended only a few kilometres north of the Wood towards Atawhai. Concentrations along this stretch were within the darkest colour band indicating lowest PM₁₀ concentrations.

3.3 Evaluation

Results of the air dispersion modelling suggest that the area to the north of Nelson does not make a significant contribution to PM₁₀ concentrations within other areas of Airshed C or other Airsheds of Nelson. If air quality in this area is less degraded than the Brook there is justification for separating this off from Airshed C and potentially imposing less stringent restrictions on wood burner installations.

Areas of Airshed C likely to have the highest PM₁₀ concentrations have been identified through modelling as the Wood and Britannia and through mobile monitoring as entry to and area to the west of the Brook and Britannia. Mobile monitoring showed lower concentrations of PM₁₀ in the Wood area. Recommended priorities for PM₁₀ monitoring in Airshed C include Britannia and the Wood.

It might be suggested that there is a case for Britannia to be included in Airshed A because data suggests concentrations are likely elevated in that area and the ridgeline that was thought to separate it from Airshed A may in fact not. The main justification for including in Airshed A would be to avoid over management of concentrations in the remainder of Airshed C, if based on higher concentrations that may be measured in Britannia. It is likely, however, that PM₁₀ concentrations in Britannia have reduced significantly since the mobile monitoring was carried out in 2008 as a result of a reduction in PM₁₀ emissions in Airshed A. If PM₁₀ concentrations in Britannia were not significantly worse than those measured at Brook Street then there may not be any need to consider changing the airshed boundary to include Britannia in Airshed A.

4 LOCATION OF A REVISED BOUNDARY

A key factor in determining the location of a separation boundary for the Nelson North (Atawhai/ Clifton) area is the airflows on days when meteorological conditions are conducive to elevated concentrations. In particular whether emissions from discharges in an area will flow out to sea or back in towards Nelson.

Emission density is also a consideration from the perspective of inclusion or exclusion of different areas when considering a boundary. From an administrative perspective a low emission density area would provide a preferable boundary. Appendix A (from Wilton & Zawar Reza, 2015) shows a large low density emission area in the vicinity of Miyazu Park, Walkers Bluff and Wakapuaka cemetery.

Figure 4.1 shows the census area unit boundaries (purple) and meshblock boundaries (black) for the Atawhai, Wood and Maitai junction and a satellite image of the area (right). The census area unit boundary for the Wood lies to the south of Miyazu Park with the Walters Bluff/ Davies Drive area within the Atawhai CAU and the Founders Park and Iwa Road areas within the Wood CAU. The CAU boundary provides a reasonable differentiation of the areas with the exception that the Walters Bluff/ Davies Drive area slopes more towards the Nelson area and may contribute to PM₁₀ concentrations in that area. The Wakapuaka cemetery area provides an alternative boundary and buffer between residential area of both CAUs.

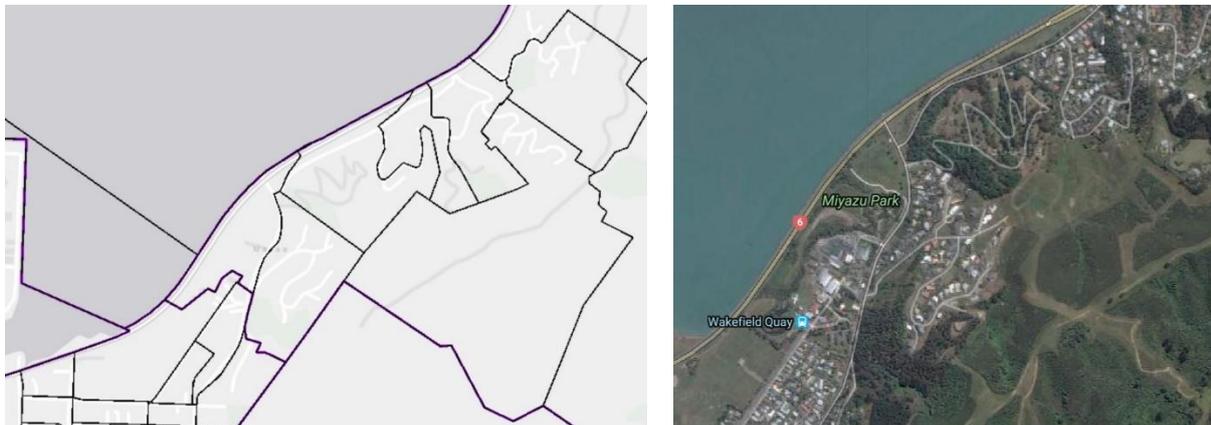


Figure 4-1: Census area unit (purple) and meshblock (black) boundaries (left) and satellite imagery (right) around the Wood and Atawhai boundary area.

It is well-known that wood-burner related air quality degradation in the South Island occurs when the region is influenced by high-pressure synoptic scale weather systems. With stagnant winds and clear skies, emissions are typically confined and advected horizontally within a 10-metre temperature inversion layer and are carried under the influence of katabatic winds from higher to lower elevation and eventually flushed towards the coastline. This is analogous to how water flows over land when the soil is saturated.

Figure 4.2 shows the wind flows under high-pressure synoptic scale weather systems with a potential boundary following a ridgeline and heading northwards of Wakapuaka cemetery. At this point emissions fall away from the direction of Nelson and flow downwards towards the sea. This forms the strongest topographical boundary from a wind flows viewpoint.

Figure 4.3 shows alternative boundaries that were considered as part of the evaluation. The basis for consideration of these was practicality and administrative purposes (red line following CAU boundary) and closer rural to urban segregation (black line). The ridgeline shown in Figure 4.2 was considered the most scientific approach and was modified slightly to account for land parcels and meshblock areas in the proposed boundary shown as the blue line in Figure 4.3. The adjustment of the boundary from north to south of the cemetery has no implications for the management of air quality owing to the area not being zoned for residential development.

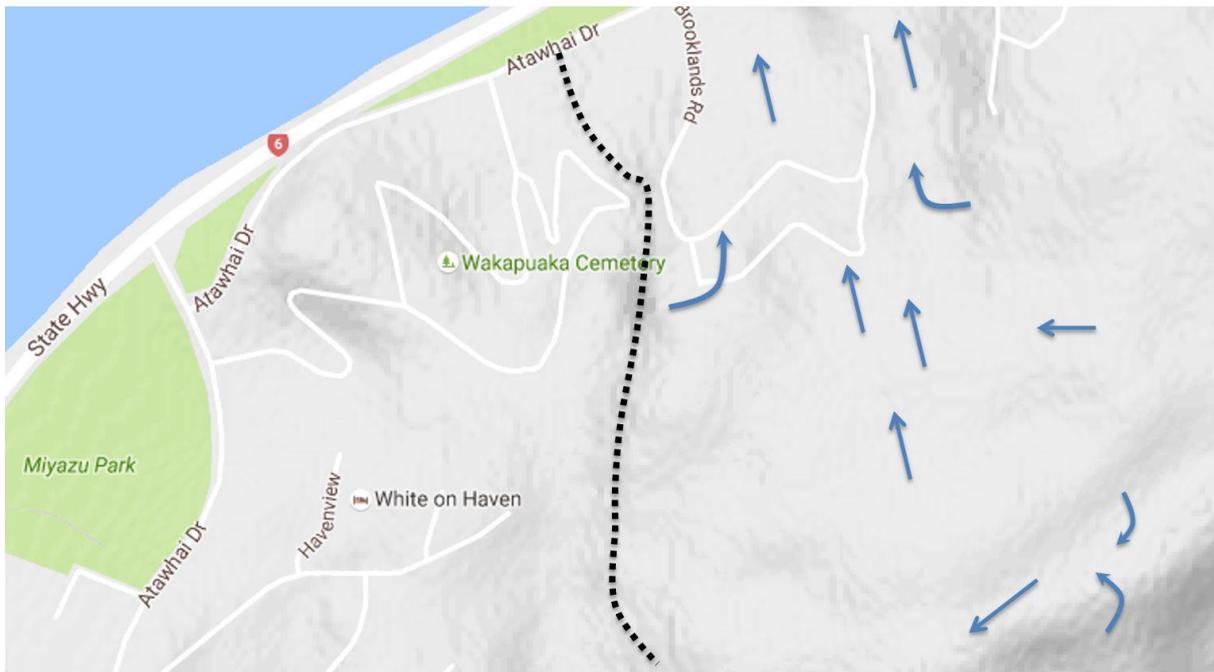


Figure 4-2: Wind flows around Atawhai junction area for high pollution evenings.



Figure 4-3: Proposed boundary adjusted for meshblock and land parcel boundaries (blue line) and other considered boundaries (red line and black line).

5 IMPLICATIONS FOR AIR QUALITY MANAGEMENT

5.1 Further differentiation in air quality management in Airshed C

Air quality monitoring data indicates the Brook is likely to have the poorest air quality of the areas monitored. Modelling confirms a location near the existing monitoring site as likely having elevated concentrations with the area of Britannia also likely having concentrations of similar or higher magnitude.

The Brook is contributed to by mainly just the Brook (with a 5% contribution from Airshed A and a 4% contribution from Maitai) and Britannia by mainly Airshed A and Britannia itself as well as Airshed B2. If these were the only areas of Airshed C which experienced elevated PM₁₀ concentrations it may be possible to consider less stringent management in more areas than just the Nelson North area. A key consideration would be the location of the 15% of PM₁₀ concentrations in Airshed A that originate from sources within Airshed C. An evaluation of data provided by Neil Gimson of the air dispersion modelling outputs from Gimson (2015) indicates that the contributions to Airshed A from Airshed C originate primarily from the Brook (8%), the Wood (2%) and Maitai (2%). Consequently, further differentiation of Airshed C is not recommended at this stage.

5.2 ULEB in Airshed C

Plan Change A3 (PC3) was adopted by Nelson City Council in 2016 and enables the installation of new ULEB in Airsheds B2 and C in dwellings that previously did not have a solid fuel burner. The assessment indicated that 1000 ULEB could be installed in Airshed B2 and 600 in Airshed C whilst still maintaining the downward trend in PM₁₀ concentrations towards the “acceptable” category, a requirement of the current Air Plan policy framework

The removal of Atawhai and Clifton from Airshed C has implications for the number of ultra-low emission burners (ULEB) that could be installed in Airshed C. An estimate of the impact of removing the Atawhai and Clifton census area units (CAU) from the evaluation indicates that the number of ULEB that could be installed should be reduced from 600 down to 420 (Figure 5.1).

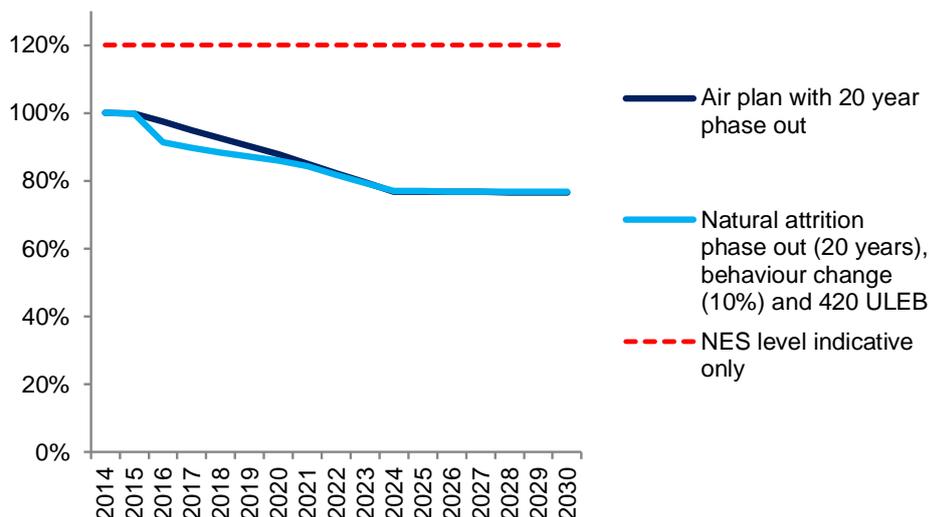


Figure 5-1: Evaluation of impact of allowing ULEB into Airshed C with adjustment for boundary (excluding Atawhai and Clifton).

5.1 Air quality management in Atawhai and Clifton

Air quality monitoring in the Atawhai and Clifton area is limited to monitoring carried out in the Dodson Valley during May and June of 2004. Concentrations measured during this time indicated a maximum concentration of $32 \mu\text{g}/\text{m}^3$ which is within the “acceptable” air quality category specified in the current air plan as a long term target for all airsheds. Given the short monitoring duration it is likely that this does not represent worst case air quality for the Nelson North area. However, it is also likely that PM_{10} concentrations have reduced in this area as a result of the natural attrition replacement of older burners with lower emission burners over time.

It is recommended that priority be given to monitoring of PM_{10} in the Dodson Valley to confirm that PM_{10} concentrations in the area are within the “acceptable” air quality category or consistent with any new air quality targets arising as a result of the plan review process.

It is likely that PM_{10} concentrations within the Nelson North area are sufficiently low as to not warrant restrictions on the numbers of ULEB that can be installed. Until such time as this can be confirmed through monitoring of PM_{10} concentrations (e.g., during winter 2017) it is proposed that the number of ULEB allowed to be installed in the area be limited to 180¹.

¹ The number which corresponds with the BCP reductions for this portion of the airshed (600 initially assessed for Airshed C less 420 which is the revised Airshed C ULEB with Atawhai and Clifton removed)

6 SUMMARY

The objective of this report was to advise Nelson City Council on:

- The scientific basis for any further differentiation of Airshed C.
- Areas that could be segregated and the most appropriate location for a boundary.
- The likely implications for air quality management including the impact on the Plan Change A3 proposals in terms of allowable ULEB in Airshed C.
- Recommendations regarding future management or assessments required for the area split off from Airshed C.
- Recommendations for future monitoring.

There is scientific basis for segregation of the Nelson North/ Atawhai area from Airshed C as PM₁₀ emissions from this area were found to not contribute significantly to PM₁₀ concentrations in other parts of Airshed C or in other Nelson airsheds. The general area for separation is the Atawhai north area which includes the CAUs of Atawhai and Clifton.

An evaluation of topography and airflows indicated that the most appropriate area for segregation is an area just south of the Wakapuaka cemetery.

Air quality monitoring data for Dodson Valley is limited to monitoring during May and June 2004. Data suggests maximum PM₁₀ concentrations during this time of around 32 µg/m³. This is within the “acceptable” air quality category which comprises the long term target for PM₁₀ concentrations within the current Air Plan. It is recommended that PM₁₀ concentrations be monitored in Dodson Valley during 2017 to confirm that PM₁₀ concentrations are within the “acceptable” air quality category or any other air quality target set through the plan review process. If monitoring indicates sufficient capacity consideration could be given to unrestricted ULEB installations in this area. In the interim it is recommended that ULEB installations be limited to 120.

There are implications for airshed management if the Nelson North area is removed from Airshed C. It is recommended that the number of ULEB that could be installed in Airshed C be reduced from 600 to 420 to allow for the revised airshed area.

Priorities for air quality monitoring within Airshed C include Dodson Valley and Britannia.

7 REFERENCES

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APPENDIX A: DISTRIBUTION IN PM₁₀ EMISSIONS ACROSS NELSON

Nelson total emissions by 2013 meshblock (Normalised)

