SOME EXAMPLES OF HOW A WOODHEATER/WOODBURNER CAN SMOKE OUT A NEIGHBOUR, AND WHY IS IT SO HARD TO FIX THE PROBLEM?

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Abstract

Ambient air monitoring has traditionally been conducted with reference-level (or equivalent) instruments at stations sited according to relevant standards (e.g. A/NZ 3580.1.1–2007). the intention has been to measure 'representative' air quality for the locality, and hence the stations are sited to limit the effects of specific local sources (e.g. nearby road traffic, etc.).

In Tasmania in recent years car-based smoke measurement surveys and the deployment of small, non-reference particle measurement stations has been directed to understanding winter-smoke levels on spatial scales of order of tens of metres to several kilometres, including work towards understanding peak exposure. Car-based surveys have proven informative for mapping smoke concentrations at street- and suburban-scales. Fixed stations deployed into residential lots have also revealed that extreme and very local degradation of air quality occurs, and likely arises due to smoke from one or a small number of nearby woodheaters. These high smoke-concentrations are not seen at the relatively 'remote', more traditionally-sited air stations.

The first part of this paper will present data from air monitoring campaigns conducted on residential properties across Tasmania, showing the level of smoke impacts (ranging from minimal to extremely high) and the circumstances in which they occur. The second part will briefly discuss some outcomes, the regulatory and legislative backgound, and the impediments to substantive rectification of the issue of badly-smoking woodheaters.

Keywords: *Woodheater/woodburner smoke, PM2.5, air quality impacts, regulation*

1. Introduction

1. Tasmanian woodheater and monitoring approaches

Woodheaters (to use the Australian term for a New Zealand 'woodburner') appear to be the primary means of household heating in approximately one third of Tasmanian residences. Woodheater use varies between urban and rural areas, typically with 1 in 6 houses using woodheaters in the central areas of Hobart and Launceston, to up to 2 in 3 (or sometimes more) in the outer suburbs of these cities, in towns, and in the rural areas of Tasmania. [https://epa.tas.gov.au/epa/air/woodheater-smoke/woodheater-and-open-fire-census-2011].

Tasmania's Base-Line Air Network of EPA Tasmania ('BLANkET') smoke monitoring network began to be established in Tasmania in 2009. Lower-cost instrumentation enabled air monitoring to be conducted across Tasmania. A common theme from the measurements was high winter-time woodsmoke levels from residential heating. A car-based instrument ('Travel BLANkET') was developed for smoke surveys, giving geo-located $PM_{2.5}$ measurements, allowing the creation of spatial maps of winter-time smoke distributions. A smaller-footprint, easily-relocatable, lower-cost real-time smoke station ('babyBLANkET') has also been developed. These provide means of monitoring in places unsuitable for the deployment of larger stations.

The instruments used in the BLANkET stations are calibrated against reference-level Low Volume Air Sampler $PM_{2.5}$ and PM_{10} instruments operating at the Hobart (New Town) station. BLANkET instruments are also in operation at reference air stations in Launceston (Ti Tree Bend) and Devonport as a check on the calibration processes.

2. Tasmanian winter air quality

The network data show that winter air quality is compromised in many Tasmanian towns and communities, as well as in the larger cities of Hobart and Launceston. Smoke from domestic woodheaters results in many areas experiencing $PM_{2.5}$ levels above the National Environmental Protection (Ambient Air Quality) Measure ('Air NEPM') 24-hour standard. Some towns can record up to 50 such days in a winter, depending on the meteorologly. Public education programs on

woodheater operation and air quality are conducted by EPA Tasmania and local councils. However, analysis of the the monitoring data suggests there has been little overall change in winter air quality above that due to interannual variability in meteorological conditions.

2. Monitoring smoke plumes from one or a small number of woodheaters

1. General

EPA Tasmania provides advice to and supports local government (council) environmental regulation. EPA has at times been approached by councils to assist in the management of residential smoke complaints from members of the public, reportedly arising from a woodheater on a neighbouring property. In some instances EPA Tasmania has undertaken monitoring to provide quantitative data to support council actions, and also to provide EPA Tasmania with data on particle exposure at very-high spatial-scales. Depending on circumstances, Travel BLANkET surveys may be uindertaken in the area of the complaint, and/or an air monitoring station may be deployed at the house of the complainant. Some examples of the results of this work will be presented here.

2. Example $PM_{2.5}$ data from air monitoring on or near residential premises

2.1 West Hobart – 2011

A resident of a house in West Hobart reported they were regularly exposed to high smoke levels from a chimney on a neighbouring house, and that over the course of a few months family members had begun to shown symptoms of asthma, and had commenced medication. EPA Tasmania undertook a Travel BLANkET survey and visual check of the area on 11 August 2011. A representation of the survey data is given in Figure 1. A large plume was seen to be coming from the neighbouring chimney. A well-defined katabatic wind flowing from the foothills of Mount Wellington took this smoke directly into the back of the complainant's house, approximately 20 metres away. The smoke plume was intercepted at ground-level with Travel BLANkET approximately 45 metres from the chimney, with instantaneous $PM_{2.5}$ levels reaching to just above 150 µg/m^3. Measurements were not made at the rear of the complainant's house, but it is considered that $PM_{2.5}$ levels there would have been higher than measured in the street over twice as far from the chimney.

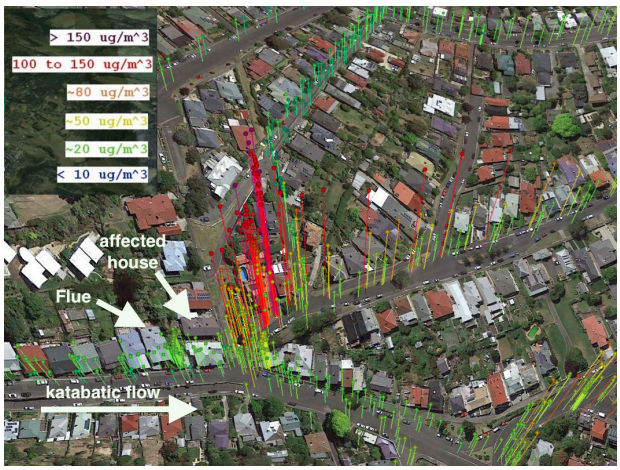

Illustration 1: Travel BLANkET survey of part of West Hobart, 11th August 2011. $PM_{2.5}$ levels are represented by colour and also by height above local ground level.

2.2 Invermay (Launceston) – 2014

A small air station was deployed for 2 weeks in a residence in Launceston in July 2014, approximately 1 km from the main Launcestion air station at Ti Tree Bend. The Invemay station recorded many instances of very high (> 100 µg/m^3) instantaneous $PM_{2.5}$ which occurred as short-lived, but frequent, episodic increases (Figure 2).

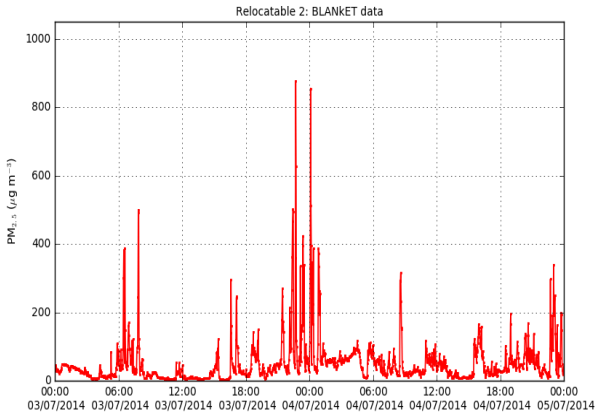

Illustration 2: Example 2-minute-resolution $PM_{2.5}$ data from the Invermay residential deployment, July 2014.

Each of the 13 full 24-hour days of monitoring at the Invermay site had a day-averaged PM2.5 level over the Air NEPM 24-hour $PM_{2.5}$ standard of 25 µg/m3. In the same interval there were no days above the $PM_{2.5}$ standard at Ti Tree Bend. These data are shown in Figure 3. A Travel BLANkET survey showed that, during the survey interval, $PM_{2.5}$ levels were higher in the general Invermay area than compared to Ti Tree Bend, as shown in Figure 4.

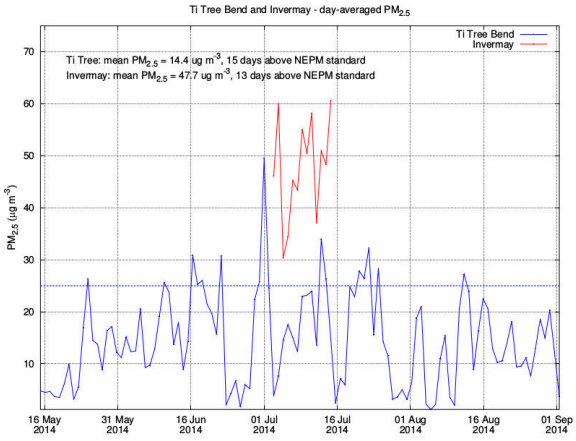

Illustration 3: Comparison of day-averaged PM2.5 (red) from the Invermany deployment and the winter 2014 data from Ti Tree Bend (blue).

The high-levels of $PM_{2.5}$ measured during the Invermay deployment most likely arose from woodheater smoke from a number of residences in the vicinity.

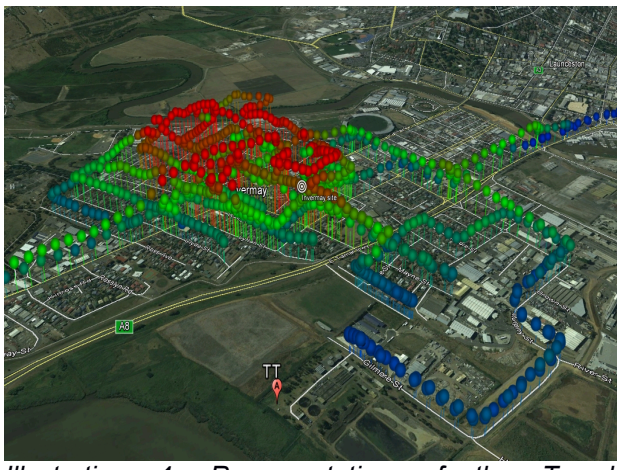

Illustration 4: Representation of the Travel BLANkET survey of Invermay, showing the deployment site (marked at centre) and Ti Tree Bend air station (foreground). PM2.5 is colour-coded from blue (low PM2.5, ~ 10 µg/m^3) through green (~50 µg/m^3) to red (~ 100 µg/m^3 or more).

2.3 Burnie – 2014

Air stations were deployed at a residence on the southern edge of Burnie in 2014. Two campaigns were undertaken, 2nd to the 23rd of July, and 3rd to the 25th of September. During the first deployment a BLANkET station was deployed on level land at the rear of the property. During the second deployment a smaller air station was deployed on a deck between the house and the neighbouring property identified by the complainant as the source of the reported smoke. Episodically-elevated $PM_{2.5}$ levels were seen during both deployments but peak levels were higher during the second deployment, even though the peak of the winter cold weather had passed. Meteorological data indicated the smoke source was in the direction of the property identified by the complainant as the source of the smoke.

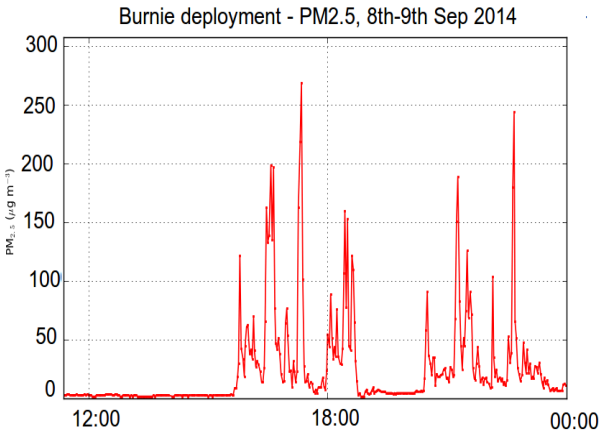

Illustration 5: Example of 2-minute-resolution $PM_{2.5}$ from the second Burnie deployment, September 2014.

2.4 Railton (northern Tasmania) – 2015

EPA Tasmania conducted two Travel BLANkET surveys of Railton in 2015, on the 12th-13th of June and 19th-20th of June, following a series of smoke complaints. PM2.5 levels were mostly low on the first survey due to the presence of a moderate wind which dispersed the smoke. On the second survey the weather was calm and cold. High smoke levels were recorded. The area near the residence of the complainant recorded some of the most consistently high levels in the survey.

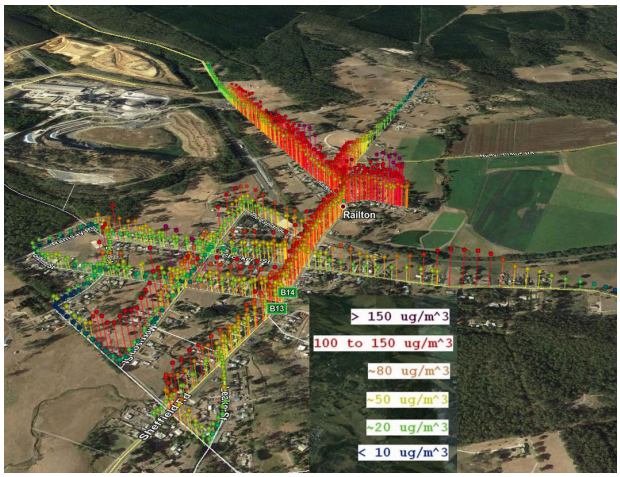

Illustration 6: Representation of the Railton Travel BLANkET survey from 19th-20th June 2015. PM2.5 levels are represented by colour and height above local ground. The high smoke levels just above and slightly to the right of image centre coincide with the location where the complainant resided.

The complainant also supplied several photographs of large smoke plumes from neighbouring chimneys.

2.5 Claremont (north Hobart) – 2016

A 'babyBLANkET' air station was installed at the rear of a residence in Claremont (northern suburbs of Hobart) in from 26th of July to the 11th of August 2016 following a series of complaints of high smoke levels. The station was located approximately 15 metres from the neighbouring chimney reported to be the source. Council and EPA officers had previously conducted drive-by visual inspections but had not seen excessive smoke. However, the monitoring station recorded the frequent occurrence of short-duration, very-elevated (> 200 µg/m^3) PM2.5 signals mostly in the evening hours. The rapidly-varying nature of the signal was well shown in 6-second resolution $PM_{2.5}$ data from the babyBLANkET station, and was consistent with a nearby localised source. Travel BLANkET surveys and visual inspections were also carried out and confirmed that the neighbouring chimney was the source of the elevated signals.

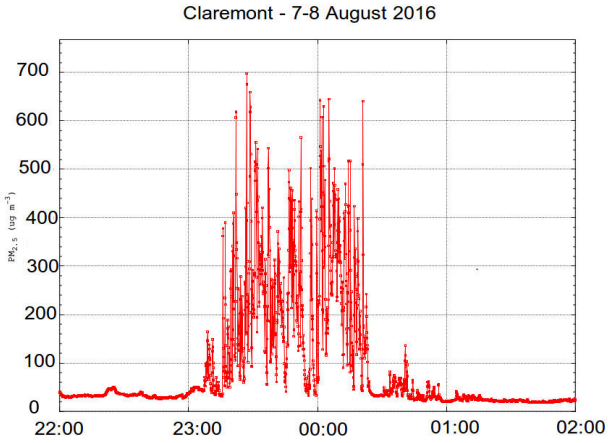

Illustration 7: Example 6-second-resolution $PM_{2.5}$ data from an air station at the rear of a residence in Claremont, 7-8 August 2016.

Day-averaged $PM_{2.5}$ levels measured at the station were below the Air NEPM 24-hour standard. The intervals of high $PM_{2.5}$ were clearly evident in hour-averaged data. This is particularly marked when comparing Claremont to the nearest BLANkET station at Glenorchy (a few kilometres away) as shown in Figure 8.

2.6 Prospect Vale (Meander Valley) – 2017

Monitoring was conducted at a residence in Prospect Vale from the 11th of July to the 22nd of August 2017 with a babyBLANkET station, again following a series of complaints. Council had not been able to substantiate the reported high smoke levels. The station was located approximately 12 metres from the chimney reported to be the smoke source. The station recorded frequent intervals of rapidly-varying and elevated instantaneous $PM_{2.5}$ (>100 µg/m^3), as shown by some example data in Figure 9. This is consistent with a nearby, localised source. Travel BLANkET surveys and visual checks were made, and a significant smoke plume was seen to be coming from the previously identified chimney.

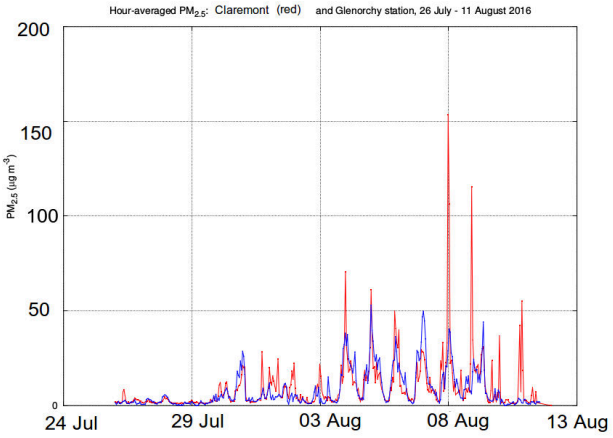

Illustration 8: Hour-averaged $PM_{2.5}$ data from the Claremont residence (red) and the nearby Glenorchy station (blue).

During the monitoring interval the complainant reported that the occupants of the neighbouring house were away during two intervals of a number of days. The highest instantaneous $PM_{2.5}$ values in the station data were recorded during the intervals when the neighbouring house was reported to be occupied. Separating the data into the reported 'occupied' and 'unoccupied' intervals shows a clear distinction between average smoke levels, with higher mean levels occuring when the neighbouring house was occupied, as shown in Figure 10. Varying meteorological conditions may also have had an influence here, but it is considered to be of secondary importance.

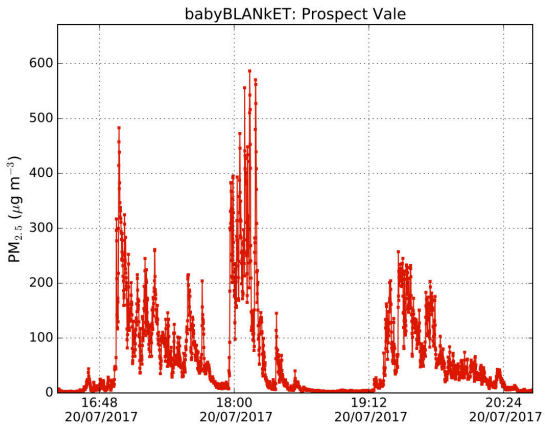

Illustration 9: Example 6-second $PM_{2.5}$ data from the Prospect Vale residence, 20 July 2017.

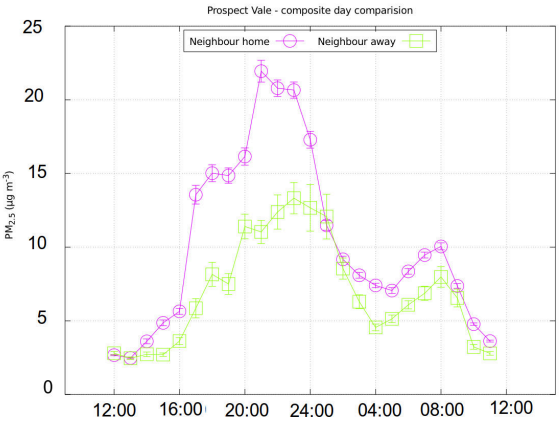

Illustration 10: Daily-profiles of hour-averaged $PM_{2.5}$ data from Prospect Vale, separated into the reported intervals when the neighbouring house was occuppied (magenta symbols) and unoccupied (green symbols).

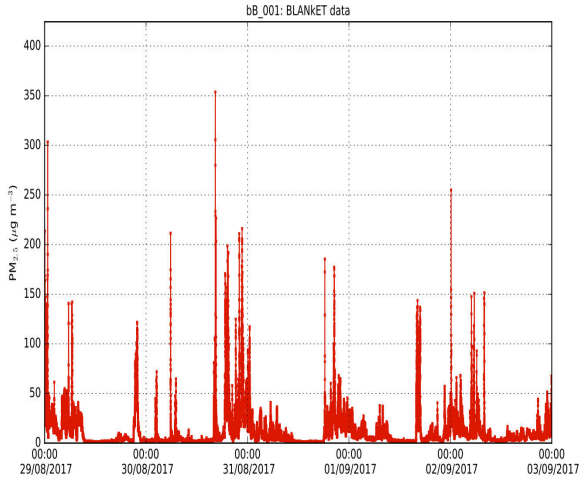

Illustration 11: Time-series of 6-second-resolution $PM_{2.5}$ from the Ulverstone deployment: Data from 29th of August to the 2nd of September 2017.

2.7 Ulverstone – 2017

Monitoring was also conducted at a residence in Ulverstone (northwest Tasmania) from 23rd of August to the 19th of September 2017 with a babyBLANkET station. The deployment again followed a series of complaints reporting smoke was impacting at the complainant's house. The council was unable to judge the severity of the impacts. The station was deployed on the complainant's property, almost touching an external wall of the complainant's house. It was approximately 9 metres from the chimney that was the reported source of the smoke.

The 6-second-resolution $PM_{2.5}$ time-series showed that frequently elevated, highly-time variable elevations occurred, often in the evening hours (Figure 11). The elevated $PM_{2.5}$ were typically in the range of 50 to 100 µg/m^3 but sometimes were several times greater. The peak instantaneous 6-second $PM_{2.5}$ value was near 750 µg/m^3. Photographs and video taken by the complainant during the monitoring interval confirmed that smoke from the neighbouring chimney was impacting the complainant's house. An analysis of the campaign data indicated that approximately 50% of the smoke measured at the station arose from a nearby, localised, source or sources.

There were no instances during the Ulverstone monitoring of day-averaged $PM_{2.5}$ above the Air NEPM 24-hour standard. The hour-averaged $PM_{2.5}$ from the Ulverstone monitoring showed that the mean night-time levels were generally much greater than at the West Ulverstone BLANkET station approximately 3.5 km to the west.

2.8 Norwood (Launceston) – 2018

Monitoring with a babyBLANkET station was conducted at a residence in Norwood from 31st of May to the 4th of July 2018. This was in response to complaints over several seasons of a large smoke impact from a neighbouring house. The councl had not been able to substantiate the reports. The station was located approximately 12 metres south east of the chimney on the neighbouring property reported to be the source of the smoke.

The station at Norwood recorded frequent episodes of highly-variable, high-peak PM2.5 values. These signals were consistent with a nearby, localised source. As seen in Figure 12, peak values were often over 200 µg/m^3. There was a clear indication that high-smoke levels preferentially were seen when the wind was north-westerly (which is the prevailing wind direction in Launceston and the direction to the chimney identified by the complainant as the smoke source).

The average $PM_{2.5}$ measured at Norwood during the campaign was 20.8 µg/m^3, with 13 days above the Air NEPM 24-hour standard, much greater than the mean of 12.5 µg/m^3 and the single day above the standard measured at the nearby South Launceston station in this interval. Travel BLANkET surveys and visual inspections by EPA Tasmania, as well as photographs and video provided by the complainant, led to the conclusion that the neighbouring chimney was the most significant source of the smoke measured during the campaign.

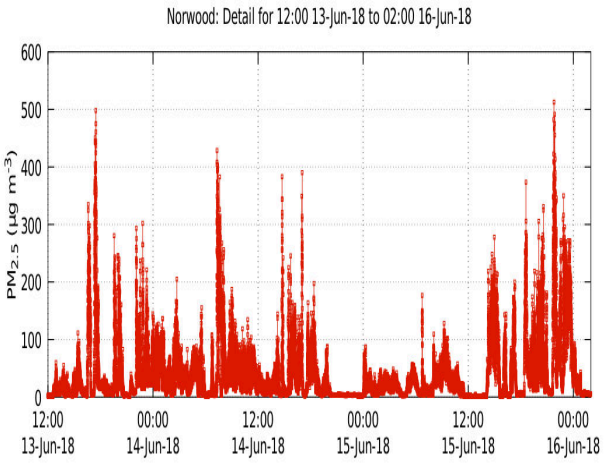

Illustration 12: Example 6-second-resolution $PM_{2.5}$ time-series fron Norwood, detail from 13th June to 16th June 2018.

3. Outcomes and regulatory framework

1. What happened after the monitoring?

Deploying air stations, conducting Travel BLANkET surveys, and carrying out detailed analysis of the data has led to a much greater awareness of peak smoke levels in Tasmanian residential areas, as well giving insight into the impact of a single woodheater. In this context the monitoring programs have been extremely worthwhile.

The work also was intended to assist councils with smoke compliant management. Arguably these outcomes have been less clear. The following is not in any way intended to be critical of council responses – each council is entitled to assign resources and priorities as they judge to be appropriate.

There are about a dozen instances where EPA Tasmania has undertaken focussed campaigns supporting councils. A summary of outcomes is given here - in some cases these are based on reports from the complainants that have not been verified by EPA Tasmania.

- One instance is on-going;
- One instance, after some time without resolution, the complainant wrote to the neighbour stating legal action may be considered if the smoke impact continued. The neighbour ceased using their woodheater;
- Two instances where the outcome is unknown;
- Three instances of councils issuing an Environmental Protection Notice (EPN) to limit or stop the use of the woodheater;
- Four instances of the complainants moving house as the issue had not been resolved to their satisfaction;
- One ongoing instance (commenced several years ago) where the complainant has now reported they will move house as soon as they can afford to do so.

Anecdotal evidence recently received by EPA Tasmania suggests that in one of the cases where an EPN was issued the original complainant has moved out, and the next-door woodheater is in use again. Potentially then, in 50% of these dozen instances, the outcome appears to be the complainant has moved or will move house.

2. Potential issues in applying regulations

It is probably appropriate to state that in many of these cases EPA Tasmania was invited to conduct monitoring as council officers were unable to determine the level of smoke impact. The monitoring data clearly demonstrate the biggest smoke impacts are usually in the evening. If often can be difficult for council officers to conduct regular smoke patrols at night, and it can also be harder to visually detect plumes after dark.

The relevant Tasmanian legislation ('Smoke Regulations', 2019, which superseded the 'Distributed Atmospheric Emissions Regulations', 2007) provide for an infringement notice to be issued if, in any 10-minute interval, smoke is visible and there is a 30-second interval when the plume is continuous and 10 metres or more in length. The monitoring data obtained by the air stations and Travel BLANkET obviously do not provide plume length information. Causing 'environmental harm' and 'environmental nuisance' are also offences under Tasmanian legislation, but appear to be less well defined or understood in the smoke pollution context. Councils in general appear unwilling to commit resources to approaches that may lead to possible legal proceedings when the outcomes are uncertain. The quantitative data provide an unambiguous assessment of the level of impact, but currently it is not clear how such quantitative data can be incorporated into a regulatory response.

Acknowledgments

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