IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of proposed Plan Change 13 to the Central Otago District Plan

STATEMENT OF EVIDENCE OF LOUISE FLEUR WICKHAM FOR PUBLIC HEALTH SOUTH IN RELATION TO AIR QUALITY

16 May 2019

QUALIFICATIONS AND EXPERIENCE

1. My full name is Louise Fleur Wickham. I am a Director and Senior Air Quality Specialist at Emission Impossible Ltd. I joined Emission Impossible Ltd in April 2011 and became a Director in July 2016.

2. I am subcontracted by the Institute of Environmental Science and Research to provide independent air quality advice to the Ministry of Health and Public Health Services. Public Health South (**PHS**), in turn, have engaged me to provide independent air quality advice on proposed Plan Change 13 (**PC13**) to the Central Otago District Plan.

3. I hold the academic qualifications of Bachelor of Chemical and Materials Engineering from the University of Auckland and a Master of Environmental Law from the University of Sydney. I am a certified Resource Management Act decision maker and was recently reappointed to Auckland Council's panel of independent commissioners. I am a member of the Resource Management Law Association, the Institute of Environmental Epidemiology and the Clean Air Society of Australia and New Zealand.

4. I have 24 years' experience in air quality gained in New Zealand, Australia and the United Kingdom in both the private and public sectors. From 2004 to 2011, I was the Ministry for the Environment's senior adviser on air quality. During this time, I was the Ministry's technical lead on air quality matters and played a key role in the introduction, implementation and review of the *Resource Management (National Environmental Standards for Air Quality) Regulations 2004*. I have authored, or co-authored, a number of national good practice air quality guidance documents.[1] I represented the Ministry in a number of domestic and international air quality and

[1] For example:

Ministry for the Environment (MfE), (2016). *Good Practice Guide for Assessing Discharges to Air from Industry*. (Co-author). Wellington. November.

MfE, (2016b). *Good Practice Guide for Assessing and Managing Odour*. (Lead author). Wellington. November.

MfE, (2016c). *Good Practice Guide for Assessing and Managing Dust*. (Co-author). Wellington. November.

MfE, (2005). *Updated Users Guide to Resource Management (National Environmental Standards Relating to Certain Air Pollutants, Dioxins and Other Toxics) Regulations 2004 (Including Amendments 2005) (second draft)*. Wellington. October.

technical forums.[2] I have also chaired and represented the Ministry in a number of national and Australasian research forums relating to air quality.[3]

5. Since 2011, I have continued to provide technical air quality advice to both government and private clients and to publish articles and guidance on air quality issues.[4] I have acted as a commissioner for Auckland Council and Hawke's Bay Regional Council, primarily for decisions on applications for resource consents with discharges to air. I have also provided expert evidence for the Public and Population Health Unit of Northland District Health Board on, *inter alia*, the use of separation distances (buffers) in the Northland Regional Council's proposed Regional Plan for Northland, a quarry application for land use consent and two appeals of the Whangarei District Plan.

6. In addition to this, I have provided, and continue to provide, expert evidence to Taranaki Energy Watch in their appeal of the South Taranaki District Plan.[5] This appeal revolves around the need for separation distances (buffers) between oil and gas activities and sensitive (residential) activities in the District Plan.

7. Further (brief) details of my qualifications and relevant experience are contained in **Attachment A.**

8. I confirm that I have read the Expert Witness Code of Conduct set out in the Environment Court's Practice Note 2014. I have complied with the Code of Conduct in preparing this evidence, and I agree to comply with it while appearing before the

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[2] For example: Environment Protection and Heritage Council (of Australia & New Zealand) Air Quality Working Group, Standards Australia/Standards New Zealand technical committee for wood burners (CS-62; 2004 - 2011), Expert Group on Best Available Techniques /Best Environmental Practices for Stockholm Convention (2006 and 2007), New Zealand National Air Quality Working Group.

[3] For example: (Chair, New Zealand) National Environmental Standards Research Advisory Group, (NZ representative) *Multicity Mortality and Morbidity Study* Research Advisory Group.

[4] For example:

Wickham L., (2017). New Zealand air quality case law review: what stinks and why. *Resource Management Journal*. April.

Emission Impossible Ltd, (2013). *2013 WHO Review of evidence on health aspects of air pollution – Emission Impossible Ltd Summary* prepared for the Ministry of Health. November. Available at: http://emissionimpossible.co.nz/wp-content/uploads/2013/12/2013-WHO-review-summary.pdf

[5] [2018] NZEnvC 227. *Taranaki Energy Watch v South Taranaki District Council*. Interim Decision. 23 November 2018.

Court. Except where I state that I am relying on the statements of another person, this evidence is within my area of expertise. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed in this evidence.

9. In preparing this evidence I have read the following documents:

   a. River Terrace Developments Ltd (**RTDL**) request for a change to the Operative Central Otago District Plan (**request document**). Prepared by Brown and Company Planning Group. 1 March 2018.
   b. RMA 1991 Central Otago District Plan Explanatory Statement Proposed Plan Change 13: River Terrace.[6]
   c. PHS submission on PC13 dated 20 June 2018.
   d. Council Summary of Decisions Requested: PC13.[7]
   e. PHS further submission by on PC13 dated 26 October 2018.
   f. Report of Planning Consultants Johnston Whitney pursuant to section 42A of the Resource Management Act 1991 (**S42A Report**) re PC13. Prepared by David Whitney. 21 March 2019.
   g. Evidence of Mr Jeffrey Andrew Brown for RTDL dated 23 April 2019.
   h. NZS 8409:2004 Management of Agrichemicals. Wellington.
   i. Deveau, Jason. (undated). Airblast 101, A Handbook of Best Practices in Airblast Spraying. 4th Edition. Canada.

SCOPE OF EVIDENCE

10. It appears that air quality has been somewhat overlooked. Council has noted potential reverse sensitivity issues arising from spraydrift from the existing orchard on future residents in their s42A report.[8] However, no evidence on spraydrift has been provided by the applicant.

11. My evidence will address:

[6] Undated. Available at www.codc.govt.nz

[7] Undated. Available at www.codc.govt.nz

[8] Council also reported that potential reverse sensitivity and spraydrift issues were noted by five submitters. CODC, (2019). At s7.10.4.6 page 53.

a. The relationship between land use and discharges to air and current regulatory requirements.
b. A need to include separation distances (buffers) between existing land uses and new activities sensitive to discharges to air from these existing land uses in PC13.
c. Proposed separation distances and mitigation in PC13.
d. The inability of no-complaints covenants to mitigate potential adverse air quality effects arising from locating incompatible activities within close proximity.
e. My recommended minimum separation distances for inclusion in PC13.

12. An important limitation of my evidence is that I have not visited the site in person. I have relied upon visual information available in Google maps at the time of writing this evidence. I have also liaised with the owner of Suncrest Orchard (Mr Michael Jones) regarding agrichemical use at his orchard.

LAND USE AND DISCHARGES TO AIR

13. National good practice air quality guidance states (MfE, 2016): [9]

> *Under section 31 of the RMA, territorial authorities have responsibility to control land use, and to achieve integrated management of the use, development or protection of land and associated natural and physical resources of the district. This includes effects of land use on air quality and on amenity values.*
>
> *District rules specify the type of activities, including industries that are allowed in different areas or zones.*

14. National guidance goes on to note (MfE, 2016): [10]

> *Maintenance of appropriate separation distances is primarily a land-use planning issue that is managed through district plan provisions, which may include:*

[9] MfE, (2016). At s1.3.7.

[10] MfE, (2016). At s3.9.4.

- *encouraging appropriate location of industry within an area that is zoned for industry in the district plan and is adequately separated from more sensitive zones, with provisions to exclude sensitive activities from the buffer area*

- *graduated zoning from heavy industry through to light industry and on to highly sensitive land uses such as residential. Councils have to balance this against making sure that the availability of industrially zoned land is not eroded over time*

- *creating zones and zone provisions (or other planning provisions such as overlays) that alert prospective owners, developers and decision-makers to the potential for reverse sensitivity effects if new sensitive activities are established in particular locations*

- *buffer distances in district or regional plans for determining activity status (eg, the Auckland Operative Air, Land and Water plan specifies new poultry farms with more than 180,000 birds and a buffer distance of less than 400 metres as discretionary).*

Separation distance provisions are included in a number of regional and district plans around New Zealand. These provisions are generally not absolute requirements; rather they determine the status of activities in the plan. This approach allows flexibility and recognises that there may be circumstances where a lesser separation distance is appropriate.

15. Accordingly, national air quality guidance, and planning guidance,[11] recommend the prudent use of **separation distances** (buffers) to manage:

    a. The potential effects of unintended or accidental discharges;
    b. The adverse effects of activities that cannot always be internalised even with the adoption of best practice; and/or
    c. Reverse sensitivity effects.

16. I support the use of separation distances in district plans to manage these issues.

[11] See for example, The Quality Planning Website. District Air Quality Planning. Available at: http://qualityplanning.org.nz/node/719. Accessed 6 May 2019.

CURRENT REGULATORY REQUIREMENTS

17. The Otago Regional Air Plan similarly supports the use of separation distances, and specifically for (integrated land use) management of spraydrift. Policy 17.2.1.2 regarding land use planning states (my emphasis added):

> *The Otago Regional Council will encourage Otago's city and district councils to control the adverse effects on air quality from land use activities and in particular those involving dust,* ***agrichemical application*** *or potentially odorous discharges through district plans, land use consents or education and information by:*
>
> *(1) Achieving physical separation of incompatible land uses through buffer zones or shelter belts;*
> *(2) Recognising existing use rights and reverse sensitivity; and*
> *(3) Encouraging people undertaking land use activities to manage the effects of their activities through following codes of practice or environmental management systems where appropriate.*

18. Standard 4.7.6.A(d) in the Central Otago District Plan mandates separation distances (buffers) for piggeries in the rural resource area. These depend on the number of pigs, ranging from 500 metres to 2,000 metres for intensive farming with more than 2,000 pigs, and are (presumably) set to manage odour issues. There are, however, no explicit separation distances for agrichemical application in the Central Otago District Plan. As noted by Ms Megan Justice the District Plan does have provisions to manage spraydrift through the resource consent process.[12]

19. The national code of practice for the management of agrichemicals *NZ Standard 8409:2004 – Management of Agrichemicals* (**NZS 8409**)[13] provides agrichemical buffer guidelines as shown in **Table 1**.

[12] Statement of evidence of Megan Justice dated 16 May 2019.

[13] NZS 8409:2004 Management of Agrichemicals is approved as a Code of Practice (No. HSNOCOP 3-1 09-04) pursuant to sections 78 and 79 of the Hazardous Substances and New Organisms Act.

Table 1 NZS 8409:2004 Agrichemical Buffer Guidelines

Application method	Distance (metres)	
	With shelter	Without shelter
Boom sprayer	2	10
Airblast sprayer	10	30
Aerial application	100	300

Note –

These distances are subject to:

(a) The equipment used (boom, Airblast, aircraft) being calibrated and operated correctly.

(b) All other appropriate strategies being observed to reduce spray drift hazard (Table 2)

(c) Shelter should be complete and without gaps at the base.

20. Mr Jones of Suncrest Orchard advised me that they employ two Airblast sprayers in their orchard adjacent to proposed PC13.[14] They have not previously employed aerial spraying and have no current plans to do so. Mr Jones further advises that the pine tree shelter belt between Suncrest Orchard and the proposed residential development is mature, the trees being 20 – 30 metres high with no lower branches (i.e. gaps at the base and all the way up the mature trees). [15] It is not, therefore, an effective agrichemical spray shelter belt. In the absence of effective shelter, the applicable NZS 8409 guideline separation distance would be 30 metres.

21. It is relevant to note that the purpose of NZS 8409 is to provide means of compliance with four hazardous substances regulations,[16] however, with respect to the Resource Management Act 1991 (**RMA**) the code is less definitive noting only (my emphasis added):[17]

[14] Personal comm. Michael Jones. 9 May 2019.

[15] Personal comm. Michael Jones. 9 May 2019.

[16] NZS 8409:2004 at Preface, page 2.

[17] *Ibid.* at Forward, page 9.

*Conforming to this Standard **may** also satisfy the requirements of the Resource Management Act and the resource plans prepared by local authorities with respect to agrichemical use.*

22. Compliance with the NZS 8409 buffer guidelines may not, therefore, provide assurance the purpose of the RMA will be satisfied. I find this to be the case as I consider 30 metres to be an inadequate separation distance between residential activities and (Airblast) agrichemical application for reasons which are explained further below. I consider the buffer guidelines in NZS 8409 may more appropriately be considered as *minimum* buffer guidelines.

23. What will satisfy the RMA is consistency with the objectives and policies, and compliance with the rules, of the Regional Air Plan for Otago. Objective 6.1.2 of the Regional Air Plan is (my emphasis added):

> *To **avoid** adverse localised effects of contaminant discharges into air on:*
>
> *(a) Human health;*
>
> *(b) Cultural, heritage and amenity values;*
>
> *(c) Ecosystems and the plants and animals within them; and*
>
> *(d) The life-supporting capacity of air.*

24. Policy 12.1.1 for agrichemical spraydrift further states the Otago Regional Council will (my emphasis added):

> *(a) Require the applicators of agrichemicals to undertake spraying in a manner that **avoids**:*
>
> *(i) Spray drift beyond the target area or boundary of the property being sprayed; and*
>
> *(ii) **Adverse effects** on human health and safety, ecosystems, sensitive areas or places, amenity values and other non-target areas or species; and*
>
> *(b) Encourage city and district councils to use land use planning mechanisms and other land management techniques to mitigate adverse effects from agrichemical spray drift.*

25. Rule 16.3.9.2 of the Regional Air Plan for Otago classifies discharges to air from agrichemical application on orchards as a *permitted activity* providing:

(a) *The agrichemical and any associated additive are authorised for use in New Zealand and are used in accordance with the authorisation; and*

(b) *The discharge is carried out in accordance with the manufacturer's directions; and*

(c) *The discharge does not exceed the quantity, concentration or rate required for the intended purpose; and*

(d) *The application does not result in any ambient concentrations of contaminants at or beyond the boundary of the property that have noxious or dangerous effects.*

26. Schedule 4 of the Regional Air Plan requires any person discharging agrichemical sprays to, *inter alia*, observe the following:

> *Make use of appropriate and effective buffer zones and/or shelter belts to minimise the risk of spray drifting to non-target areas.*

27. Schedule 4 of the Regional Air Plan further sets out detailed good practice requirements to avoid or minimise adverse effects on the environment from agrichemical application. Schedule 4 has adopted drift hazard guidance from NZS 8409 as shown in **Table 2**, (which follows).

28. Based on my review of the application and agrichemicals employed at Suncrest Orchard and the requirements of Schedule 4 of the Regional Air Plan, I consider the overall potential drift hazard for PC13 as **high** based on:

a. Lack of any buffer zone (high);

b. Proximity (of the existing orchard) to sensitive area (< 100 m = high);

c. Particle (droplet) size (150 – 200 µm = moderate); and

d. Shelter belts (no effective shelter = high);

e. Toxicity (some Class 6.1A substances = high).[18]

[18] Further details at [32]

Table 2 Regional Air Plan/NZS 8409 Drift hazard guidance chart

Potential drift hazard scale			
Factor	**High hazard**	**Low hazard**	**Comments**[19]
Wind speed	Zero/very low (<1 m/s or >6 m/s)	Steady (1 – 3 m/s)	Measure or estimate using smoke
Wind direction	Unpredictable	Predictable, and away from sensitive areas	Use smoke to indicate
Humidity	Low (delta T>8°C)	High (delta T<4°C)	Measure, using whirling psychrometer
Atmospheric stability	Inversion layer present	No inversion layer	Use cold smoke to indicate
Maximum height of release of agrichemical	>1.5 m above the target	< 0.5 m above the target	Application technique (see 5.3.4.2)[1]
Particle (droplet) size	< 50 microns diameter	> 250 microns diameter	See Q1[2]
Volatility of agrichemical	High (vapour pressure >10 mPa)	Low (vapour pressure <0.1 mPa)	Check product label, SDS or PSC
Sensitive area	Close (<100 m away)	Non, or more than 1,000 m distant	Identify on property protocol (see M4)[3]
Buffer zone	None	Yes (>100 m)	Guideline only
Shelter belts	No shelter	Live shelter, >3 m high and 1 m thick	Not for herbicides
Toxicity	Class 6.1A, B, C, D	Class 6.1E	Check label

NOTE –

(1) The potential drift hazard scale is given as high or low, and intermediate situations should be rated accordingly. For example, a drop size of 150 microns diameter would represent a moderate drift hazard.

(2) Some factors can be changed to reduce the hazard rating, e.g. use lower volatility chemical, larger droplet size.

(3) All of the weather related factors are to be assessed at the application site.

(4) Toxicity of the agrichemical has been included on the chart, but of a schedule heading is only one indicator of toxicity and is not always sufficient. In all cases, users should select the least toxic agrichemical that is suitable for the specific application. Check the label and product information.

(5) 1 m/s = 3.6 km/hr; 6 m/s = 20 km/hr (approx.).

[19] Schedule 4 of the Regional Air Plan (adopted in 2003) refers to the 1999 version of NZS 8409 (i.e. NZS 8409:1999). However, the drift hazard guidance chart in Schedule 4 is identical to the most recent version of NZS 8409 (NZS 8409:2004) with two exceptions (i) the latter publication has an additional comments column; and (ii) the latter publication has updated toxicity specifications. As the (Toxic Substances Act 1979) toxicity requirements in Schedule 4 have been superseded, Table 2 reproduces NZS 8409:2004 and includes this additional and updated text (with grey highlight).

29. As noted above, NZS 8049 recommends a (minimum) buffer guideline of 30 metres (in the absence of effective shelter) but at a practical level, I consider that this not adequate to *avoid* potential adverse effects from spraydrift. Irrespective of the calibrated droplet size, there will always be a fraction of spray that is fine aerosol. Fine aerosols travel significant distances (e.g. hundreds of metres). A separation distance of 30 metres *might* be adequate to avoid adverse effects when conditions are perfect (for example when there is a steady predictable wind blowing away from sensitive receptors). However, I do not consider that a separation distance of 30 metres (with an ineffective shelter belt) would be adequate to avoid adverse effects in less than perfect conditions (for example if the wind changes and/or picks up).

30. This difference between guidance and practice is recognised in the Regional Air Plan and the national code of practice NZS 8409. **Table 2** outlines factors that contribute to spray drift hazard. The guide states that the spray drift hazard is high when there is a sensitive area within 100 metres. Spray drift hazard is low when sensitive areas are 1,000 metres away.

NEED FOR SEPARATION DISTANCES IN PC13

31. PC13 proposes to develop a residential area adjacent to a large orchard (Suncrest Orchard), which employs agrichemicals to control pests and weeds. PC13 therefore, introduces a potential reverse sensitivity effect whereby residents may be exposed to spraydrift from the existing activity.

32. To protect their fruit, Suncrest Orchard employs a wide variety of pesticides to reduce the risk of resistance. Typical pesticides employed at Suncrest to protect summer fruit and pip fruit include:

    a. Insecticides – carbamate, organophosphate and synthetic pyrethroids;
    b. Herbicides –glyphosate (roundup) and glufosinate; and
    c. Fungicides – benzimidazole, carboxamide, triazole and strobilurins.

33. With respect to potential health effects of such chemicals the US EPA notes:[20]

> *The health effects of pesticides depend on the type of pesticide. Some, such as the organophosphates and carbamates, affect the nervous system. Others may irritate the skin or eyes. Some pesticides may be carcinogens. Others may affect the hormone or endocrine system in the body.*

34. However, it is also important to note (MoH, 1998):[21]

> *Spraydrift occurs via deposition drift and aerosol/vapour drift. The principal source of human exposure is deposition drift leading to exposure by dermal contact and ingestion. Field measurements indicate that inhalation of aerosol or vapour spraydrift is a minor route of human exposure.*

35. My evidence focuses on recommending the prudent application of separation distances to *avoid* exposure as opposed to calculating potential human health risk. This is consistent with the objectives and policies of the Regional Air Plan which primarily seek avoidance of adverse effects of discharges to air on human health. Accordingly, the toxicity of the pesticides listed in [32] will not be discussed other than to note that it is well established that exposure to pesticides can result in adverse human health effects.[22]

PROPOSED MITIGATION AND SETBACKS

36. The request document for PC13 proposes:[23]

> *The RTRA proposes a 5m setback from the boundary with a 2m buffer planting strip adjacent to the boundary (2m height at planting, and at an effective density) which will be adequate to mitigate the effects of spray drift or agrichemicals from the boom spray and air blast spray application techniques.*

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[20] US EPA, (2019). *Human Health Issues Related to Pesticides*. [Online]. Accessed 13 May 2019.

[21] Ministry of Health, (1998). *The Investigation and Surveillance of Agrichemical Spraydrift Incidents Guidelines for Public Health Services*. Wellington. June. Available at www.moh.govt.nz. At page 10.

[22] See for example, Kim K *et al.*, (2017). Exposure to pesticides and the associated human health effects. *Sci Total Environ*. Jan 1;575:525-535.

[23] River Terrace Developments Ltd, (2018). At page 64.

37. Mr Jeffrey Brown's evidence has amended this proposal to include the provision of a 3-metre high fence between Suncrest Orchard and future residential activities (but no change to the proposed 5 metre setback).[24]

38. Suncrest Orchard grows primarily cherries, but also apples, pears, peaches and nectarines. Mr Jones advises that the fruit trees are well established ranging up to 4 metres high. This suggests that the proposed 2 metre high planting, augmented with a 3 metre high fence, would be inadequate because it is necessary to spray to at least to the height of the trees (i.e. 4 metres). I have previously discounted the existing (very tall) pine trees as an effective agrichemical spray shelter belt because, being mature, they have gaps at the base and all the way up.

39. Agrichemical application involves the spraying of thousands of litres per hectare.[25] **Attachment B** provides some photographs of Airblast spraying in operation to give an idea of the scale and size of agrichemical application. In my view the 2 metre high planting, 3 metre high fence and absence of any significant separation distance will not be adequate to mitigate potential adverse effects from spraydrift.

40. The proposed setback of 5 metres is significantly less than the 30 metre (minimum) buffer guideline in NZS 8409 (that I consider inadequate for the reasons outlined at [29]).

NO-COMPLAINTS COVENANTS

41. No-complaints covenants may be appropriate to manage amenity effects; however, they provide no actual *mitigation*. They cannot, therefore, address potential adverse health effects that may arise due to exposure to spraydrift discharges to air.

RECOMMENDED SEPARATION DISTANCE FOR PC13

42. Establishment of a sensitive area within 100 metres of the Suncrest Orchard would increase the spray drift hazard (as defined in the Regional Air Plan) to **high**. This could

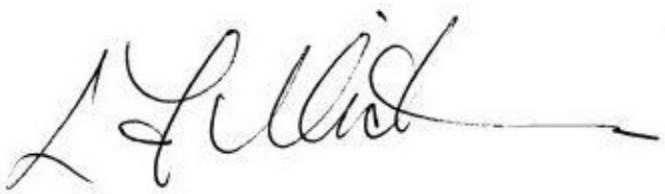
[24] Primary Statement of Evidence of Mr Jeffrey Brown dated 23 April 2019 at [4.24]

[25] It should be noted that the active ingredient, e.g. chlorpyrifos, typically comprises only a very small (<0.1%) of this amount.

significantly affect the ability of the orchard to undertake their spray activities while also placing residents in a high-risk location.

43. In my view the 30 metre (minimum) buffer guideline for spray application of agrichemicals in the national code of practice (NZS 8409) is inadequate and offers insufficient protection to avoid potential adverse effects from pesticide exposure from spraydrift. This is especially true of abnormal operation, for which separation distances are recommended as a good practice land use planning tool.

44. For these reasons I consider that more reasonable separation distance between residences and agrichemical application (by Airblast sprayer) would be at least 100 metres. This would provide a more reasonable distance for dispersion in the event that something goes wrong (e.g. change in wind direction during spraying). A key reason for specifying air quality separation distances is to prudently manage unintended or accidental discharges.



Louise Wickham

16 May 2019

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NZS 8409:2004. Management of Agrichemicals. Wellington.

ATTACHMENT A CURRICUM VITAE: LOUISE WICKHAM

March 2019

With degrees in both chemical engineering and environmental law, Louise is an air quality expert with a comprehensive understanding of both applied science and resource management. Louise has 25 years' experience working for both private and public sectors in New Zealand, Australia and the United Kingdom on all aspects of air quality management including:

- *Local, regional and national air quality policy and regulation*
- *Techniques and best practice for assessing the effects of discharges to air*
- *Air pollution control*
- *Odour control and assessment*

Louise is an experienced presenter and has acted as an expert witness, Commissioner and Chair in numerous public hearings under the Resource Management Act 1991.

Current Position

Director and Senior Air Quality Specialist, Emission Impossible Ltd (since 2011)

Qualifications

Master of Environmental Law, University of Sydney, Australia, 2003
Bachelor of Chemical and Materials Engineering, University of Auckland, New Zealand, 1993
Certified decision maker under Resource Management Act 1991 (current until 31 Dec 2020)

Academic and Employment History

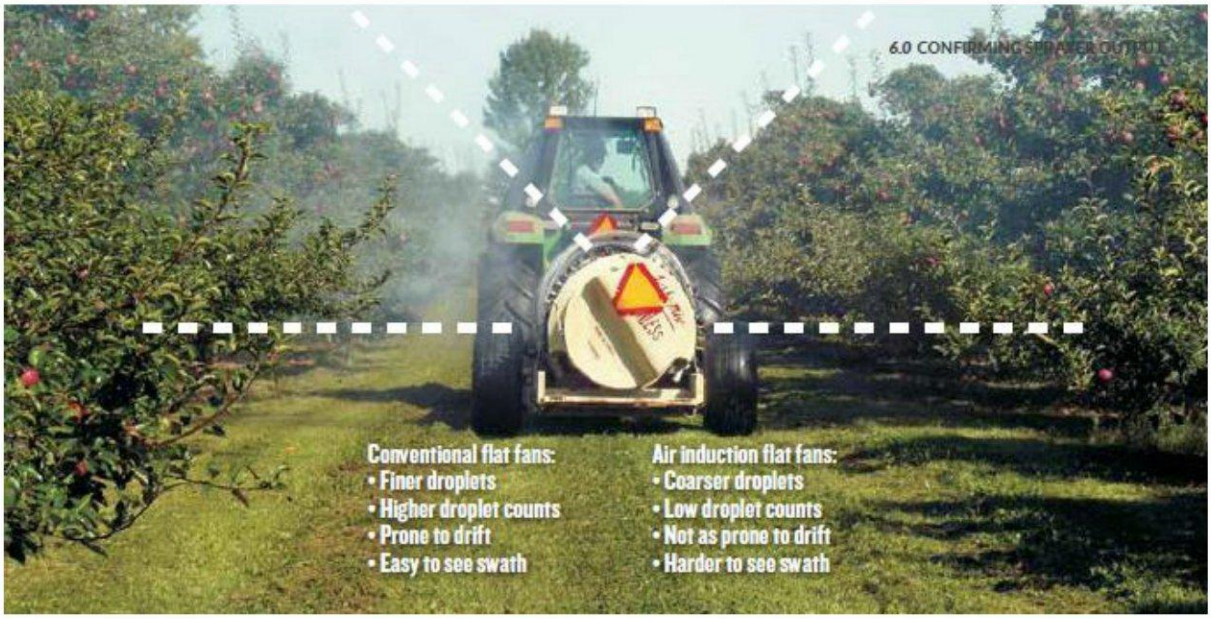
Senior Analyst, Ministry for the Environment, New Zealand (8 years)
Senior Policy & Programmes Officer, NSW Environment Protection Authority, Australia (2 years)
Senior Engineer - Air Quality, URS Australia Pty Ltd, Australia (4 years)
(Contract) **Environmental Engineer,** Environment Protection Authority Victoria, Australia (3 months)
Business Area Manager – Air Quality, RSK Environment Ltd, United Kingdom (2 years)
(Contract) **Project Manager**, Dames & Moore, United Kingdom (3 months)
Environmental Engineer, Woodward-Clyde NZ Ltd, New Zealand (3 years)
Undergraduate Engineer, Tasman Pulp & Paper, New Zealand (9 months)

Professional and Other Involvement

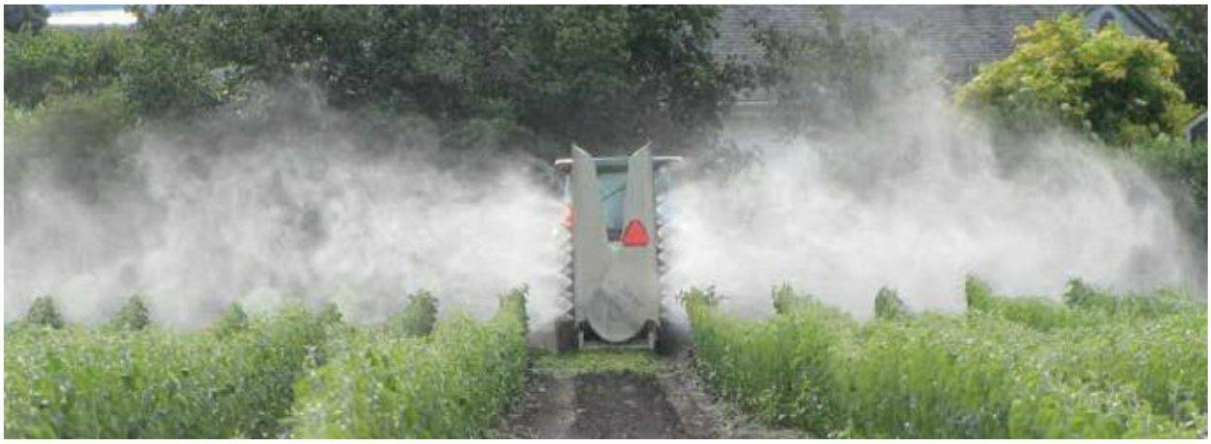
Member, Resource Management Law Association
Member, Clean Air Society of Australia and New Zealand
Approved Commissioner, Auckland Council Independent Panel

ATTACHMENT B PHOTOGRAPHS OF AIRBLAST SPRAYING

All photographs from *Airblast 101, A Handbook of Best Practices in Airblast Spraying*.



Handbook, page 102



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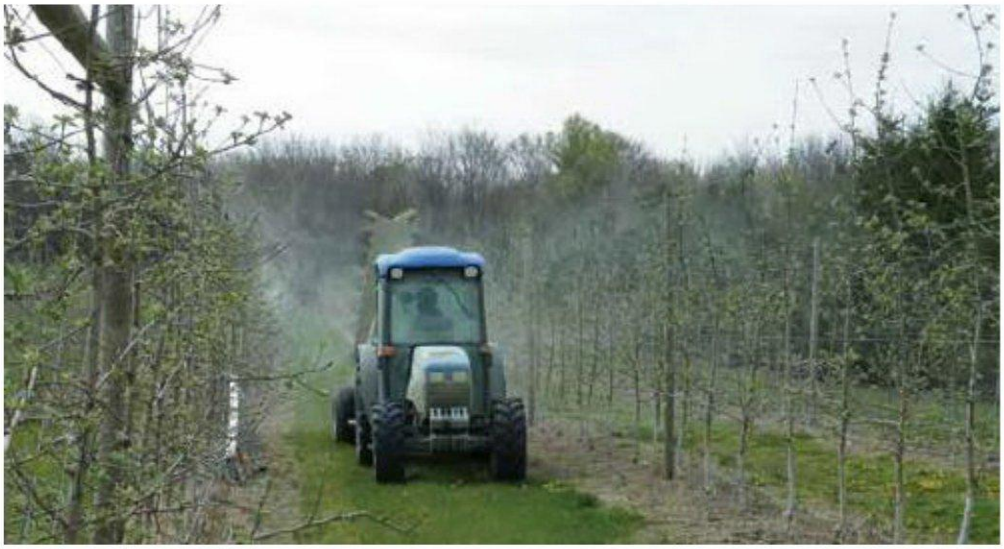

Handbook, page 56

Handbook, page 91