CHRISTCHURCH CITY COUNCIL

IN THE MATTER	THE RESOURCE MANAGEMENT ACT 1991
A N D	
IN THE MATTER	OF THE HEARING OF SUBMISSIONS ON PROPOSED PLAN CHANGE 14 (HOUSING AND BUSINESS CHOICE) TO THE CHRISTCHURCH DISTRICT PLAN
AND	A SUBMISSION BY RAVENSDOWN LIMITED (SUBMITTER #243)

STATEMENT OF EVIDENCE OF RICHARD LESLIE CHILTON

AIR QUALITY SCIENTIST

TONKIN & TAYLOR LTD

20 SEPTEMBER 2023

INTRODUCTION

Qualifications and experience

1 My full name is Richard Leslie Chilton.

2 I am an Air Quality Scientist with Tonkin & Taylor Limited (**T+T**), where I hold the positions of Technical Director - Air Quality and Discipline Manager of Environmental Engineering. I have 24 years' experience in air quality assessment and management. This includes working as a consultant since 2004 and prior to that working as an air quality officer for the Auckland Regional Council where I was involved in consenting, compliance and enforcement duties.

3 I hold the following qualifications, membership and certification:

- a Bachelor of Science (Geography)
- b Master of Science (Honours) in Environmental Science
- c Member of the Clean Air Society of Australia and New Zealand (CASANZ)
- d Certified Air Quality Professional (CAQP)

4 I have been extensively involved in assessing discharges to air from (and presenting expert evidence) in relation to industrial discharges. Some notable examples include the following:

- a 2020-2022: Assessment of discharges to air associated with the continued operation of the Ravensdown Limited Napier Works site where it manufactures superphosphate – discharges from this site are analogous to those from the Christchurch Works;
- b 2007: I was involved in the preparation of the air quality assessment for Ravensdown Christchurch Works as part of its resource consent application to renew its air discharge permit.
- c 2019-2020: The assessment of emissions from the continued operation of the New Zealand Oil Refinery at Marsden Point as part of renewal of its air discharge management plan. For the New Zealand Refining Company.
- d 2006 – present. Assessment of air discharges from various Fonterra dairy manufacturing plants throughout New Zealand, including: Edendale, Stirling, Studholme, Clandeboye, Darfield, Brightwater, Takaka, Kaikoura, Pahiatua, Hautapu, Waitoa, Te Awamutu, and Kauri sites.
- e 2014-2019: Preparation of the air quality assessments for the consenting of the City Rail Link project in Auckland. This included assessments of construction and operational effects associated with all sections of the project and subsequent detailed dispersion modelling assessment of the operation discharges from the rail tunnel.

5 I have also presented expert evidence to the hearings panel considering the Proposed Canterbury Regional Plan (CARP) on behalf of Fonterra. I was also involved in presenting expert evidence to the hearings panel considering the Proposed Auckland Unitary Plan ("PAUP") in relation chapters on air quality and the provisions for industry zones for New Zealand Starch Limited.

Involvement in the project

6 I have been asked by Ravensdown Limited (**Ravensdown**) to provide expert air quality evidence in relation to its submission on Proposed Plan Change 14 (**PC14**) to the Christchurch City Plan (**CCP**). In particular, to provide evidence in relation to the potential reverse sensitivity air quality effects on Ravensdown's **Christchurch Works** arising from proposed **PC14**.

7 I have been to the subject site on a number of occasions, and I am familiar with the locality. I was involved in preparing the air quality assessment[1] for the site as part of the application to the Canterbury Regional Council in 2007 for a new resource consent to discharge contaminants into air from the existing acid and fertiliser manufacturing and related activities (**CRC080001**). Additionally, I have undertaken air quality assessments for Ravensdown's two other superphosphate manufacturing sites in Napier and Dunedin.

8 In preparing this evidence I have read the following documents:

a Ravensdown's submission (#243) with regard to PC14.

b The air quality assessment submitted with the resource consent application for its current air discharge permit by Ravensdown in 2007. Golder Kingett Mitchell, 2007. Assessment of Air Discharges – Ravensdown Fertiliser Hornby Works, Christchurch.

c A stack height options assessment in relation to Ravensdown's Acid Plant. Golder Associates 2010. Ravensdown Fertiliser Co-operative Limited, Hornby Works – Assessment of Acid Plant Stack Height Options.

CODE OF CONDUCT

9 I confirm that I have read the Code of Conduct for expert witnesses contained in the 2023 Environment Court Practice Note and that I agree to comply with it. I confirm that I have considered all the material facts that I am aware of that might alter or detract from the opinions I express. In particular, unless I state otherwise, this evidence is within my sphere of expertise, and I have not omitted to consider material facts known to me that might alter or detract from the opinions I express.

PURPOSE AND SCOPE OF EVIDENCE

10 The purpose of my evidence is to address the potential reverse sensitivity air quality effects of proposed Plan Change 14 (herein referred to as '**PC14'**) as they relate to Ravensdown's submission on **PC14** and the impacts on its **'Christchurch Works'**. Further details of Ravensdown's submission are provided in the evidence of **Ms Jane Whyte**.

11 My evidence is structured as follows:

a A general discussion of reverse sensitivity air quality effects for air quality and how these are recognised by the Ministry for the Environment (**MfE**), and managed under the Canterbury Air Regional Plan (**CARP**),

[1] Golder, 2007. Assessment of Air Discharges – Ravensdown Fertiliser Hornby Works, Christchurch. Report prepared by Golder Kingett Michell for Ravensdown Fertiliser Co-operative Ltd.

b A description of an example of reverse sensitivity air quality effects that I have experienced with an industry in Auckland that is analogous to the issue that is faced by Ravensdown in relation to **PC14**;

c The nature of discharges to air from Ravensdown's Christchurch Works;

d The consequence of increasing the height of residential building adjacent to the Ravensdown Site, and how doing so increases potential exposure to air contaminants compared with what is currently allowed to occur.

SUMMARY OF EVIDENCE

12 [To be completed]

REVERSE SENSITIVITY AIR QUALITY EFFECTS STATUTORY CONTEXT

Definition

13 Reverse sensitivity air quality effects occur where a new activity increases the sensitivity of the area to necessary discharges from a legally established industrial activity.

14 I describe how MfE good practice guidance for air quality assessment and the CARP treat this issue in the following paragraphs.

Ministry for the Environment good practice guides

15 Reverse sensitivity air quality effects are a recognised issue for industrial activities and are described in various Ministry for the Environment (**MfE**) Good Practice Guides (**GPG**) relating to air discharges, such as that for odour[2], dust[3], and for industrial discharges[4]. The GPG for assessing discharges to air from industry describes reverse sensitivity as follows:

> *"Reverse sensitivity occurs when sensitive activities, such as residential properties, are allowed to locate where they may be adversely affected by existing industrial or noxious activities. This has the adverse effect of limiting the ability of the industry or noxious activity to operate efficiently and with long-term certainty. Allowing sensitive activities to establish in close proximity to existing industry can potentially result in adverse effects on the health, safety or amenity values of people, as well as potentially adversely affecting the economic and safe operations of industries."*

Canterbury Air Regional Plan objectives and policies relating to reverse sensitivity

16 The Canterbury Air Regional Plan (**CARP**) includes objectives and policies that recognise and seek to manage reverse sensitivity air quality effects in relation to industrial activities discharging to air. In particular, I note the following objectives and policies:

> *Objective 5.7: Discharges from new activities are appropriately located to take account of adjacent land uses and sensitive activities.*

---

[2] MfE 2016a. Good Practice Guide for Assessing and Managing Odour. Ministry for the Environment.
[3] MfE 2016b. Good Practice Guide for Assessing and Managing Dust. Ministry for the Environment.
[4] MfE 2016c. Good Practice Guide for Assessing Discharges to Air from Industry. Ministry for the Environment.

Objective 5.8: Discharges from existing activities are managed in response to evolving characteristics of the receiving environment.

Policy 6.9: Discharges into air from new activities are appropriately located and adequately separated from sensitive activities, taking into account land use anticipated by a proposed or operative district plan and the sensitivity of the receiving environment.

Policy 6.10: If the sensitivity of the receiving environment is altered by authorised land use change so that an existing discharge results in significant adverse effects on the receiving environment, require the effects of that discharge to be reduced and provide a reasonable timeframe for achieving that reduction.

17 Objective 5.8 and Policy 6.10 are relevant to Ravensdown given it is an existing consented activity. This objective and policy place an onus on Ravensdown to monitor and respond to changes in its receiving environment, such as that sought by **PC14**, in order to enable its ongoing operations at its Christchurch Works.

EXAMPLE CASE IN AUCKLAND

18 Reverse sensitivity effects in relation to air discharges often occur when sensitive activities are allowed to establish closer (in a horizontal sense) to a discharge source. However, they can also occur when sensitive activities are allowed to establish vertically adjacent to a discharge stack as well.

19 I have direct experience of an instance where this occurred when I worked as an Air Quality Officer for the Auckland Regional Council (1999-2004). During that time, I was involved in processing of resource consents for discharges to air, as well as compliance and enforcement in relation to those consents. The discharges with which I was involved in regulating in this capacity included those from an established flexible packaging manufacturing operation (Huhtamaki Van Leer Limited[5]) located in west Auckland. Air emissions from the operation were discharged via a number of tall stacks.

20 As a result of a district plan change authorised by the Waitakere City Council, it became possible for a high-rise apartment block to be constructed on a property adjacent to this industry, with balconies and windows that opened at a similar height of the discharge stacks.

21 Following the establishment of the apartment block and residents moving in, I was involved in responding to and investigating a complaint made to the Auckland Regional Council by the new residential neighbours in relation to the emissions from the established industry. The resulting outcome for the industry was that the effects of its discharges on the new residential activities were such that it was no longer able to operate in compliance with its environmental obligations at that location.

[5] Air discharge permit 22459, File 14/10/Air/14027, issued by Auckland Regional Council

NATURE OF THE DISCHARGES TO AIR FROM RAVENSDOWN

Overview

22 To understand the potential for reverse sensitivity effects on Ravensdown, it is important to provide some context in relation to Ravensdown's operation and its discharges to air.

23 Ravensdown manufactures superphosphate fertiliser at its Christchurch Works. Superphosphate is manufactured by reacting phosphate rock with concentrated sulphuric acid that is manufactured on-site.

24 Discharges to air from the site are authorised under the site's air discharge permit (CRC080001), which sets out an extensive number of conditions that must be met, including various discharge limits, extensive monitoring requirements, complaints procedures, and survey requirements, aimed at managing the site's off-site air quality affects.

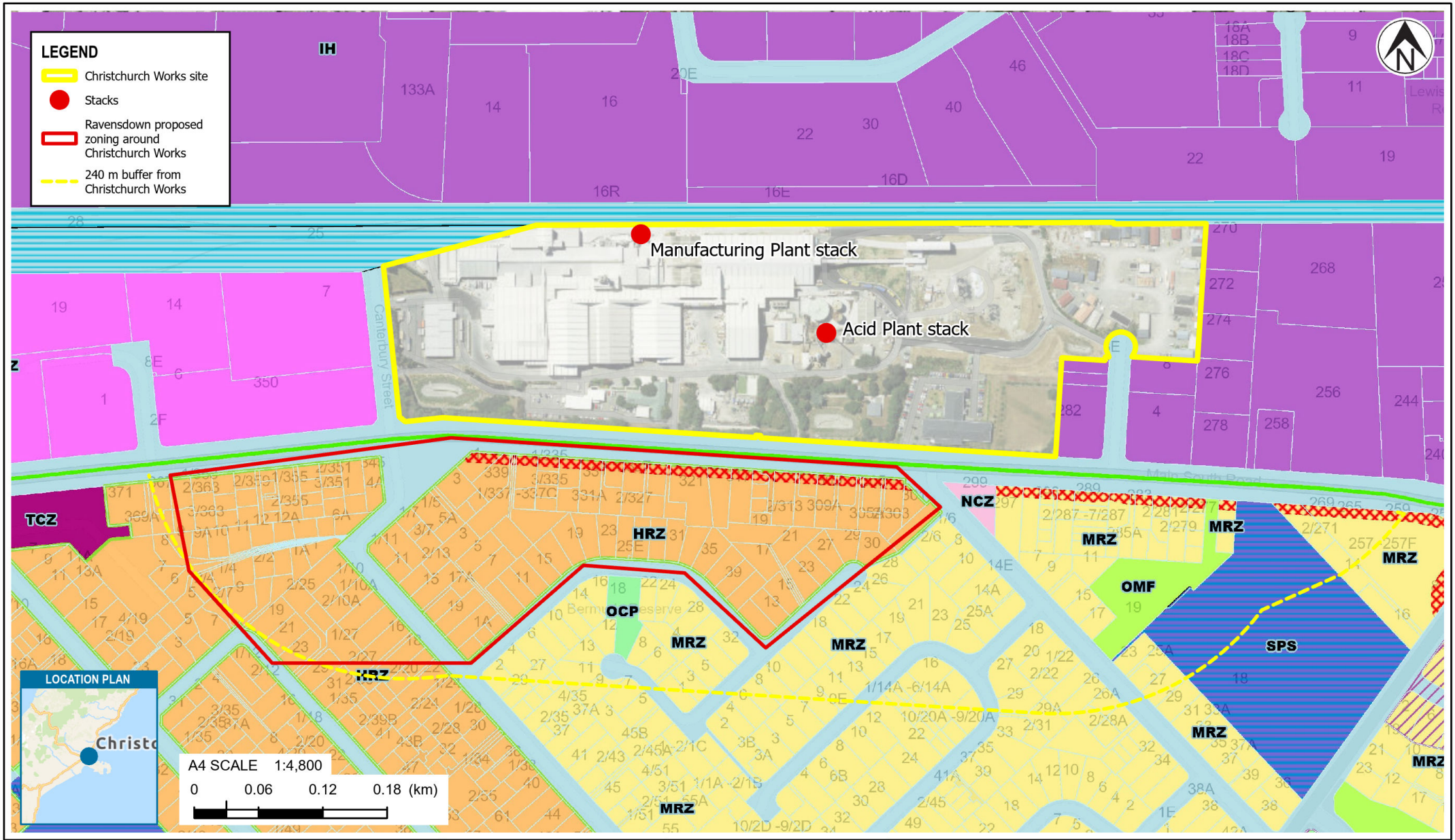
25 The manufacturing process involves two distinct stages that each give rise to air emissions. Emissions from the process stages are carefully controlled using emission control technology, with the residual emissions being discharged via tall stacks that promote atmospheric dispersion. These stages are:

a The manufacture of sulphuric acid (Acid Plant). This process gives rise to the discharge of sulphur dioxide (SO_2) gas, in particular, which after scrubbing to minimise the discharge is discharged via a tall 60 m high stack.
The MfE describes SO_2 as a potent respiratory irritant when inhaled, causing symptoms of wheezing, chest tightness, shortness of breath or coughing, with epidemiological studies showing significant association between daily average SO_2 levels and mortality from respiratory and cardiovascular causes.

b The manufacturing of superphosphate (Manufacturing Plant), where sulphuric acid is reacted with ground phosphate rock. This process gives rise to emissions of fluoride gas (which is a constituent of phosphate rock). The fluoride emissions from the reaction are captured and scrubbed prior to being discharged via a tall 42 m high stack.
Fluoride is principally a concern in terms of its impacts on vegetation (with there being a number of ambient air quality guidelines in this regard) and its ability to cause clouding of glass surfaces, which can be an amenity concern for neighbours. It is less of a concern in terms of potential human health effects, with guidelines for human health being particularly high relative to concentrations typically experienced in the receiving environment as a result of Ravensdown's discharges.

26 The amount of SO_2 and fluoride that can be discharged from the discharge stacks are limited by conditions of CRC080001. The location of the two discharge stacks is shown in Figure 1. This figure shows the Christchurch Works in the context of the zoning proposed by PC14 and is annotated with the area set out in Ravensdown's submission where it seeks relief in relation to the **HRZ** within 240 m of its site.

P:\1091430\WorkingMaterial\GIS\Hornby\Hornby.aprx Layout: Figure 1 - Christchurch Works re PC14 2023-Sep-18 12:27 pm Drawn by RICH



Tonkin+Taylor

www.tonkintaylor.co.nz

Exceptional thinking together

NOTES:

NZ Hybrid Reference (Vector): Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors.. NZ Navigation Map: Eagle Technology, LINZ, StatsNZ, NIWA, Natural Earth, © OpenStreetMap contributors.. NZ Imagery: Eagle Technology, Land Information New Zealand, GEBCO, Community maps

REVISIONS	NO.	BY
First version (14/09/23)	0	RICH

PROJECT No. 1234567.1000		
DESIGNED	RICH	SEP.23
DRAWN	RICH	SEP.23
CHECKED		
APPROVED		DATE

CLIENT **RAVENSDOWN LIMITED**

PROJECT **RAVENSDOWN CHRISTCHURCH WORKS**

TITLE CHRISTCHURCH WORKS IN RELATION TO PLAN CHANGE 14 ZONES

SCALE (A4) 1:4,800 FIG No. FIGURE 1. REV 0

28 The underlying planning map also shows a small strip of land (10 m in width) indicated by red hatching to the south of Ravensdown's site that is a 'Residential-Industrial Interface Qualifying Matter' (**RII-QM**). For reasons that I will set out later in my evidence, I consider the extent of the **RII-QM** is inadequate for managing reverse sensitivity air quality effects on Ravensdown's Christchurch Works.

29 Discharges from the stacks will disperse and dilute in the atmosphere before reaching the ground level at the neighbouring properties. The ambient air concentrations at this point can then be assessed against relevant air quality criteria. Air quality criteria are comprised of two components: A concentration value, typically expressed in units of micrograms per cubic metre (µg/m³); and a time period that the concentration is averaged over. The relevant air quality criteria in relation to SO_2 and fluoride are summarised in Table1.

Table1: Relevant air quality criteria in relation to SO_2 and fluoride

Contaminant	Concentration (µg/m³)	Averaging period	Reference
SO_2	570 (not to be exceeded) 350 (9 allowable exceedances per year)	1-hour	NES_{AQ}
	120	24-hour	AAQG
Fluoride *(Vegetation – general land use)*	3.7	12-hour	AAQG
	2.9	24-hour	
	1.7	7-day	
	0.84	30-day	
	0.5	90-day	

Note: NESAQ = NZ National Environmental Standards for Air Quality; AAQG = NZ Ambient Air Quality Guidelines;

30 Ravensdown's operation also gives rise to a number of other discharges to air but those occur much closer to ground level and are less of a concern in relation to the reverse sensitivity issue being presented here.

Purpose of tall stacks

31 The purpose of tall stacks is to augment dispersion and dilution of residual emissions (i.e., the discharge post emission control systems), to reduce contaminant concentrations to which people may be exposed by the time the emission plume reaches sensitive neighbours (e.g., residential areas). This concept is schematically illustrated in Figure 2, which conceptually illustrates how contaminant concentrations reduce from the centre of the plume, both vertically and horizontally, but also with distance from a stack.

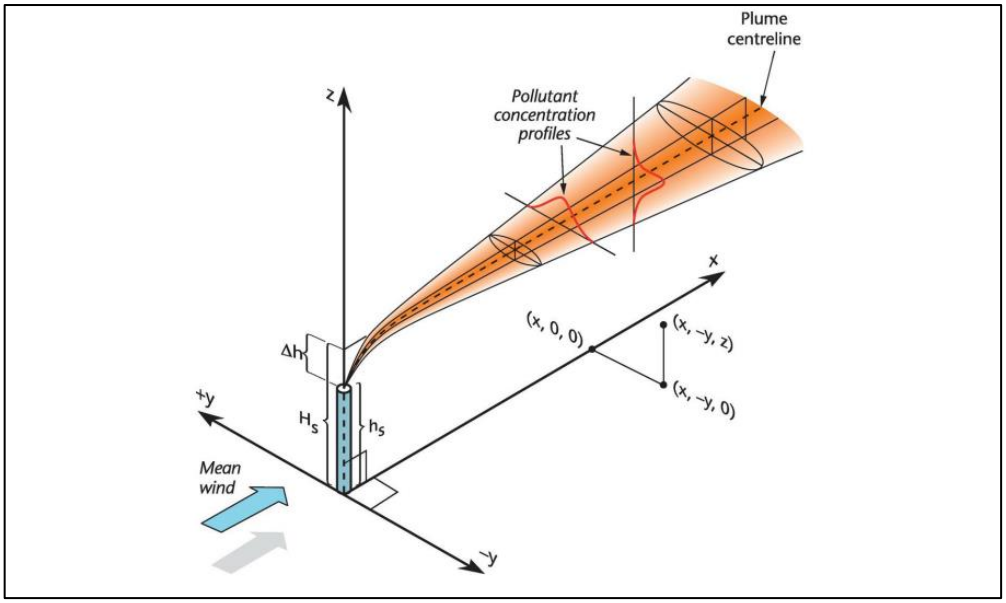


Figure 2: Schematic illustration of plume dispersion from an industrial stack[6]

32 Because **PC14** proposes to increase the height of residential buildings that can be established opposite Christchurch Works, there is the potential for the upper storeys of those buildings to be exposed to higher concentrations at the point where the plume from the stack meets those upper storeys (than would be currently experienced at residences located nearer to ground level). The resulting potential for exposure to higher contaminant concentrations thereby creates a reverse sensitivity effect on the discharging activity (Christchurch Works in this case).

ASSESSMENT OF PC14 IMPACTS ON CHRISTCHURCH WORKS

Purpose and approach

33 The extent to which **PC14** would change the sensitivity of the residential area to the south of the Ravensdown Site to air contaminants, is in my opinion a relevant reverse sensitivity consideration given the potential for sensitive land uses to move vertically into an area not previously occupied where ambient air contaminant concentrations resulting from Ravensdown's operation are likely to be higher.

34 This reverse sensitivity outcome would be facilitated as a consequence of **PC14** and the proposed rezoning of the land to the immediate south of the Christchurch Works to High-density Residential Zone (**HRZ**), due to the increased provisions for building heights within that proposed zone. In this regard I understand that the **HRZ** would:

a Permit residential buildings up to 14 m in height (i.e., 4 storeys)

b Provide a consent pathway for residential buildings of up to 20 m (6 storeys)

[6] https://www.envitrans.com/air-dispersion-modeling.php

c Provide a consent pathway for buildings over 20 m where a Town Centre Intensification Precent applies.

35 To better understand the potential reverse sensitivity air quality effect of **PC14** on the Christchurch Works, I have undertaken an air dispersion modelling assessment to predict concentrations at various heights above ground level.

36 Dispersion modelling is a tool that allows prediction of ambient air concentrations resulting from a discharge source at locations in the surrounding area. It uses information on emission rates, stack configuration, and local meteorology (among other inputs).

37 A dispersion modelling assessment was used to inform the air quality assessment for Ravensdown's resource consent application in 2007 to renew its air discharge permit, which I was involved in preparing. That assessment followed current standard dispersion modelling practice of predicting concentrations at ground level, which is appropriate in my opinion for low-rise residential receiving environments.

38 I have used the same dispersion modelling approach to assess the implication of **PC14** on the Christchurch Works. However, I have also configured the model to predict contaminant concentration at several heights above ground level, representing the mid-point of each floor of a building being considered. The different scenarios that I modelled are as follows:

a Ground level – 0 m (this essentially represents the scenario that is the basis for Ravensdown existing resource consent)

b 3 storeys – 9.5 m

c 4 storeys – 11.5 m

d 6 storeys – 17.8 m

e 8 storeys – 23.8 m

f 10 storeys – 30 m

Results

39 **Appendix A** provides the results of my dispersion modelling investigation with the spatial distribution of predicted ambient contaminant concentration visually displayed as contour plots. This is done for each contaminant and for selected time-averaging periods to illustrate the change in concentration associated with the model scenarios representing ground-level, 3, 4 and 10 storey building heights. These contour plots are intended to enable a simple visual comparison of the change in predicted concentrations with increasing height above ground.

40 **Appendix A** also provides charts showing graphically how concentrations increase with height for all of the scenarios.

41 The following provides my summary of the findings from these contour plots:

a There are relatively small increases in contaminant concentrations for residential properties up to 4-storeys in height, although the horizontal extent of impact increases.

b At heights above 4 storeys, the concentrations increased notably with the potential for SO_2 concentrations to approach or exceed the NES_{AQ} (1-hour average of 570 µg/m³) and AAQG (24-hour average of 120 µg/m³). Those

increases would be significant in my opinion and would likely impact on Ravensdown's ability to manage its off-site air quality effects to an acceptable level.

c Similarly, fluoride concentrations are relatively unchanged up to 4 storeys but increase notably above this. While the levels are not of concern in terms of human health effects, they are a concern in so far as the amenity effect of glass clouding. Ravensdown currently operates a glass replacement programme with its neighbours where this has happened. This would be exacerbated with multi-storey buildings where the upper levels would be subject to higher exposure to fluoride. Should the glass require replacing on taller buildings, this would be more difficult due to the need for double-glazed units and the need for scaffold and/or cranes to facilitate the replacement of panes.

d The spatial extent of where the increase in concentrations with height occurs is aligned well with the relief sought by Ravensdown:

i To extend the **RII-QM** buffer to the south of the Christchurch Works to include an area land within 240 m of the Industrial Heavy Zone (**IHZ**) that overlays the **HRZ** (this area is shown in red in each contour plot given in Appendix A as well as Figure 1); or alternatively

ii To rezone the same area from **HRZ** to **MRZ.**

42 Based on my findings, I support the relief set out in the evidence of **Ms Whyte**.

CONCLUSION

43 In summary, it is my opinion that:

a PC14 will enable taller buildings housing people to be established south of Ravensdown's Christchurch Works. This will have the effect of allowing people to reside at higher elevations and be exposed to higher concentrations of contaminants discharged from Ravensdown's tall stacks than current occurs. In my opinion, PC14 will cause a reverse sensitivity air quality effect on Ravensdown.

b Ravensdown's operations at the site discharge sulphur dioxide (SO_2) and fluoride, which occur primarily from two tall discharge stacks,. Exposure to high concentrations of SO_2 has the potential to cause adverse human health effects. Fluoride gas, by comparison, is less of a concern in terms of human health effects, but does have the potential to cause clouding of glass, thereby creating an amenity issue.

c I have used air dispersion modelling to assess the reverse sensitivity air quality effects of PC14. Specifically, I have modelled the discharges of SO_2 and fluoride gas from the Christchurch Works to understand how concentrations vary in the adjacent residential area with increasing height above ground level. From this I have concluded that contaminant concentrations at heights up to 4-storeys are unlikely to have a significant impact, but above that height the concentrations increase markedly, to the extent that in my opinion they would likely impact on Ravensdown's ability to manage its off-site air quality effects to an acceptable level.

Dated: 20 September 2023

_____

Richard Leslie Chilton

APPENDIX A – RESULTS

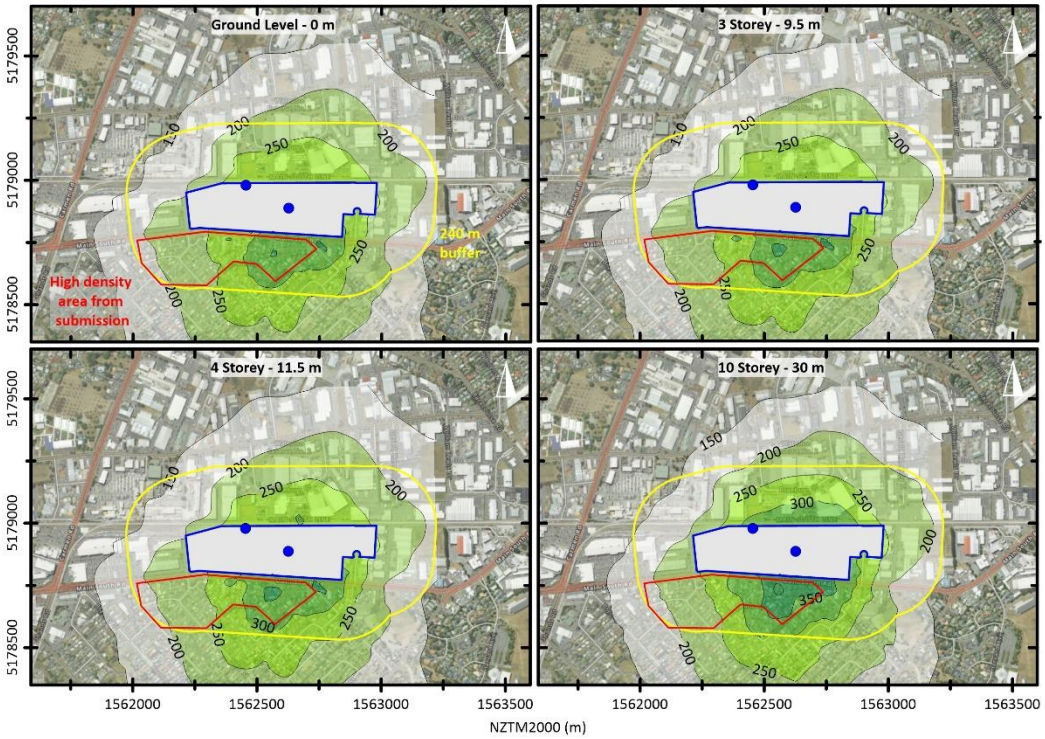


Figure A.1: Predicted 1-hour average SO_2 concentrations

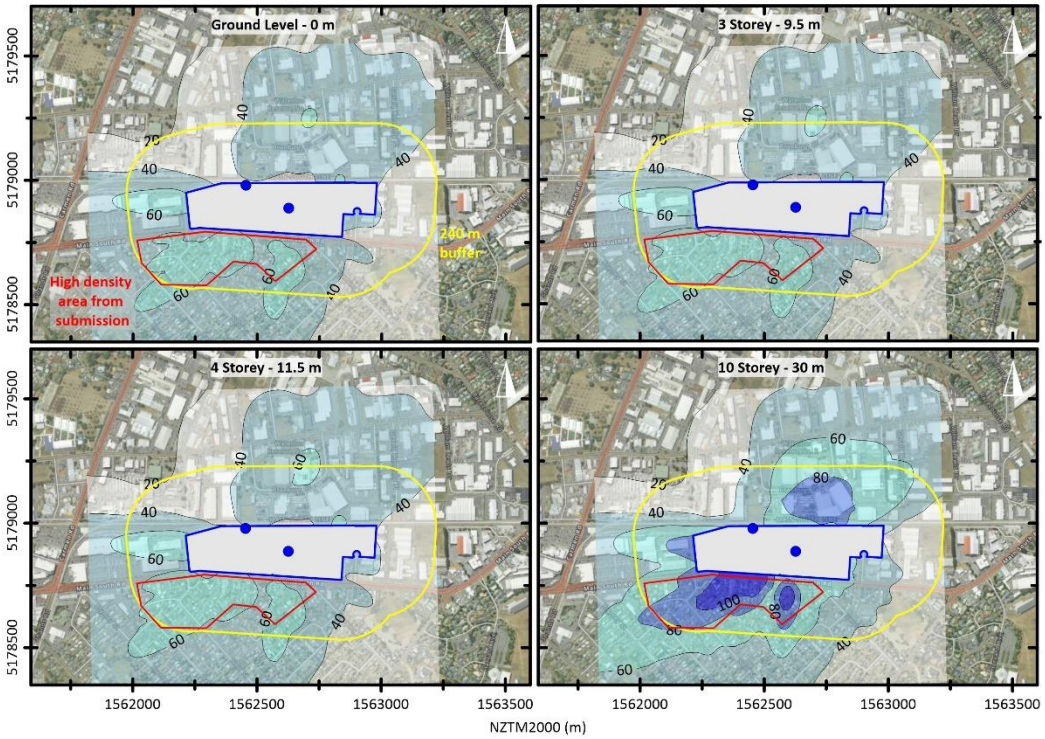


Figure A.2: Predicted 24-hour average concentrations

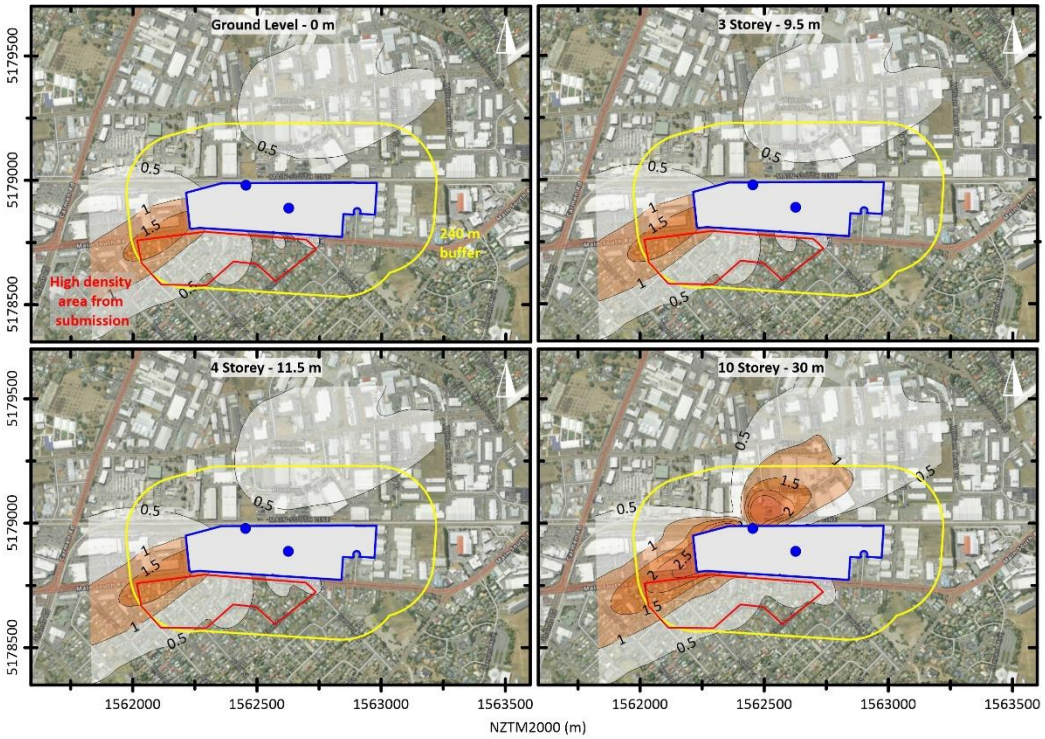


Figure A.3: Predicted 7-day average fluoride concentrations

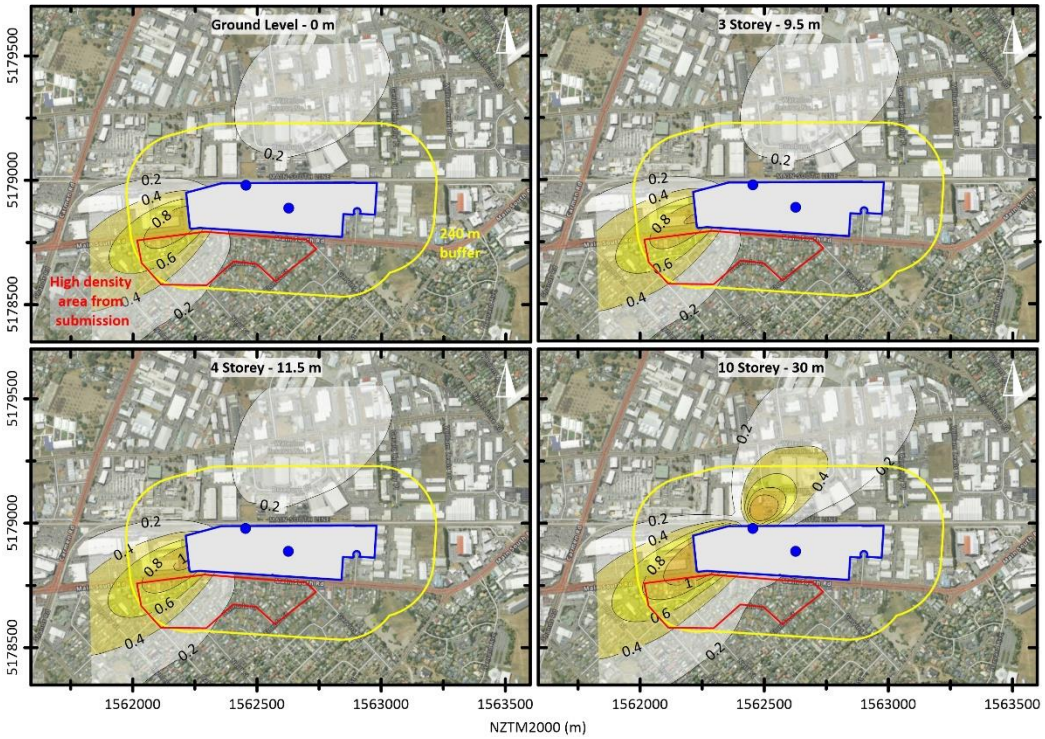


Figure A.4: Predicted 90-day average concentrations

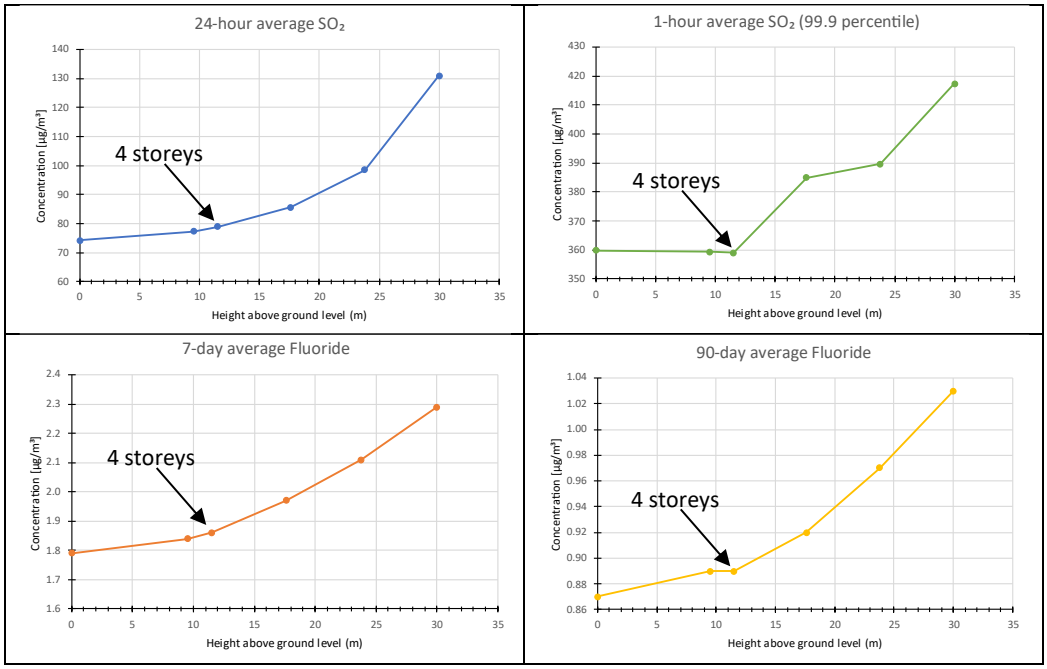


Figure A.5: Results for most impacted receptor location with increasing height above ground level

p:\1091430\workingmaterial\3. evidence\evidence_10923.docx