BEFORE THE SOUTH TARANAKI DISTRICT COUNCIL

INDEPENDENT HEARING PANEL

IN THE MATTER of the Resource Management Act 1991

AND

IN THE MATTER of the proposed South Taranaki District Plan

STATEMENT OF EVIDENCE BY LOUISE WICKHAM

On behalf of Taranaki Energy Watch

6 June 2016

1.0 Introduction

1 My name is Louise Fleur Wickham. I am a Senior Air Quality Specialist at Emission Impossible Ltd. I have been in this position since April 2011.

2 I have been retained by Taranaki Energy Watch (TEW) to provide advice on air quality issues associated with petroleum exploration and production activities in relation to land use planning in the Proposed South Taranaki District Plan (Proposed Plan).

3 I hold the academic qualifications of Bachelor of Chemical and Materials Engineering from the University of Auckland and a Masters of Environmental Law from the University of Sydney. I am a certified Resource Management Act decision maker and a member of the Resource Management Law Association and the Clean Air Society of Australia and New Zealand.

4 I have over 20 years' experience in air quality gained in New Zealand, Australia and the United Kingdom and split equally between 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 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 technical air quality guidance.[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. Further details of my qualifications and relevant past experience are contained in Attachment A.

6 In preparing this evidence I have reviewed the following documents:

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[1] For example:
Ministry for the Environment, (2011). *New Zealand domestic solid fuel burner authorisation manual*: March 2011 edition, March.
Ministry for the Environment, (2008). *Good practice guide for assessing discharges to air from land transport*, June. (co-author)
Ministry for the Environment, (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)*, October.

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

[4] For example:
Ministry for the Environment, (in press). *Good practice guide for assessing and managing odour*, (lead author).
Ministry for the Environment, (in press). *Good practice guide for assessing discharges to air from industry*, (co-author)
Ministry for the Environment, (in press). *Good practice guide for assessing and managing dust*, (co-author)
Auckland Council, (2014). *Use of background air quality data in resource consent applications*, GD2014-01, July.
See also 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.

6.1 Relevant parts (Sections 1, 2, 8, 12, 13 and 20 only) of the Proposed South Taranaki District Plan (Proposed Plan) dated 15 August 2015

6.2 Submissions by Petroleum Exploration and Production Association, the Oil Companies, and Shell Todd Oil Services on the Proposed Plan all dated 12 October 2015

6.3 *Section 42A Officer's Report: Energy* for the Proposed South Taranaki District Plan prepared by Mr Hamish Wesney dated 27 May 2016

6.4 Various technical air quality reports by Taranaki Regional Council. The specific items are referenced where relevant in my evidence

6.5 Regulatory guidance on flaring and separation distances in relation to petroleum exploration and production by a variety of international jurisdictions. The specific items are referenced where relevant in my evidence.

2.0 Code of conduct

7 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 hearing panel. 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.

8 I am engaged by Taranaki Energy Watch (TEW) as an independent expert. My company Emission Impossible Ltd provides advice on air quality issues to a range of clients including community groups, local government, central government and private industry. I do not behave as an advocate for any party. I have no other interest in the outcome of the proceedings.

3.0 Scope

9 My evidence will specifically address the following:

- Sources of discharges to air from oil and gas exploration and development;
- Potential health effects of these air discharges; and
- Good practice air quality planning with recommendations for separation distances and minimum exclusion zones.

10 My focus is largely on air quality matters from a health perspective. However, amenity issues (i.e. odour and dust) arising from petroleum exploration and production activities would be similarly addressed through my recommendations for separation distances and minimum exclusion zones.

11 My evidence is primarily operational and does not cover environmental or health impacts arising from discharges to other media such as land or water. I defer to Ms Jenny Polich on matters of serious risk, including accidental discharges to air (these largely being overtaken by other matters such as immediate risks to life and property). I defer to Mr Greg Carlyon on matters of planning.

4.0 Sources of discharges to air from oil and gas exploration and development

12 From a harmful emissions perspective, there are two primary sources of discharges to air from oil and gas exploration and development:

- Flaring
- Fugitive sources

These are discussed in turn below.

13 I note that discharges of methane (a greenhouse gas) from exploration and development of oil and gas are also widely acknowledged as being significant,[5] and significantly underestimated.[6] However, my evidence will concentrate on discharges to air that are relevant to local public health to inform the STDC District Plan.

Flaring

14 Flaring is the burning of natural gas in an open flame. A flare (as referred to in Regulation 27 of the *Resource Management (National Environmental Standards for Air Quality) Regulations 2004*) is like a Bunsen burner in a science laboratory, but on a much larger scale. A metal pipe (the flare stack) carries gas to the top where a pilot light ignites the gas. The flare may have steam injection at the nozzle or burner tip to reduce discharges of oxides of nitrogen. The flare may also have a liquids separator, known as a knockout drum, which removes water and petroleum liquids from the gas stream before it reaches the flare stack so that the gas burns more efficiently. [7] (This is not particularly high tech, a knock drum is simply a metal container that allows the gas to expand and condense en route to the flare stack).

15 It is well established that "*flaring wastes potentially valuable natural gas and produces emissions that can affect human health, livestock and the environment*".[8] As a result there has been international action to ban routine flaring and to dramatically reduce flaring during all other activities. (There will always be a need for flaring to safely dispose of gas during equipment failures, power outages and other emergencies or upsets in

[5] US EPA, (2013). *Natural Gas STAR Program.* https://www3.epa.gov/gasstar/basic-information/index.html Accessed 4 May 2016.

[6] Miller *et al.*, (2013). Anthropogenic emissions of methane in the United States. *Proceedings of the National Academy of Sciences of the United States of America*. Vol 110. No. 50. 20018-20022. Available at: http://www.pnas.org/content/110/50/20018. Accessed 4 May 2016.

[7] CCEI, (2007). *Flaring: Questions and Answer.* Second Edition. Robert D. Bott. Canadian Centre for Energy Information. Available at: www.centreforenergy.com. At page 4.

[8] CCEI, (2007). At Introduction.

drilling or processing operations). There is a Global Gas Flaring Reduction Partnership that includes 18 countries from the United States to Nigeria, Uzbekistan and the Russian Federation, all the major oil companies and the European Union and the World Bank.[9]

16 For example, the Canadian Centre for Energy Information reports that from 1998 to 2005, the total amount of flaring in Alberta was reduced by 54 per cent despite strong growth in natural gas exploration and production.[10]

> Despite a tripling of the number of wells drilled annually since the mid-1990s, the total amount of natural gas flared during well tests in Alberta declined due to new procedures and regulations, and venting during well tests was almost eliminated.

17 This has been achieved by a combination of:[11]

- Containment of natural gas and delivery to customers;
- Burning in properly designed incinerators (which are generally more efficient than flares);
- Using natural gas to generate electricity and steam (e.g. microturbines); and/or
- Underground injection.

18 It is therefore disappointing to see that flaring still routinely occurs in Taranaki. Further that flaring in pits is still common practice (unconfined burning pits have been banned overseas).[12]

19 A full description of discharges to air from flaring is provided in Attachment B. Key discharges of harmful pollutants include:

- Benzene, toluene, ethylbenzene, xylene (BTEX compounds);
- Other volatile organic compounds (VOCs) including, acetylene, ethylene, propylene, styrene, 1,3-butadiene,
- Aldehydes including acetaldehyde, formaldehyde, acrolein, methyl ethyl ketone and benzaldehyde
- Polycyclic aromatic hydrocarbons (PAHs) including naphthalene, acenaphthene, anthracene, fluoranthene, pyrene, benzo(b)fluoranthene, benzo(e)pyrene, indeno(1,2,3-cd)pyrene, benzo(a)pyrene

[9] World Bank, (2016). *Zero Routine Flaring by 2030*, Global Gas Flaring Reduction Partnership (GGFR). http://www.worldbank.org/en/programs/gasflaringreduction. Accessed 4 May 2016.

[10] CCEI, (2007). At page 9.

[11] CCEI, (2007). At Introduction.

[12] World Bank Group, *(2004). *Regulation of Associated Gas Flaring and Venting, A Global Overview and Lessons from International Experience*. April. See for example Qatar at page 66. This 2004 report states all flaring in New Zealand is approved by the Minister for Commerce.

- Nitrogen dioxide
- Sulphur dioxide, sulphides (e.g. hydrogen sulphide, carbon disulphide) and mercaptans[13]
- Particulate matter
- Dioxins and furans

20 The above list contains a number of contaminants that are cancerous and/or known to be hazardous to human health (e.g. benzene, formaldehyde and particulate matter). It further includes nitrogen dioxide, particulate matter less than 10 micrometres in diameter (PM_{10}) and sulphur dioxide which are regulated in the *Resource Management (National Environmental Standards for Air Quality) Regulations 2004*.

21 However, flaring is essentially combustion in the open air and these discharges are very difficult to quantify accurately. The US EPA only provides emission factors for total hydrocarbons and total volatile organic compounds, as opposed to individual contaminants.[14] As noted by James Seebold, a retired oil and gas engineer:[15]

> The external combustion of gaseous hydrocarbon mixtures by any means, including flaring, literally manufactures and subsequently emits to the atmosphere traces of all possible molecular combinations of the elemental constituents present either in the fuel or in the air including ozone precursor highly reactive volatile organic compounds (HRVOCs) and carcinogenic hazardous air pollutants (HAPs).

22 Actual discharges are influenced by, *inter alia*, flare design and the composition of the gas being combusted as well as external factors such as wind speed. Several scientific studies in the 1990s indicated that flare efficiency could be lower than previously believed. Specifically in cases of low gas flow rates and high winds, flare efficiency can be as low as 66 per cent under actual field conditions.[16] Poor flare combustion increases the amount of pollutants with potentially harmful human health effects that are emitted to air.

Fugitive sources

23 Fugitive discharges refer to those air pollutants that enter the atmosphere without first passing through a stack or duct designed to direct or control their flow.[17] Generally speaking, fugitive discharges to air from oil and gas activities are unintended leaks or

[13] Taranaki Regional Council, (2012). *Investigation of air quality arising from flaring of fracturing fluids - emissions and ambient air quality.* Technical Report 2012–03. Stratford. May.

[14] US EPA, (1995). Emissions Factors & AP 42, *Compilation of Air Pollutant Emission Factors*. Chapter 13.5, Industrial Flares. United States Environmental Protection Agency. Available at: https://www3.epa.gov/ttn/chief/ap42/ch13/index.html

[15] Seebold J. (2011). *Submission on 2010 TCEQ Flare Study Project Final Report [D R A F T] The University of Texas at Austin The Center for Energy and Environmental Resources May 23, 2011* Submitted by James G. Seebold, Chevron (Retired) Independent Consultant, Atherton, CA, June 20, 2011.

[16] CCEI, (2007). At page 16.

[17] Air and Waste Management Association, (1992). *Air Pollution Engineering Manual*. Edited by A. J. Bunicore and W. T. Davis. Van Nostrand Reinhold. New York.

irregular releases of gases. Key sources of fugitive discharges to air from oil and gas activities (excluding accidents and equipment failures)[18] are:

- Equipment leaks;
- Process venting; and
- Evaporation losses.

24 Venting is the release of natural gas directly into the atmosphere without flaring or incineration. The Canadian Center for Energy Information notes:[19]

> Most of the venting in Canada occurs during the production of crude oil and oilsands bitumen. Some natural gas is released at the wellhead as the oil or bitumen is brought to the surface, and some is released during treatment and storage. Although the quantities released at any given well are typically small, there are many such wells, so the total amount is significant. Venting also may occur during well testing – primarily from shallow, sweet, low-volume natural gas wells – and in the operations of natural gas wells, pipelines and processing plants. Changes in equipment and procedures have greatly reduced the amount of venting in Canada since the mid-1990s. In Alberta, for example, the total amount of venting dropped 55 per cent between 2000 and 2005.

25 Despite not being discussed in any assessment documents I have seen, it is reasonable to assume that process venting routinely occurs in Taranaki.

26 I also note that land farming is a potentially significant source of fugitive discharges to air (i.e. through volatilisation of hydrocarbons).

27 Fugitive discharges to air are not combusted and thus reflect the product or raw gas being extracted. The primary contaminants of concern are BTEX compounds (i.e. benzene, toluene, ethylbenzene and xylene), polycyclic aromatic hydrocarbons (PAHs) and volatile organic compounds (VOCs).

5.0 Potential health effects

28 Potential health effects of the pollutants discussed in paragraphs 12-27 can be characterised as follows:

(i) Acute (short-term) respiratory or cardiovascular adverse effects, e.g.

- sore eyes and throat from formaldehyde;
- aggravation of asthma from particulate matter; or
- nausea or headaches from (odorous) hydrogen sulphide and mercaptans.

[18] Addressed by Ms Jenny Polich in terms of risk.

[19] *Ibid.* At page 5.

(ii) Chronic (long-term) adverse effects, e.g.

- Post neo-natal respiratory mortality from particulate matter;
- Retarded lung development from nitrogen dioxide; or
- cancer from benzene.

29 However, actual health effects are determined by an individual's actual exposure to the pollutant in question. This in turn depends upon:

- Concentration (i.e. how much a person is exposed to). This is influenced by where the person lives in relation to the source of the pollutant, local topography, local meteorology, how *much* is emitted and *how* it is emitted;
- Frequency and duration (i.e. how often and how long a person is exposed); and
- Sensitivity of the individual (e.g. babies and children whose lungs are still developing are extremely sensitive to air pollution as are people with pre-existing respiratory conditions such as asthma).

30 South Taranaki is characterised by complex terrain and experiences winds from many directions. These factors mean that actual exposure is highly specific to each individual's location and circumstances.

31 For example, Jane living less than 500 metres from two well sites may spend all day in town working and only return home at night. Jane's house may also be in a location that is generally upwind of the well sites. Jane would therefore, have very little actual exposure to air discharges from the well sites.

32 Conversely, John living just over 500 metres from two well sites in a location that is generally downwind of all the well sites may work from home. John would have increased exposure to air discharges from the well sites compared with Jane who lives closer to the well sites.

33 The complexities of individual actual exposure do not lend themselves well to hard and fast rules from a planning perspective. Overall, I am inclined to agree with the Canadian Centre for Energy Information who summarises the issues as follows: [20]

> Many of the substances emitted by flaring, incineration and venting can affect humans, animals, plants and the environment. Effects depend on the magnitude, duration and frequency of exposure, as well as the susceptibility of the individual organism or environment.
>
> However, there is no question that high enough concentrations of petroleum-related emissions could affect the respiratory health, vision and skin of humans and animals. Exposure to some VOC and PAH substances increases the likelihood of cancers. VOCs,

[20] CCEI, (2007). At page 13.

NOx and particulate matter can cause smog. Odours can affect quality of life – for example, make it difficult for people to sleep.

34 In light of the adverse health effects caused by and/or associated with exposure to discharges to air from oil and gas activities I consider that these discharges warrant serious and careful attention from a regulatory perspective. Specifically, I consider that good practice, perhaps even *best* practice, air quality planning is warranted. This will support STDC promoting sustainable management of natural and physical resources whilst safeguarding the life supporting capacity of the air.[21] Equally important, it will assist STDC taking into account the need to maintain and enhance the quality of the environment.[22]

35 I note there has been no comprehensive air quality monitoring of toxic contaminants such as benzene undertaken in Taranaki.[23] This means that background air quality is not well characterised.

6.0 Good practice air quality planning

36 I have reviewed good practice air quality planning with respect to managing discharges to air from oil and gas exploration, development and production. This section of my evidence discusses that review and outlines recommendations to achieve the Energy objectives and policies in the Proposed Plan, namely to ensure:

36.1 the adverse effects of oil and gas activities are avoided, remedied or mitigated (Objective 2.9.7, Policy 2.9.10)

36.2 new sensitive activities and subdivisions do not create reverse sensitivity effects on the efficient operation of existing energy resource activities (Policy 2.9.12).

Flaring

37 International consensus supports urgent, and strategic, reduction in flaring.[24] Global initiatives to this effect are already well underway and practicable alternatives exist.[25] I recommend STDC consider including a new objective in the Proposed Plan to eliminate routine flaring altogether.

[21] s5(1) and s5(2)(a) Resource Management Act 1991.

[22] s14(1)(h)(ii) Local Government Act 2002.

[23] Taranaki Regional Council, (2013). *Air monitoring survey of hydrocarbon compounds (BTEX) in the Taranaki Region* dated 25 October 2013 is a screening survey of only a few locations for only a few hours using a method of low accuracy. A good example of comprehensive BTEX ambient air quality monitoring (i.e. continuous sampling over a period of more than a year) may be found at Auckland Council (2014), *Benzene, 1,3 butadiane and other volatile organic compounds in Auckland, 2001-2013*. Technical Report 2014/037. November. Available at: www.aucklandcouncil.govt.nz

[24] World Bank, (2016).

[25] See for example, CCEI, (2007).

Separation Distances

38 Good practice air quality planning, as stated on the Quality Planning website, states:[26]

> Regional councils and territorial authorities should consider using buffer zones and separation distances to manage pervasive effects (e.g. odour, dust and spray drift) or for incompatible land uses (e.g. motorways and early childhood education centres).

39 Similarly, the (Ministry for the Environment) *Good Practice Guide for Assessing and Managing Discharges to Air from Industry* notes:[27]

> Separation distances (buffers) are primarily intended to manage:
>
> - the effects of unintended or accidental discharges
> - the adverse effects of activities that cannot always be adequately avoided, remedied or mitigated without a separation distance, even with the adoption of best practice (for example, landfills)
> - reverse sensitivity effects.
>
> Separation distances are not intended as an alternative to source control. They are implemented in addition to pollution controls that are consistent with the best practicable option.
>
> Separation distances to sensitive land uses can be achieved in several ways:
>
> - appropriate location of industry within an area that is zoned for industry in the district plan, and is adequately separated from more sensitive zones
> - graduated zoning in district plans from heavy industry through to light industry and finally to highly sensitive land uses such as residential
> - ownership of the separation distance by the industry creating the discharge
> - use of notional boundaries or complaint covenants.

40 I also note support for separation distances in case law, most recently in *Craddock Farms v Auckland Council 2016*:[28]

> [124] We note the emphasis Mr Lee Marr, the applicant's planning witness, gave to the separation distances set out in the Auckland ALW Plan as merely setting the status of the activity that determines whether or not it is discretionary or restricted discretionary. The same could be said of the approach in other plans nationally given any setbacks or similar approaches are generally used as a trigger for a resource consent of different stringency. We think that is to unjustifiably downgrade the importance of the consideration that should be given to separation as an approach.

41 I agree that separation distances are a useful and important tool in good practice air quality planning and I recommend their inclusion in the Proposed Plan. However, also as noted in the *Good Practice Guide*:[29]

[26] http://www.qualityplanning.org.nz/index.php/planning-tools/air-quality/key-issues-for-air-quality-planning visited on 22 Apr 2016.

[27] MfE, (2015). *Good Practice Guide for Assessing and Managing Discharges to Air from Industry.* DRAFT for consultation. Wellington. The final version of this document (in press) is largely unchanged.

[28] 2016 NZEnvC 051

When considering an appropriate separation distance for a site, the assessor should always review the relevant guidance and ensure that the basis of the recommended separation distance is clearly understood.

42 In light of the potential health effects from to air discharges from oil and gas activities I therefore recommend the Proposed Plan specify minimum separation distances between new oil and gas exploration and development and sensitive activities *explicitly* for the purpose of managing:

42.1 **The effects of unintended or accidental discharges**, i.e. **fugitive emissions to air** from leaks, spills or small releases associated with normal operation. (I defer to the evidence of Ms Jenny Polich on low risk but high impact issues, e.g. fatality from explosion).

42.2 **The adverse effects of activities that cannot always be adequately avoided, remedied or mitigated without a separation distance**, even with the adoption of best practice (i.e., flaring discharges that impact beyond the relatively small footprint of the actual well site); and

42.3 **Reverse sensitivity effects** (i.e. to safeguard industry from encroachment by sensitive activities). I understand the oil and gas industry has made supportive submissions to this effect.[30]

43 In recognition of the toxic and carcinogenic nature of many discharges to air from oil and gas activities I recommend STDC consider adopting a prudent and careful approach to specifying separation distances. I recommend specifying separation distances that err on the side of being *more* protective of public health than less. To avoid being unduly onerous, I recommend that proposed oil and gas development within these separation distances require detailed assessment of people's exposure. This will promote sustainable management whilst safeguarding the life carrying capacity of the air. This recognises that whilst it's generally not a good idea to carry such activities out within the specified separation distance, there may be occasions or places where adverse air quality effects would not arise (within the separation distance).

44 However, I consider there is also a need to provide minimum baseline protection for specific oil and gas activities for which emissions and associated adverse health effects are well established. I therefore also recommend the inclusion of minimum exclusion zones, within which distance from sensitive activities, the specified oil and gas activities are *prohibited.* Where my recommendations are less than those recommended by Ms Polich on the basis of risk, the greater minimum exclusion zone should prevail.

45 I have reviewed existing regulatory practice for minimum separation distances and minimum exclusion zones for oil and gas activities overseas. There is wide disparity in approaches, some recommending minimum separation distances of 1,500 metres[31]

[29] *Ibid.*

[30] See for example submission to STDC by Petroleum Exploration and Production Association of New Zealand (PEPANZ) dated 12 October 2015 re provision 3.2.2 at page 7.

[31] South Australia EPA, (2007). *Guidelines for Separation Distances*. Adelaide. December. Base factor; adjusted factors 1,400 – 2,230 metres.

whereas others are as low as 250 metres.[32] The only guidelines explicitly addressing risk (i.e. of explosion or fire) support significantly higher separation distances; 2,000 metres.[33]

46 I note the dispersion modelling study undertaken by Taranaki Regional Council on flaring emissions. This study indicated that maximum concentrations from a flare pit occurred 600 metres downwind.[34] However, it is not possible to draw any meaningful, or transferable, conclusions from this study because:

- Flare emissions vary significantly depending, *inter alia*, on the gas composition, gas flow rate, flare combustion efficiency and flare design;
- Downwind concentrations vary significantly depending on flare release parameters (height, temperature, exit velocity), meteorology and topography.

47 The study was for a flare pit which is a ground source and not representative of typical, elevated flares. The study quantified only *some* constituents of the flare emissions. It was by no means rigorous or representative of all flare conditions, particularly high wind, low combustion efficiency conditions which are known to exist.

48 Importantly, the dispersion modelling study assumed flat terrain – which is not the case for South Taranaki, comprising mostly rolling hills or complex terrain.

49 I note that Taranaki Regional Council (TRC) has routinely required residential neighbours within 1,000 metres be notified prior to flaring.[35] I further note that TRC has a *de facto* minimum separation distance of 300 metres for flaring activities, these being either a controlled activity, or a restricted discretionary activity within this distance of a house.[36]

50 I also note the Canadian guidelines requiring 500 metres minimum separation distance between residences and land farms.[37]

51 In the absence of any rigorous scientific studies in New Zealand, and in recognition of the toxic and carcinogenic nature of many pollutants arising from oil and gas activities (both fugitive and flaring discharges), I recommend the reasonably prudent **separation distances** within which the specified activities should require **detailed assessment** of people's exposure as detailed in Attachment C and summarised in Table 1 which follows.

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[32] EPA Victoria, (2013). *Recommended Separation Distances for Industrial Residual Emissions*. Carlton. March.

[33] WA EPA, (2005). *Guidance for the Assessment of Environmental Factors (in accordance with the Environmental Protection Act 1986) Separation Distances between Industrial and Sensitive Land Uses*. June.

[34] Backshall D., (2013). *Atmospheric Dispersion Modelling of Discharges to Air from the Flaring of Fracturing Fluid*. Prepared for Taranaki Regional Council. March.

[35] See for example, Cheal A Wellsite Consent 4728-2. Available at www.trc.govt.nz

[36] Taranaki Regional Council, (2011). *Regional Air Quality Plan for Taranaki.* July. Rules 9-12.

[37] Government of Canada, (2006). *Federal Guidelines for Landfarming Petroleum Hydrocarbon Contaminated Soils*. Federal Contaminated Sites Action Plan. March. Editorial Update 2013.

52 In light of the increased risks of cancer associated with exposure to benzene,[38] and to *explicitly safeguard the life carrying capacity of the air* I further recommend the minimum exclusion zones within which the specified activities should be prohibited as outlined in Attachment C and summarised in Table 2 which follows.

53 Please note that the activity or land use type is the important feature of my recommendations to avoid adverse public health effects. From an air quality point of view, a person in a house on a farm is the same as a person in a house in a town because both are potentially living and breathing discharges to air from oil and gas activities for significant periods of time. Similarly, people working on farms spend considerable periods of time outdoors on land that may otherwise be viewed as unoccupied from a land use perspective.

54 This is where I diverge from Mr Wesney's view that oil and gas activities should "*not be prohibited or restricted, except in circumstances where the environment is particularly sensitive to the effects of these activities (e.g. coastal and urban environments).*"[39] This is because I consider the risks of cancer or other serious adverse health effects are not confined to urban environments, but any location were people may reasonably be exposed. In my opinion, when assessing the costs and benefits of separation distances for discretionary activities, it is necessary to consider the benefits of safeguarding the life supporting capacity of the air. To date, Mr Wesney has not done so.[40]

[38] IARC (1987). *Summaries & evaluations: Benzene (Group 1).* Lyon, International Agency for Research on Cancer, p. 120 (IARC Monographs on the Carcinogenicity of Chemicals to Humans, Supplement 7

[39] Section 42A Officer's Report: Energy for the Proposed South Taranaki District Plan prepared by Mr Hamish Wesney dated 27 May 2016 at paragraph 160.

[40] *Ibid.* at paragraph 205.

Table 1. Summary recommended air quality separation distances

Activity	Separation Distance (within which activity requires detailed assessment)
Petroleum exploration	
Drilling	
Single wellhead	300 m
Multiple wellheads	500 m
Flaring	1,000 m
Petroleum production	
Well operations including storage and handling:	
Single wellhead	300 m
Multiple wellheads	500 m
Flaring	1,000 m
Land farming	500 m

Table 2. Summary recommended air quality minimum exclusion zones

Activity	Minimum Exclusion Zone (within which activity prohibited)
Petroleum exploration	
Drilling	
Single wellhead	100 m
Multiple wellheads	300 m
Flaring	300 m
Petroleum production	
Well operations including storage and handling:	
Single wellhead	100 m
Multiple wellheads	300 m
Flaring	300 m
Land farming	100 m

Proposed Plan Minimum Distance Provisions

55 In consideration of the potential harmful effects from air discharges from oil and gas exploration and development I do not support the proposed permitted activity status for oil and gas activities within 200 m of residential housing (i.e. Rule 12.3.1.1 in association with Rule 13.1.1(c)(iii) of the Proposed Plan).

56 The Proposed Plan does not articulate any basis for these rules (such as those I have proposed in paragraphs 42.1 – 42.3) and the selection of a distance of 200 m appears unreasonably close given the toxicity and carcinogenicity of the discharges to air. I recommend petroleum exploration and production activities (including land farming) require detailed assessment of people's exposure. This will promote sustainable management whilst safeguarding the life carrying capacity of the air.

Matters for assessment

57 I concur with Mr Wesney's recommendation to introduce reverse sensitivity as a matter for assessment when considering resource consents for subdivisions.[41] This is helpful for protecting, *inter alia*, oil and gas activities from being encroached by residential development.

58 I therefore recommend the following amendment to that proposed by Mr Wesney for assessment matter 20.5.6:

> 20.5.6 Sensitive Activities on Sites near Other Activities and Infrastructure
>
> An assessment of the reverse sensitivity effects arising from a sensitive activity being located near an existing other activity or infrastructure shall be made that includes consideration of the following:
>
> (a) The frequency, duration, character and intensity of the relevant adverse effect;
>
> (b) The degree of effect on the relevant existing activity in its particular environment having regard to such factors as air quality, noise and visual amenity…

59 I further recommend that STDC require effects assessments for land use consent applications for oil and gas activities be sufficiently detailed so as to establish *people's (air quality) exposure* within the nominated separation distance. This would require proposals to consider the composition of the hydrocarbon gas stream to explicitly assess the key pollutants discussed in paragraph 19 in light of likely:

59.1 Concentration (i.e. how much a person(s) is exposed to);

59.2 Frequency and duration (i.e. how often and how long a person(s) is exposed); and

59.3 Individual sensitivity (particularly location of babies, children and others sensitive to air pollution)

[41] *Ibid.* at paragraph 265.

60 I suggest this be achieved by amending assessment matter 20.5.12 as follows:

> 20.5.12 Petroleum Exploration and Production Activities
> The following assessment matters will be used in assessing land use applications relating to Petroleum Exploration and Production activities:
> …
> (d) The effects of the use, storage, transport and disposal of hazardous substances.
> (e) The actual and potential air quality effects of the proposal including:
>
> (i) Concentration (i.e. how much a person is exposed to);
> (ii) Frequency and duration (i.e. how often and how long a person is exposed); and
> (iii) Individual sensitivity (particularly location of babies, children and others sensitive to air pollution).
>
> (ef) The actual and potential noise effects of the proposal…

Relationship between land use and air discharges

61 I note that Mr Wesney considers the effects of discharges of contaminants (to land) to be outside the jurisdiction of STDC.[42] It could be similarly argued that the Proposed Plan is not the appropriate statutory instrument for managing discharges to air (i.e. because discharges to air are primarily regulated under the regional plan). If so, it would not be appropriate to specify separation distances or minimum exclusion zones or to require detailed assessment of discharges to air for consideration of resource consent for land use.

62 Section 31 of the RMA outlines the primary function of territorial authorities is to manage the **effects** of land use. The above argument therefore, ignores this primary role of territorial authorities which is to manage the location of activities that may discharge contaminants to air (such as oil and gas activities). In line with good practice, and as recommended by the Ministry for the Environment[43] and the Quality Planning website,[44] I support the use of separation distances and minimum exclusion zones in the Proposed Plan to manage the effects of (discharges to air from) land use.

63 When considering land use consent, section 104(1)(b) of the RMA requires assessment of discharges of contaminants in the *Resource Management (National Environmental Standards for Air Quality) Regulations 2004* (NES for air quality). Schedule 4 further requires the assessment be commensurate with the scale and significance of the effects that the activity may have on the environment.

64 This is why, for example, the New Zealand Land Transport Agency currently prepares air quality assessment of effects when applying for land use consent for roads, despite motor vehicles being permitted activities in all regional plans in New Zealand.

[42] Section 42A Officer's Report: Energy at paragraph 156.

[43] MfE, (2015).

[44] See for example, http://qualityplanning.org.nz/index.php/planning-tools/air-quality/district-air-quality-planning. Accessed 30 May 2016.

65 As noted above, discharges to air from oil and gas activities include contaminants in the NES for air quality, as well as discharges to air that are toxic and carcinogenic. I therefore consider it mandatory to require assessment of air quality effects arising from oil and gas activities.

7.0 Conclusions

66 Oil and gas activities emit a large number of toxic and carcinogenic pollutants to air. In light of the seriousness of the adverse health effects caused by and/or associated with these pollutants, I have made a number of recommendations for good practice air quality planning for the Proposed South Taranaki District Plan. These reflect the requirements of the RMA for assessment of effects commensurate with the scale and significance of the activity and include:

a. Separation distances for oil and gas activities and land farms from sensitive activities explicitly for the purpose of managing:

   i. The effects of unintended or accidental discharges;
   ii. The adverse effects of activities that cannot always be adequately avoided, remedied or mitigated without a separation distance, even with the adoption of good practice; and
   iii. Reverse sensitivity effects.

b. Grant of land use consent for petroleum exploration and production to be conditional upon assessments that are sufficiently detailed so as to establish the potential exposure for any people within the separation distance; i.e.

   i. Concentration;
   ii. Frequency and duration; and
   iii. Sensitivity of the person(s).

c. Requirement to assess reverse sensitivity effects from *new* sensitive activities within the nominated separation distances of *existing* oil and gas activities and land farms.

d. Minimum exclusion zones for oil and gas activities and land farms from sensitive activities explicitly for the purpose of safeguarding the life supporting capacity of the air.

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Louise Wickham
6 June 2016

ATTACHMENT A CURRICULUM VITAE LOUISE WICKHAM

Career Summary

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

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)
(Contract) Senior Engineer – Air Quality, Woodward-Clyde NZ Ltd, New Zealand (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)

Qualifications

Master of Environmental Law, University of Sydney, Australia, 2003
Bachelor of Chemical and Materials Engineering, University of Auckland, New Zealand, 1993
Certificate in Resource Management Act 1991 decision making, Ministry for the Environment, New Zealand (current until end 2020)

Affiliations

Advisory Board Member, School of Chemical and Materials Engineering, University of Auckland
Former Editorial Board Member, Journal of the Clean Air Society of Australia & New Zealand
Member, Resource Management Law Association
Member, Clean Air Society of Australia & New Zealand

Employment Summary

since April 2011

Emission Impossible Ltd, Senior Air Quality Specialist

Providing specialist advice to a range of clients on the improved management of air quality and industrial emissions.

Example projects include:

- Commissioner for Auckland Council Hearing for Notice of Requirement for proposed designation for Wiri Oil Terminal (Recommendations July 2015)
- Commissioner for Auckland Council Hearing for air discharge permit for proposed intensive egg laying facility in Patumahoe (Decision January 2015)
- Expert witness for Auckland Council on air quality section of Proposed Auckland Unitary Plan (2015)
- Commissioner for Hawke's Bay Regional Council Hearing for air discharge permit for proposed tyre pyrolysis plant in Napier (2014)
- Odour monitoring of two wastewater treatment plants for Tauranga City Council (2014). Co-author with Paul Baynham of AirQuality Ltd
- Odour monitoring of five pumping stations for Tauranga City Council (2014). Co-author with Paul Baynham of AirQuality Ltd
- Section 32 Cost and Benefit Analysis for proposed separation distances between busy roads and new childcare centres in the Proposed Auckland Unitary Plan for Auckland Council (2013)
- *Masterton and Carterton Domestic Fire Emissions Inventory*, (co-author with Surekha Sridhar), Report prepared for Wellington Regional Council (2013)
- Technical summary on 2013 World Health Organisation Review of evidence on health aspects of air pollution for the Ministry of Health. Presentation of summary and key findings for New Zealand to National Health Protection Forum (2013).
- Technical summary on 2013 World Health Organisation *Review of evidence on health aspects of air pollution* for the Ministry of Health. Presentation of summary and key findings for New Zealand to National Health Protection Forum, November 2013
- Assessment of Environmental Effects of Discharges to Air – Stevensons East Tamaki concrete batching plant, September 2013
- Follow-up assessment of Ngāpuna Dust Reduction Plan for Bay of Plenty Regional Council, June 2013
- Pre-lodgement review (against Section 88 of the Resource Management Act) for Environmental Protection Agency on the proposed Basin Reserve improvements by NZTA
- Economic assessment of proposal by Otago Regional Council to mandate 15 year retirement of bus contracts (in partnership with Jagadish Guria), September 2012
- Development of code of environmental practice for odour control from wastewater treatment systems for the Government of Samoa, June 2012
- Separation Distances for Roads – A Discussion Document for Auckland Council, July 2012
- Discussion document on separation distances for industry for Auckland Council to consider amenity and health impacts of industrial emissions on sensitive parts of the population, July 2012
- Development of offsets policy for the Rotorua Airshed for Bay of Plenty Regional Council, February 2012
- Development of dust management plans for 33 commercial and industrial sites in Rotorua for BOPRC. Workshop and liaison with industry on behalf of BOPRC.

- Officers Decision Report for Auckland Council on application for resource consent by Auckland Foam, January 2012
- Development of an Odour Management Plan for the proposed upgrade of the Greytown wastewater treatment plant on behalf of South Wairarapa District Council, October 2011
- Preparation of an Assessment of Environmental Effects (Air Quality) for the proposed upgrade of the Greytown wastewater treatment plant on behalf of South Wairarapa District Council (pending), October 2011

Example publications include:

- Technical summary of 2013 WHO *Review of evidence on health aspects of air pollution* for the Ministry of Health. , November 2013.
- *Separation Distances for Roads*: Discussion Document for Auckland Council, July 2012.
- *Code of Environmental Practice: Odour Control from Wastewater Treatment Systems*, Ministry of Natural Resources and Environment, Samoa, June 2012.

- *Rotorua Offsets Programme: Draft Guidance for Industry and BOPRC* for Bay of Plenty Regional Council, February 2012 (available on request).
- (Co-author) *Background Air Quality for Resource Consent Applications: Draft for Consultation*, Ref: GD 2011/002, September 2011. Available on request from Auckland Council.
- Clean Air Society of Australia and New Zealand (2011). *Air Quality Regulation and Odour Management in Australia & New Zealand 2011*, June 2011.

2004 to 2011

Ministry for the Environment, Senior Analyst – Air Quality

Providing specialist advice to the Minister for the Environment on air quality policy and regulation in New Zealand. Representing the Ministry for the Environment in regulatory fora, research steering groups, special interest groups, technical advisory panels and industry groups.

Example projects include:

- Revision and update of New Zealand's national air quality standards. This included:
  - Project management of regulatory amendment
  - Preparation of briefings, cabinet papers, regulatory impact statements
  - Updating cost benefit analyses to reflect amended policy
  - Specialist advice to Minister for the Environment
  - Specialist advice to technical reference groups drafting regulations
  - Specialist advice to technical advisory group reporting to Minister

- Review of implementation of the national air quality standards by regional councils in New Zealand.
- National audit of wood burners (2006 Phase 1 and 2, commenced 2011 audit).
- Preparation of Users Guide to National Air Quality Standards (2004, update 2005)
- Peer review of numerous Ministry publications including all air quality website related information
- Project management, peer review and publication of New Zealand air quality best practice guidance

Example representative and relationship roles include:

- Environment Protection and Heritage Council (EPHC) of Australia and New Zealand Air Quality Working Group (reporting to EPHC Steering Committee and Ministerial Council)
- New Zealand National Air Quality Working Group
- Joint research steering groups (New Zealand Transport Agency, Health Research Council-Ministry for the Environment-Ministry of Health-Ministry of Transport, Foundation for Research, Science and Technology)
- Liaison with New Zealand Home Heating Association Executive (manufacturers)
- Joint Australia/New Zealand Technical Standards Committee for wood burner test methods (CS-62)

Example publications include:

Ministry for the Environment (2011). *Revised National Environmental Standards for Air Quality – Section 32 Evaluation*, Ministry for the Environment, March 2011.

- Ministry for the Environment (2011). *Proposed Amendments to the National Environmental Standards for Air Quality Report on Submissions*, Publication ME1037, Ministry for the Environment, January 2011.
- Ministry for the Environment (2010). *Regulatory Impact Statement: Amending the PM_{10} Air Quality Standards*, Ministry for the Environment, November 2010.
- Ministry for the Environment (2009). *2008 Report on Progress: National Environmental Standards for Air Quality*, Publication ME945, Ministry for the Environment, June 2009.
- Ministry for the Environment (2008). Co-author *Good Practice Guide for Assessing Discharges to Air from Industry,* Publication ME880, Ministry for the Environment, June 2008.
- Ministry for the Environment (2008). *Good Practice Guide for Assessing Discharges to Air from Industry: Report on Submissions on Draft for Consultation*, Publication ME882, Ministry for the Environment, June 2008.
- Ministry for the Environment (2008). Co-author *Good Practice Guide for Assessing Discharges to Air from Land Transport,* Publication ME881, Ministry for the Environment, June 2008.
- Ministry for the Environment (2008). *Good Practice Guide for Assessing Discharges to Air from Land Transport: Report on Submissions on Draft for Consultation*, Publication ME883, Ministry for the Environment, June 2008.
- Ministry for the Environment (2008). *National Wood Burner Performance Review: Phase 2*, Publication ME875, Ministry for the Environment, April 2008.
- Ministry for the Environment (2007). *National Wood Burner Performance Review: Phase 1*, Publication ME815, Ministry for the Environment, June 2007.
- Ministry for the Environment (2005). Co-author *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)* Publication ME695, Ministry for the Environment, October 2005.
- Ministry for the Environment (2004). Co-author *Good Practice Guide for Atmospheric Dispersion Modelling*, Publication ME522, Ministry for the Environment, June 2004.

Models used include:

- AERSCREEN
- AUSPLUME (Gaussian Plume Dispersion Model)
- ISC3 (US EPA Dispersion Model)
- CALMET/CALPUFF (US EPA Complex Terrain Dispersion Models)
- SCREEN (US EPA Screening Dispersion Model)
- CTSCREEN (US EPA Complex Terrain Screening Dispersion Model)
- TSCREEN (US EPA Toxic Release Screening Dispersion Model)
- CHARM (Radian International Complex Hazardous Release Model)
- SLAB (US National Technical Information Centre Dense Gas dispersion model - flat terrain)
- DEGADIS (US EPA Dense Gas Dispersion Model)

Other specialised training

- Certificate in Resource Management Act 1991 decision making (grade = excellent), Ministry for the Environment, New Zealand (current until 31 Dec 2020)
- CALMET/CALPUFF (complex terrain modelling) training course, Brisbane, 2000
- Odour Workshop (EPA Vic), Melbourne, 1998
- Air Quality Management in European Cities (South Eastern Institute of Public Health), London, UK, July 1997
- Offshore Survival Training Course (OPITO certified to UK OOA guidelines), Aberdeen, UK, 1997
- Complex Hazardous Air Release Model (CHARM), Users Training Course, Kaiserslaten, Germany, 1997
- Integrated Pollution and Prevention Control Conference (IBC), London, UK, 1996
- 40 hr Health and Safety Training Course for Hazardous Waste Sites (Woodward-Clyde)

ATTACHMENT B FLARING DISCHARGES TO AIR

Discharges to air from flaring include: [45,46]

- Carbon dioxide, carbon monoxide
- **Aldehydes** including acetaldehyde[(2B)], formaldehyde[(1)], acrolein, acetone, propanal, methyl ethyl ketone, benzaldehyde, isopentanal, pentanal, o-tolualdehyde, m-tolualdehyde, p-tolualdehyde, hexanal
- Benzene[(1)], toluene, ethylbenzene, xylene (**BTEX compounds**);
- Other volatile organic compounds **(VOCs)** including, acetylene, 1-butene, cis-2-butene, butane, ethane, ethylene, hexane, heptane, octane, propane, propyne, propylene, styrene, 1,3-butadiene[(1)],
- Polycyclic aromatic hydrocarbons **(PAHs)** including naphthalene[(2B)], acenapthylene, acenaphthene[(2B)], phenanthrene, anthracene, fluoranthene, pyrene, benzo(b)fluoranthene[(2B)], benzo(e)pyrene, indeno(1,2,3-cd)pyrene[(2b)], benzo(g,h,i)perylene, benzo(a)pyrene[(1)], coronene
- Oxides of nitrogen (e.g. nitrogen dioxide)
- Sulphur dioxide, sulphides (e.g. hydrogen sulphide, carbon disulphide) and mercaptans
- Particulate matter[(1)] including fractions less than 10 micrometres in diameter (PM_{10}) and less than 2.5 micrometres in diameter ($PM_{2.5}$)
- Dioxins and furans

Group 1 and 2 carcinogenicity in brackets; 1 = Known human carcinogen, 2A = Probable human carcinogen, 2B = Possible human carcinogen (WHO, 2016)[47]

45 US EPA, (1997). *The Origin and Fate of Toxic Combustion Byproducts in Refinery Heaters: Research to Enable Efficient Compliance with the Clean Air Act*. Petroleum Environmental Research Forum Project 92-19. Final Report. August.

[46] Taranaki Regional Council, (2012). *Investigation of air quality arising from flaring of fracturing fluids - emissions and ambient air quality.* Technical Report 2012–03. Stratford. May.

[47] WHO list of Agents Classified by the IARC Monographs, Volumes 1–112. World Health Organisation. http://monographs.iarc.fr/ENG/Classification/ClassificationsAlphaOrder.pdf visited on 21 Apr 2016.

ATTACHMENT C RECOMMENDED AIR QUALITY MINIMUM EXCLUSION ZONES AND SEPARATION DISTANCES

Activity	Source	Discharges to air *	Recommendation	Comments
Petroleum prospecting (including seismic testing)	Storage of explosives	None	None	
	Use of explosives in seismic testing	Very minor	None	
Petroleum exploration (including drilling and well testing)	Drilling: single wellhead Fugitive discharges	BTEX compounds PAHs VOCs	300 m Separation Distance	Require detailed assessment of discharges to air
	Drilling: single wellhead Fugitive discharges	BTEX compounds PAHs VOCs	100 m Minimum Exclusion Zone	Prohibited activity within this distance
	Drilling: multiple wellheads Fugitive discharges	BTEX compounds PAHs VOCs	500 m Separation Distance	Require detailed assessment of discharges to air
	Drilling: multiple wellheads Fugitive discharges	BTEX compounds PAHs VOCs	300 m Minimum Exclusion Zone	Prohibited activity within this distance
	Flaring	NES contaminants Dioxins and furans BTEX compounds PAHs VOCs	1,000 m Separation Distance	Require detailed assessment of discharges to air
	Flaring	NES contaminants Dioxins and furans BTEX compounds PAHs VOCs	300 m Minimum Exclusion Zone	Prohibited activity within this distance
Petroleum production	Operation of single well including storage and handling of oil and gas Fugitive discharges	BTEX compounds PAHs VOCs	300 m Separation Distance	Require detailed assessment of discharges to air
	Operation of single well including storage and handling of oil and gas Fugitive discharges	BTEX compounds PAHs VOCs	100 m Minimum Exclusion Zone	Prohibited activity within this distance

Activity	Source	Discharges to air *	Recommendation	Comments
	Operation of multiple wells including storage and handling of oil and gas Fugitive discharges	BTEX compounds PAHs VOCs	500 m Separation Distance	Require detailed assessment of discharges to air
	Operation of multiple wells including storage and handling of oil and gas Fugitive discharges	BTEX compounds PAHs VOCs	300 m Minimum Exclusion Zone	Prohibited activity within this distance
	Flaring	**NES contaminants** Dioxins and furans BTEX compounds PAHs VOCs	1,000 m Separation Distance	Require detailed assessment of discharges to air
	Flaring	**NES contaminants** Dioxins and furans BTEX compounds PAHs VOCs	300 m Minimum Exclusion Zone	Prohibited activity within this distance
	Oil and gas pipelines Fugitive discharges	BTEX compounds PAHs VOCs	None	Better addressed under risk
	Gas reinjection and underground storage Fugitive discharges	BTEX compounds PAHs VOCs	None	Better addressed under risk
Land farming	Fugitive discharges	BTEX compounds PAHs VOCs Odour	500 m Separation Distance	Require detailed assessment of discharges to air
	Fugitive discharges	BTEX compounds PAHs VOCs Odour	100 m Minimum Exclusion Zone	Prohibited activity within this distance

*** Table Notes** [Refer **Attachment B** for further details]

- BTEX compounds = Benzene, toluene, ethylbenzene, xylene
- VOCs = volatile organic compounds
- PAHs = Polycyclic aromatic hydrocarbons
- NES contaminants = contaminants in the Resource Management (National Environmental Standards for Air Quality) Regulation 2004 for which there are ambient standards; i.e. nitrogen dioxide, sulphur dioxide and PM_{10}.