Before the Independent Commissioner Hearing Panel

Under	the Resource Management Act 1991 (**RMA**)
In the matter of	an application by **Dunedin City Council** to develop a landfill at Smooth Hill, Dunedin.

Statement of evidence of Matthew Peter Welsh

29 April 2022

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Qualifications and experience

1 My name is Matthew Peter Welsh.

2 I am a Senior Environmental Scientist, GHD Pty Ltd (Sydney Office, Australia).

3 I have a Bachelor degree in Environmental Science (1st Class Honours) from the University of Sussex in the United Kingdom (graduating in 1998). Since 2000, I have worked in the fields of landfill environmental management (landfill gas specialism) and contaminated land assessment and management in Australia and the United Kingdom. During this time, I have worked in an environmental capacity at a laboratory, 'on site' at several landfill sites / quarries, as an 'in house' landfill gas consultant for two international landfill companies and now as an environmental consultant for GHD.

4 Since 2007, I have worked on landfill and landfill gas related projects in all States and Territories of Australia and completed several landfill gas projects in New Zealand. Between 2008 and 2009, I was seconded to Environment Protection Authority (EPA) Victoria (Melbourne, Australia) for a 9-month period to support it in relation to landfill gas matters. I have helped develop several Victorian and Australian guidelines in relation to landfill gas. I was an expert witness for the New South Wales (NSW) government (Australia) in relation to landfill gas management during 2017 for the largest financial claim made to date in the NSW Land and Environment Court. The case was awarded in favour of the NSW government.

5 I have read the Code of Conduct for Expert Witnesses in the Environment Court Practice Note 2014. This evidence has been prepared in accordance with it and I agree to comply with it. I have not omitted to consider material facts known to me that might alter or detract from the opinions expressed.

Scope of evidence

6 I have been asked to prepare evidence in relation to Landfill Gas Management. This includes:

(a) Identification of what landfill gas is and why it needs to be appropriately managed;

(b) Identification of how landfill gas risks are typically assessed and managed;

(c) Identification of potential rates of landfill gas generation at the proposed landfill site;

(d) Completion of a preliminary assessment of landfill gas related risks at the proposed landfill site;

(e) Summarisation of relevant National and International regulatory documents and guidelines for landfill gas management; and

(f) Identification of landfill gas management measures for the proposed landfill site.

7 This evidence is based on Landfill Gas Assessment and Concept Landfill Gas Management Measures attached as Appendix A to the Landfill Concept Design Report, Appendix 3 of AEE.

8 It also responds to matters raised in Otago Regional Council (ORC)'s peer review of the application, submissions, and the Council's s42A report as they relate to landfill gas matters.

Executive summary

What is landfill gas and why does it need to be appropriately managed?

9 Landfill gas is a complex mixture of different gases produced by the degradation of biodegradable waste materials deposited within landfill sites. The emission rate and chemical composition of the landfill gas varies depending on many factors. During the anaerobic phase, when decomposition of biodegradable waste materials occurs in the absence of oxygen, methane and carbon dioxide are the major constituents of the landfill gas generated. Numerous other gases may also be present at low concentrations.

10 The timescale for the evolution of significant quantities of landfill gas typically varies from three to twelve months following waste deposition. Landfill gas generation can continue for more than 30 years following the termination of waste landfilling activities.

11 Landfill gas can cause health, safety, amenity and environmental impacts due to the gases it contains. Under certain conditions, it can:

(a) Be flammable and explosive;

(b) Present an asphyxiation (suffocation) hazard;

(c) Be toxic to humans, flora and fauna;

(d) Be odorous;

(e) Be corrosive;

(f) Contribute to greenhouse gas emissions; and

(g) Contribute to photochemical smog.

12 Due to its hazardous nature, landfill gas must be appropriately assessed and managed at landfill sites.

How are landfill gas risks typically assessed and managed?

13 The typical approach to assessing landfill gas related risks at a landfill site is to:

(a) Identify potential physical hazards that may be associated with landfill gas emitted from the landfill site;

(b) Review relevant site information in relation to landfill gas. Typically, this includes information on topography, geology, hydrogeology, landfill design, construction and operation, waste types and quantities, locations of potential receptors such as nearby houses, and relevant regulatory documents and guidance;

(c) Estimate potential future rates of landfill gas emissions from the landfill site;

(d) Develop conceptual site models (CSMs) that illustrate how landfill gas could be emitted from the landfilled waste (pathways) and the parties it could impact upon (receptors);

(e) Prepare an assessment of landfill gas related risks; and

(f) Following the completion of the tasks above, identify potentially appropriate landfill gas management measures for the site (and ultimately implement and refine them as required).

14 The approach above was adopted for assessing and managing landfill gas risks that may be associated with the proposed landfill site. Further relevant information on the works completed are summarised in this document and detailed in the Landfill Gas Assessment (LGA).

15 The issue of potential impacts of combusted landfill gas on air quality at nearby receptors is not addressed by this evidence or detailed in the LGA. That matter is summarised in GHD (2020) DCC Smooth Hill Consenting –

Air Quality Assessment, Appendix 10 of the AEE and the evidence of Peter Stacey.

Potential physical hazards associated with landfill gas at the proposed site

16 There are no potential physical hazards associated with landfill gas beyond the matters identified in paragraphs 7 to 10 above.

Potential rates of landfill gas generation at the proposed landfill site

17 In order to understand the potential magnitude of landfill gas emission rates at the site over time, a landfill gas emission model of the proposed site was created. The model was for a landfilling period of 39 years (consistent with the total design capacity identified in the Landfill Concept Design Report, Appendix 3 of AEE and was created using the USEPA's Landfill Gas Emission Model (LandGem) Version 3.02). The start date for landfilling in the model was 2028 (this is subject to confirmation).

18 Various assumptions were made in relation to the parameters applied within the model as outlined in the LGA. These assumptions were considered to be reasonable based on the available information and continue to be so at this time.

19 The estimated landfill gas emission rates from the model are presented in Figure A below as m^3/LFG[1]/h.

[1] Landfill gas

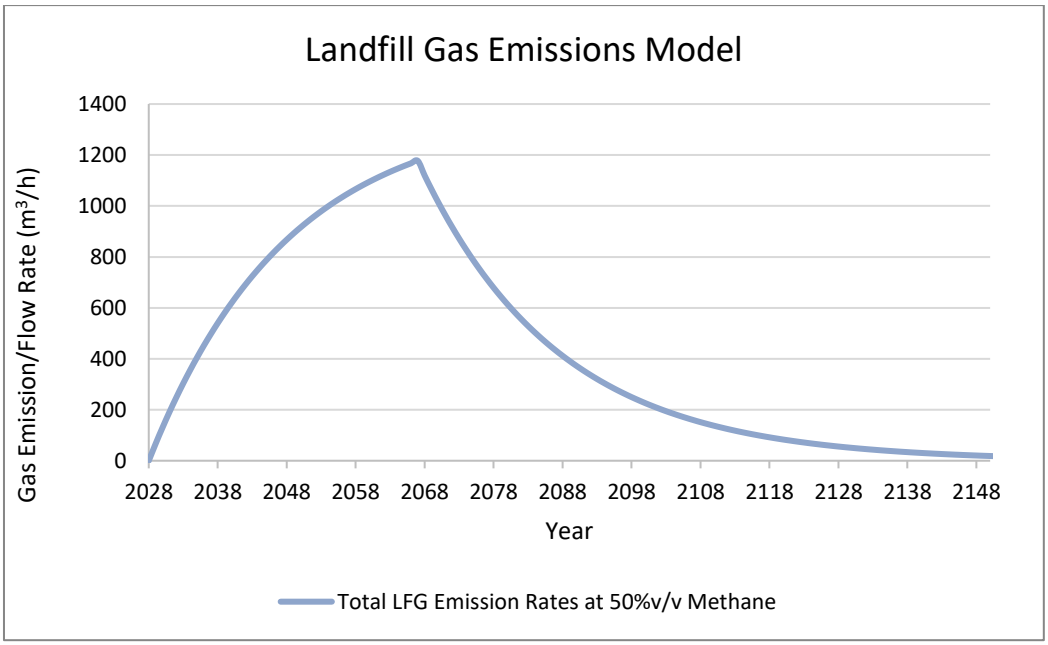

Figure A – Outputs of landfill gas emission model created for proposed landfill site

20 Figure A above identifies that:

(a) The proposed landfill site is expected to start emitting landfill gas in 2028 and will continue to do so for many years after landfilling of waste has ceased in 2066;

(b) The landfill gas emission rate at the proposed landfill site will peak in 2067 at 1,177 m^3/LFG/h and will steadily decrease every year post 2067;

(c) The landfill gas emission rate will be greater than 250 m^3/LFG/h (i.e. moderate to large generation rates[2]) between 2033 and 2097 (65 years); and

(d) The landfill gas emission rates will be greater than 100 m^3/LFG/h at 50% v/v methane (i.e. theoretically sufficient to operate a flare according to EPA Victoria (2015)) from 2030 to 2116 (87 years).

21 Based on the magnitude and longevity of the estimated landfill gas emission rates, it is considered that active[3] landfill gas management using flares

[2] According to EPA Victoria (Australia) (2015) *BPEM, Siting, design, operation and rehabilitation of landfills*, Section 6.7.1 on page 35

[3] i.e. under vacuum

and/or engines will be required at the proposed landfill site for many decades to appropriately manage the landfill gas emitted.

22 It is noted that the outputs from uncalibrated landfill gas emission models (such as this one) should be considered to be indicative only until they can be calibrated against actual landfill gas collection data at a landfill site.

Preliminary assessment of landfill gas related risks at the proposed landfill site

23 A preliminary assessment of the risks associated with landfill gas at the proposed landfill site was undertaken using the source-pathway-receptor approach. This is a commonly applied approach in landfill gas and contaminated land assessment. The purpose of this task was to assist with understanding potential landfill gas related risks at the proposed landfill site and what landfill gas management measures may be appropriate to manage them.

24 Certain assumptions and limitations are associated with the preliminary risk assessment as identified in the LGA. These include the following:

(a) The risk assessment is preliminary in nature and is based on information available at the time of its preparation;

(b) The nature of risk assessment is subjective. One individual's tolerance for risk may differ from another individual's tolerance;

(c) The preliminary landfill gas risk assessment should be updated through the project life of the proposed landfill site and refined accordingly;

(d) That the environment surrounding the proposed landfill site would remain unchanged from the present day to the time at which the preliminary landfill gas risk assessment is completed (2067); and

(e) The year of 2067 was selected as the year of the preliminary landfill gas risk assessment. This was because:

(i) It is the year with the maximum modelled landfill gas emission rate; and

(ii) It is the year when final capping and landfill gas collection measures are anticipated to have been placed at the site. This time may pose a risk in relation to possibly increasing subsurface landfill gas migration due to placement of final cap

and final balancing of the landfill gas collection and treatment system.

25 The major source of ground gas at the proposed landfill site will be landfilled waste. Other minor sources of ground gas may also be present.

26 There are several pathways for landfill gas emission from the proposed landfill site. The most significant are considered to be via subsurface geology, surface emissions and on-site sub-surface services. Given the extensive landfill engineering proposed to be installed, operated and maintained at the proposed site through its lifecycle, the risk of significant landfill gas emissions migrating via the identified pathways is considered to be low at the point of closure.

27 There are a number of potential receptors that have been identified for landfill gas emitted from the proposed landfill site. The receptors of greatest significance are considered to be the following:

(a) On-site workers;

(b) On-site buildings and structures;

(c) On-site subsurface services; and

(d) On-site visitors/trespassers.

28 The key risks associated with landfill gas at the proposed landfill site during 2067 are considered to be as follows:

(a) Impact upon on-site workers and visitors;

(b) Impact upon on-site buildings and structures; and

(c) Impact upon future on-site subsurface services.

29 Given the key risks identified above and the magnitude and longevity of the estimated landfill gas emission rates, a range of landfill gas management measures will be required at the proposed landfill site for many decades to appropriately manage the landfill gas. These landfill gas management measures will include active landfill gas management (i.e. collection and combustion), regular monitoring and appropriate waste covering and containment systems[4].

[4] As detailed in Richard Coombe's evidence…

Summary of relevant national and international regulatory documents and guidelines for landfill gas management

30 To assist with the development of the landfill gas management measures identified in paragraph 27 above, a review of relevant regulatory documents / guidelines for landfill gas management at landfills in New Zealand and internationally was undertaken. The key points of note in relation to these documents are provided in the following lines.

31 There are two key documents in relation to landfill gas management in New Zealand. These are:

(a) The Resource Management National Environmental Standards for Air Quality Regulations 2004 (NES-AQ); and

(b) Waste Management Institute New Zealand (WasteMINZ) (2018) Technical Guidelines for Disposal to Land.

32 Furthermore (although considered of lesser direct relevance) the following two documents exist:

(a) Climate Change Response Act 2002; and

(b) Ambient Air Quality Guidelines 2002 update.

33 In addition to the documents above, there is a range of international guidance available in relation to landfill gas assessment and management in Australia, the United Kingdom, Canada, the United States of America and elsewhere.

34 The guidance provided in the local New Zealand documents was considered and incorporated into the development of the landfill gas management measures identified for the proposed landfill site. Where information or guidance was limited in the New Zealand documents identified above, relevant international guidance was applied.

Recommended landfill gas management measures for the proposed landfill site

35 Based on the outputs of the works presented in the preceding sections of this report, the following landfill gas management measures were considered to be appropriate for the proposed landfill site:

(a) Installation and appropriate construction quality assurance (CQA) of a low permeability basal and sidewall lining system that meets the

WasteMINZ 2018 Technical Guidelines for Disposal to Land for a Class 1 landfill;

(b) Installation, appropriate CQA and operation of a leachate management system at the site. Leachate pumping systems to be designed and operated in accordance with relevant standards in relation to LFG as applicable (e.g. AS/NZS 2381.1.1:2005);

(c) Regular covering of waste with appropriate daily and intermediate cover materials. It is anticipated that daily cover will be applied at the end of each day's waste placement and intermediate cover will be placed on areas where further waste will not be placed for three months;

(d) Progressive capping and rehabilitation of the site with a low permeability landfill cap over the site's lifetime. A final cap that meets the WasteMINZ 2018 Technical Guidelines for Disposal to Land for a Class 1 landfill will be installed at the proposed landfill site;

(e) Progressive installation, operation and monitoring of an active landfill gas collection, treatment and destruction system (i.e. gas wells, pipework, manifolds, flares and/or engines) that is suitable for the rates of landfill gas emitted by the proposed landfill site as development progresses. It is anticipated that active landfill gas management will commence after two years of landfill operations. Emissions from the combustion of landfill gas at the flares and/or engines must meet the requirements of the NES-AQ and the ambient air quality guidelines at agreed locations (see evidence of Mr Peter Stacey). Emission issues are discussed further in the Air Quality Report (GHD 2020), and evidence of Mr Stacey. Appropriate design, installation and validation of buildings and structures and subsurface services (for example in accordance with AS/NZS 2381.1.1:2005 if relevant) on-site to prevent landfill gas entering and/or accumulating within them;

(f) Design, installation and implementation of an appropriate landfill gas monitoring network and program. This network and program should be reviewed and potentially updated on an ongoing basis as conditions change at/adjacent to the site over time;

(g) Completion of a detailed landfill gas risk assessment (LFGRA) prior to waste filling occurring and on-going review and update of that document as conditions change at/adjacent to the site over time. This detailed LFGRA should further consider / investigate organic

mudstone / lignite as potential sources of ground gas at the proposed landfill site;

(h) Development and implementation of appropriate work, health and safety procedures for on-site workers who may be at risk of being exposed to landfill gas emissions; and

(i) Concept designs have been developed for the proposed landfill site for the active landfill gas collection and treatment/destruction system and perimeter landfill gas monitoring bore network.

36 Certain assumptions and limitations are associated with these concept designs as identified in the LGA. The assumptions in relation to the active landfill gas collection and treatment/destruction system and the perimeter landfill gas monitoring bore network were considered reasonable at the time of the development of the concept designs and continue to be so at this time.

37 The concept design of the active landfill gas collection and treatment destruction system is shown on Drawings C501 and C502, Appendix 4 of AEE.

38 The concept design of the perimeter landfill gas monitoring bore network is shown on Drawings C503 to C505, Appendix 4 to the AEE.

39 In relation to the preliminary landfill gas monitoring bore network, it is noted that two concept designs were developed. Initially a design based on guidance provided in EPA Victoria (2015) Siting, Design, Operation and Rehabilitation of Landfills Publication 788.3* August 2015 was developed for the site assuming that no landfill gas risk assessment had been completed. Following development of that network it was reviewed against the site's local environs, the findings of the preliminary Land Fill Gas Risk Assesment (LFGRA), and other work completed in the LGA. This review identified that the number of bores contained in the initial network was considered to be unnecessary at that time (and still is). Therefore, the initial design was further refined.

Response to issues in ORC peer review

40 No issues of relevance to landfill gas are identified in the ORC peer review.

Response to issues in section 42A report

41 I have reviewed the *Otago Regional Council Section 42A Staff Recommending Report Application RM20.280 Dunedin City Council* dated 20/04/2022 as relevant to landfill gas. I note that the only relevant matter

raised is the recommendation that a condition be placed on the operation and maintenance of the landfill gas flare (as identified in Section 6.1.5 *Effects on Air Quality* of the Section 42A report). I am in broad agreement with this recommendation.

Response to draft conditions

42 I have reviewed the draft conditions of consent in relation to the matter of landfill gas. I am in broad agreement with these draft conditions as they relate to landfill gas (Air Quality Section only).

Response to issues raised in submissions

43 One matter of relevance to landfill gas was identified in the submissions. This is detailed and responded to in paragraphs 44 to 50 below.

44 The submission from Big Stone Forest Ltd, S & A Ramsey – 689 Big Stone Road (opposite application site) states:

> The risk posed by oxygen concentrations in the landfill and safety risks for neighbouring properties has not been addressed. The number of flares proposed or what redundancy is incorporated to address fire or flare failure is unclear. There are no standards in the conditions to ensure oxygen levels in the landfill are managed to minimise risks of landfill fires; and
>
> Hydrogen sulphide is a key source of odour at landfills, and which is widely accepted to be offensive and objectionable. Other landfills have landfill gas emission standards and are required to monitor hydrogen sulphide constantly. Proposed conditions fall short of what is considered best practice.

45 In relation to the statement made above the following comments are made:

(a) It is acknowledged that the presence of elevated quantities of oxygen in landfilled waste can result in the waste oxidising and sub-surface hot spots developing. This is further discussed in the evidence of Anthony Dixon with respect to fire risks; and

(b) The number of flares proposed at the site will be a product of actual gas flows at the site over time. At this time it is envisioned that two flares (one principal and one back-up) would be installed at the site. Further details on the requirements for those flares in relation to fire and flare failure are provided in the LGA and the Air Quality Assessment. For example both flares will have:

(i) Flame arrestors;

(ii) Automatic backflow prevention devices between the flares and the landfill; and

(iii) Automatic isolation switches that ensure that, if the flame is lost, no significant discharges of unburnt gas from the flares occurs;

(c) The landfill gas collection system will be designed, installed, operated and maintained by an appropriately qualified party. This will be done in accordance with appropriate industry guidance and include the regular monitoring of oxygen (as an indicator of air ingress into the waste) and carbon monoxide (as an indicator of potential combustion) in the collected gas. Guidance to be considered by the qualified party includes but is not limited to:

(i) Conestoga-Rovers and Associates, 2010, Landfill Gas management Facilities Design Guidelines, British Columbia Ministry of Environment, Richmond;

(ii) Todeka Limited (2012), Landfill Gas Industry Code of Practice: The Management of Landfill Gas, United Kingdom;

(iii) C&P Environmental Ltd, Biffa, Infinis Limited, Sita UK, Viridor Waste Management, Waste Recycling Group, 2008, Industry Code of Practice Management and Prevention of Sub-surface fire, United Kingdom, 1st Ed;

(iv) UK Environment Agency, 2004, Guidance on the management of landfill gas, Environment Agency, Bristol; and

(v) WasteMINZ, 2018, Technical Guidelines for Disposal to Land, WasteMINZ, Auckland;

(d) The landfill gas system will be designed, installed, operated and maintained to minimise potential oxygen ingress into the landfilled waste whilst also adequately controlling landfill gas generated by the landfilled waste. Example measures that the qualified party may implement to achieve this are as follows:

(i) Minimisation for potential oxygen ingress during design and installation phases;

(ii) Regular oxygen and carbon monoxide monitoring of the gas and assessment against appropriate assessment criteria;

(iii) Regular inspection and maintenance of above ground pipework; and

(iv) Regular 'balancing' of the gas collection and treatment system; and

(e) As part of the detailed design documentation, a landfill gas monitoring plan with associated assessment criteria will be developed as part of the Landfill Management Plan and implemented at the site following commencement of filling. Typical trigger levels for action and associated actions (such as reducing suction pressures or further investigations) will be identified and implemented by the qualified party that designs, installs, operates and maintains the landfill gas collection and treatment system. Examples of oxygen and carbon monoxide trigger levels are identified in Todeka Limited (2012).

Conclusion

46 The proposed landfill site will generate rates of landfill gas that may present risks to certain receptors if not appropriately managed.

47 As outlined in paragraph 33, a series of management measures acting in tandem is required to ensure that the landfill gas generated by the proposed landfill site is adequately managed. Two key management measures are:

(a) An active landfill gas collection and treatment/destruction system; and

(b) A perimeter landfill gas monitoring bore network.

48 These measures would be coupled with appropriately designed monitoring and maintenance programmes. Monitoring data gathered would be assessed against appropriate criteria, and appropriate management actions then taken as required.

49 The suggested landfill gas management measures outlined in paragraph 35 represent typical current industry practice in relation to landfill gas management.

Matthew Peter Welsh

29 April 2022