Investigating Odour at a Landfill

Environmental Compliance Conference 2016
Dr Doug Boddy
MWH Global, now part of Stantec

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Agenda

1 Introduction

2 Assessment techniques

3 Assessing odour

4 Mitigating odour

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1 Introduction

"Objectionable and offensive odours have the potential to cause significant adverse effects on people's lives and wellbeing. Complaints about odour emissions are one of the most frequent environmental pollution incidents reported to regulatory authorities."

– Ministry for the Environment, 2003. Good Practice Guide for Assessing and Managing Odour in New Zealand, June 2003 [the 'Good Practice Guide for Odour'].

Introduction …

- This study evaluates the odour effects during the operation of a municipal solid waste landfill using a variety of methodologies and techniques
- The landfill has a history of odour nuisance complaints
- The principal odour emission sources and the potential adverse effects will be discussed
- Mitigation measures are suggested to reduce the potential for further odour nuisance effects arising in the community

2 Assessment techniques

Assessment techniques …

- Review the landfill odour complaints record
- Subjective field odour investigation / sniff test
- Landfill gas (LFG) monitoring
- Odour emissions monitoring using a flux chamber and analysis by dynamic dilution olfactometry
- Atmospheric dispersion modelling using CALPUFF
- Continuous ambient air quality monitoring for hydrogen sulphide (H_2S) by ultraviolet (UV) fluorescence

3 Assessing odour

Assessing odour …

Complaints record

- There is a history of odour complaints from the owners of the nearest residential property to the landfill, which is located approximately 100 m to the north-east of the site boundary (receptor 'R1')
- The complaints record covers the period between 13 February 2014 and 3 September 2014 (202 days in duration)
- During this period there were 69 complaints (all relate to receptor 'R1')


83%
of complaints occurred
between 4 pm and 8 am
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Assessing odour …

Subjective field odour assessment

- A subjective field odour investigation or sniff test was undertaken at various locations across the landfill, in accordance with the guidance contained in the Good Practice Guide for Odour
- The principal odour emission sources at the landfill were identified at the following locations:
  - Leachate collection sump
  - Stage 2 (three emission hotspots on an area with intermediate cover consisting of sand and mulch i.e. no capping)

Leachate collection sump

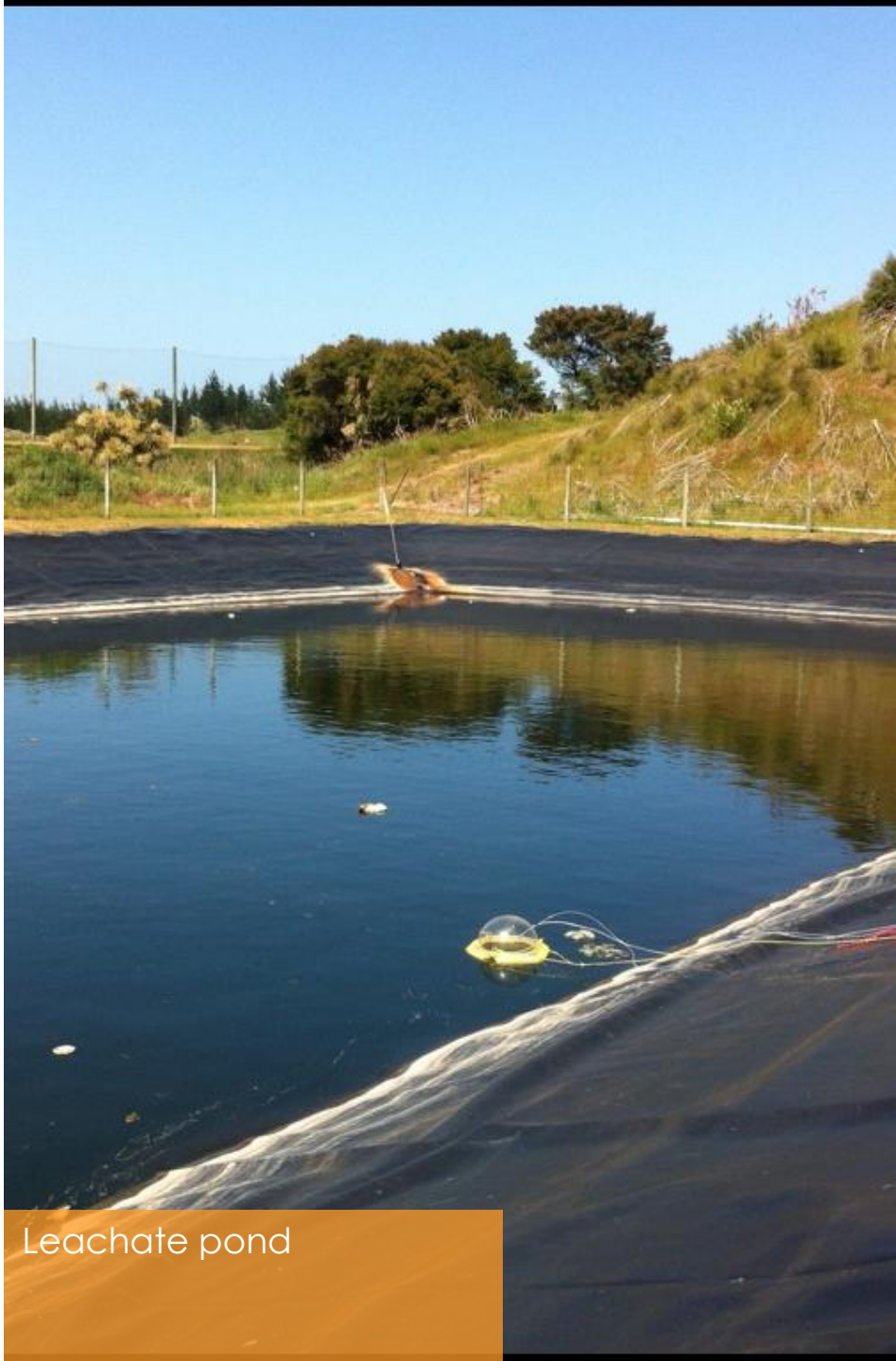
Stage 2
(intermediate cover)

Assessing odour …

Subjective field odour assessment

- Minor odour emission sources located at the landfill include:
  - the working face and active cells (both from the placement of 'fresh' waste and from fugitive emissions of odour permeating through daily cover)
  - leachate pond (open storage)

Working face



Leachate pond

Assessing odour …

Odour emissions monitoring

- Odour concentrations and emission rates were determined by DDO at the following locations:
  - Leachate pond (3 samples at 1 location)
  - Leachate collection manhole (3 samples at 1 location)
  - Stage 2 intermediate cover (3 locations):
    - Hotspot #1 (2 samples)
    - Hotspot #2 (3 samples)
    - Hotspot #3 (3 samples)
  - Working face (4 samples/locations)

Assessing odour …

- The results indicate that the highest odour concentrations were found at the leachate collection manhole
- The odour emissions at the working face and leachate pond were relatively low compared with the leachate collection manhole

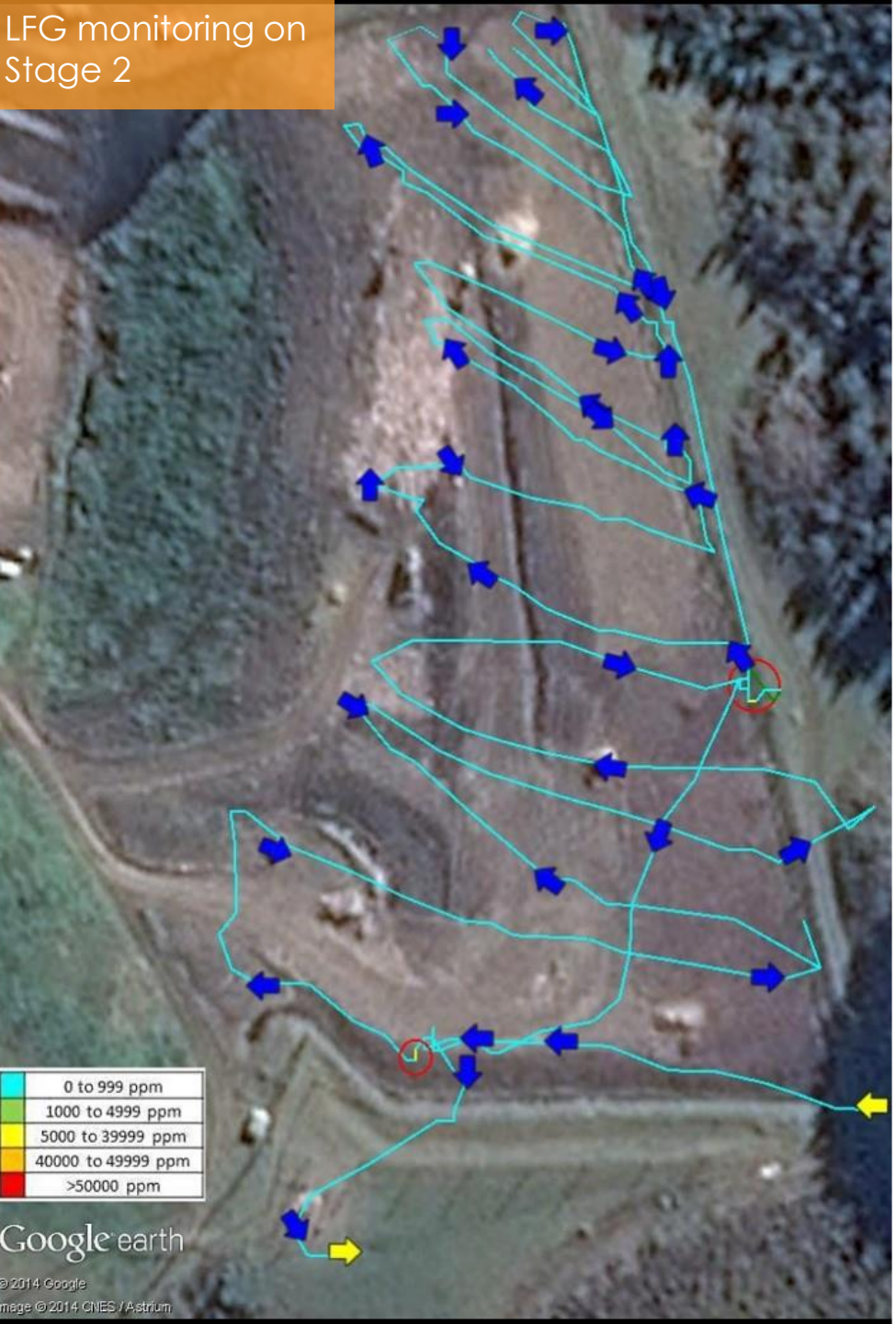


Assessing odour …

LFG monitoring

- A portable methane monitor was used and operated in "survey" mode (response time of ~0.6 seconds)
- The instrument automatically switched to "monitor" mode (response time of ~1 sec) at the leachate collection manhole and the Stage 2 emission hotspots due to high CH_4 concentrations
- A GPS unit was used to determine accurate geo-spatial data at a time-resolution of ~1 sec

LFG monitoring on Stage 2



LFG monitoring at the leachate collection sump

Assessing odour …

- The results indicated that the principal sources of CH_4 were:
  - leachate collection manhole (maximum concentration of 380,500 ppm)
  - 3 emission hotspots located on Stage 2 (maxima ranged from 5,827 ppm to 39,007 ppm)

Assessing odour …

Atmospheric dispersion modelling

- Atmospheric dispersion modelling using CALPUFF
- The aim was not to confirm or deny the odour complaints history but to assess the potential benefits associated with undertaking mitigation
- Furthermore, there is an accepted degree of uncertainty regarding results generated by dispersion modelling, particularly for odour

Assessing odour …

The modelling scenarios were assessed:

- Scenario 1 Baseline (existing) emissions
- Scenario 2 Baseline emissions except with a biofilter to control odour at the leachate collection sump
- Scenario 3 Baseline emissions except with the implementation of effective capping (e.g. clay layer) across Stage 2 to reduce fugitive odour and LFG emissions
- Scenario 4 A combination of Scenarios 2 and 3 (i.e. biofilter + effective capping)

Assessing odour …

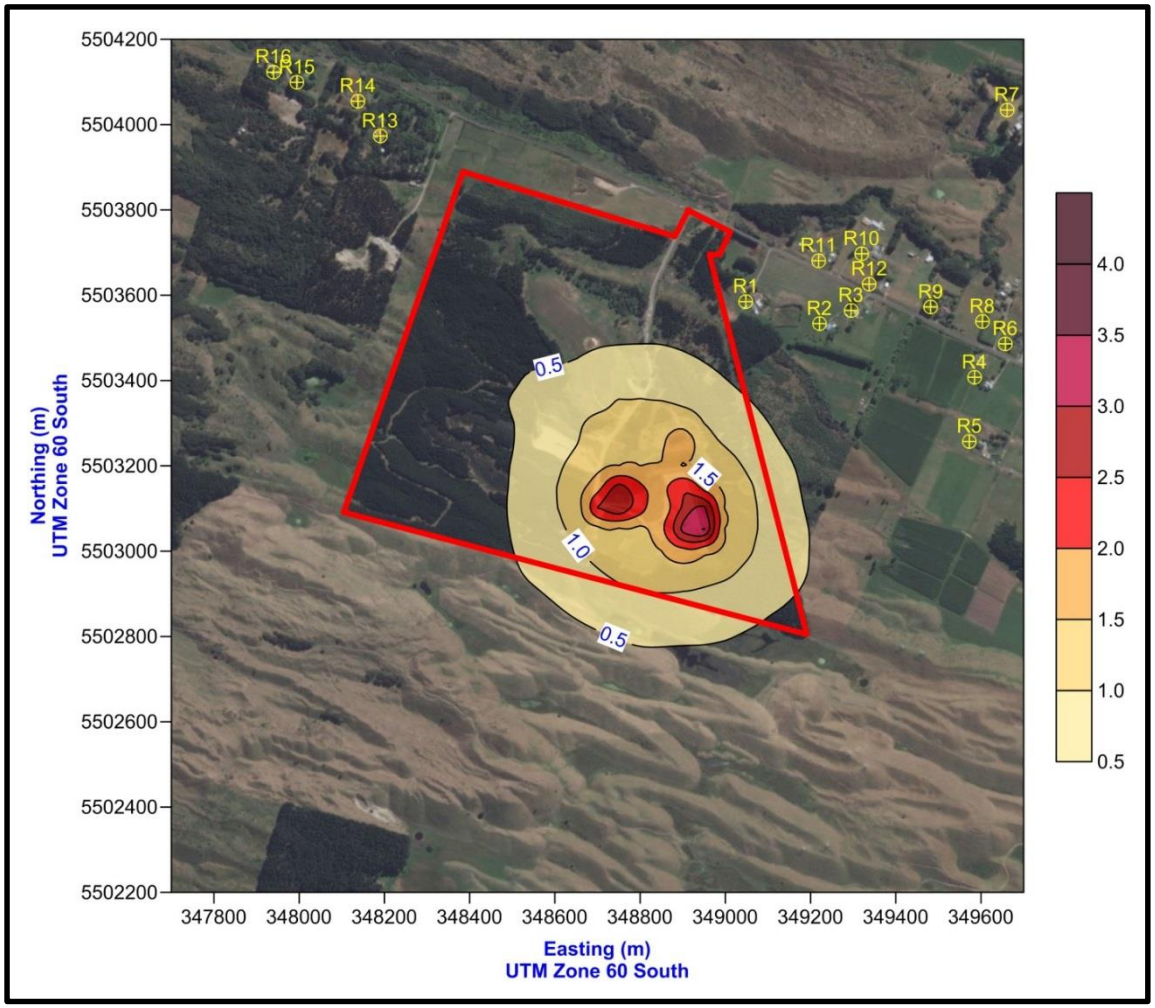
The predicted 1-hour mean (99.9%ile) ground-level odour concentrations (OU/m^3)

Receptor	Scenario 1	Scenario 2	Scenario 3	Scenario 4
R1	0.24	0.23	0.10	0.10
R2	0.18	0.17	0.08	0.07
R3	0.16	0.16	0.07	0.07
R4	0.14	0.14	0.05	0.05
R5	0.15	0.15	0.06	0.06
R6	0.13	0.13	0.05	0.05
R7	0.10	0.09	0.04	0.04
R8	0.13	0.13	0.05	0.05
R9	0.14	0.14	0.06	0.05
R10	0.15	0.14	0.06	0.06
R11	0.15	0.15	0.06	0.06
R12	0.14	0.14	0.06	0.06
R13	0.13	0.13	0.05	0.05
R14	0.11	0.11	0.05	0.04
R15	0.09	0.09	0.04	0.04
R16	0.09	0.09	0.04	0.04

The odour assessment criterion was 2 OU/m^3

Assessing odour …

The predicted 1-hour mean (99.9%ile) ground-level odour concentrations (OU/m^3) for Scenario 1



The odour assessment criterion was 2 OU/m^3

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Assessing odour …

- A modelling uncertainty factor of 10 was based on a review of the potential sources of modelling error and following a model 'headroom' analysis
- The highest 99.9%ile 1-hour mean odour concentrations predicted:
  - At any location beyond the site boundary for Scenario 1 was 5 OU/m^3
  - At any sensitive receptor location (receptor 'R1') was 2 OU/m^3

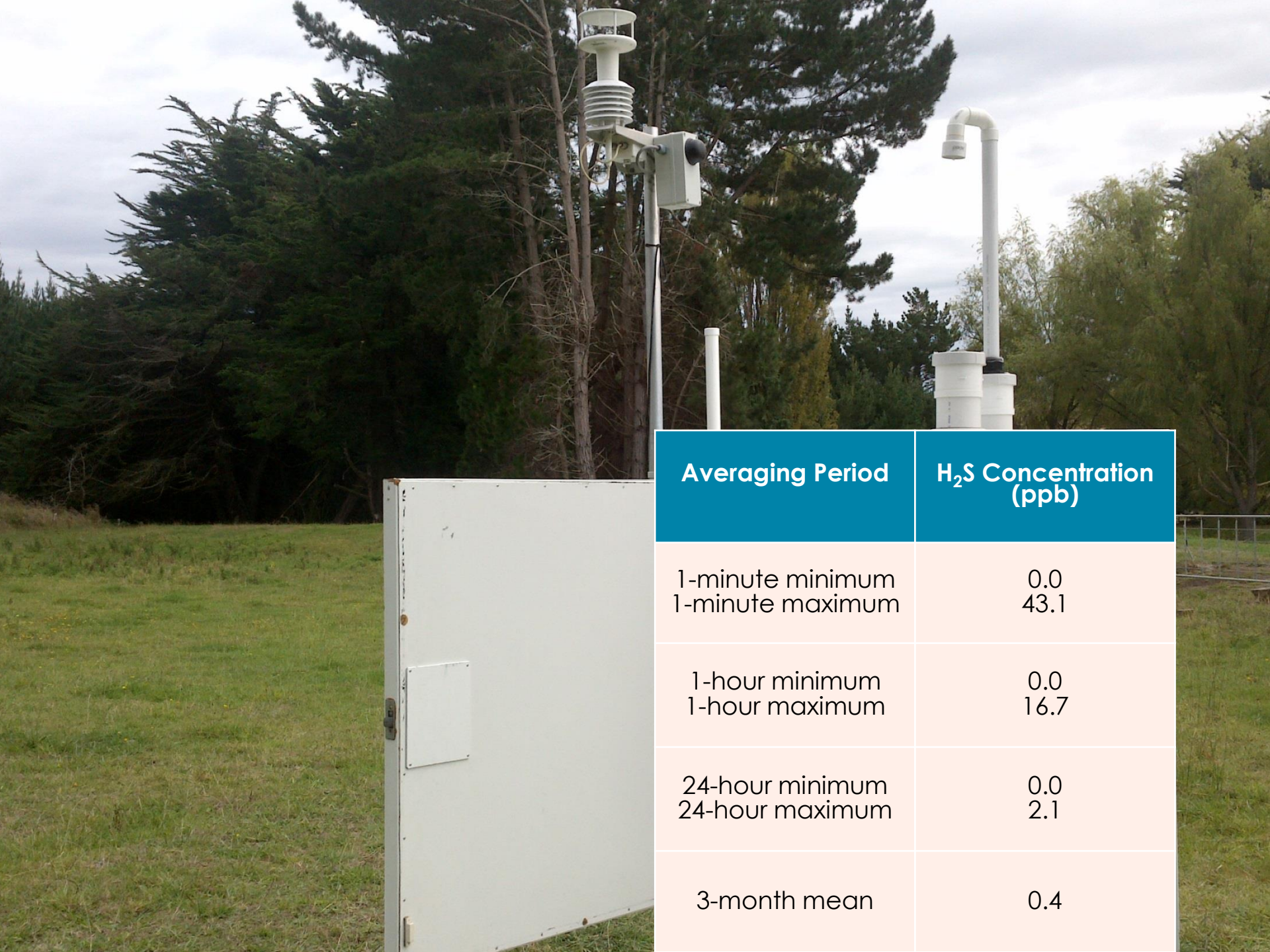
Assessing odour …

- The results for Scenario 3 suggest that with the application of effective cover across Stage 2 the maximum 99.9%ile 1-hour mean concentration at receptor 'R1' would be 1 OU/m^3
- Odour has the potential to be detected from time-to-time but is unlikely to be objectionable or offensive (i.e. result in a nuisance complaint)
- The results for Scenario 2 indicate that the biofilter alone is unlikely to result in a significant reduction in odour beyond the site boundary

Assessing odour …

Ambient monitoring for hydrogen sulphide

- Concentrations of H_2S were measured at sensitive receptor 'R1' over a period of 3 months between 17 March and 18 June 2015
- The sampling port was positioned at a height of 2 m above ground level
- An ultrasonic anemometer was co-located with the sampling port to measure wind speed and wind direction



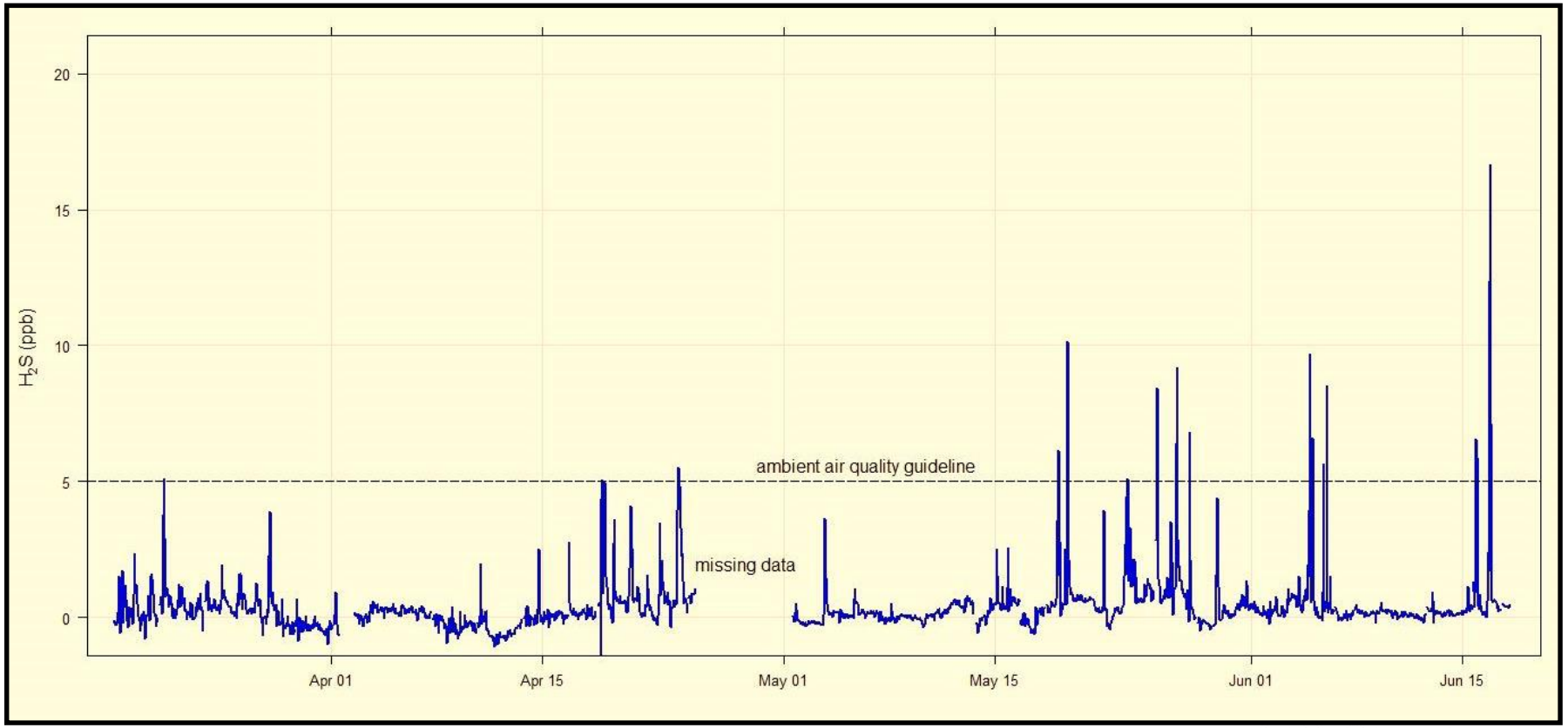
Averaging Period	H_2S Concentration (ppb)
1-minute minimum 1-minute maximum	0.0 43.1
1-hour minimum 1-hour maximum	0.0 16.7
24-hour minimum 24-hour maximum	0.0 2.1
3-month mean	0.4

Assessing odour …

- Exceedances of the New Zealand Ambient Air Quality Guideline (AAQG) of 7 µg/m^3 as a 1-hour mean (or 5 ppb at 20 °C) were measured on **23 separate occasions** (1% of the total 1-hour periods or 2,221 hours)
- The majority of the exceedances occurred during:
  - Westerly (W) winds (43%)
  - West-north-westerly (WNW) winds (22%)
  - West-south-westerly (WSW) winds (13%)
- The monitoring data indicate that the exceedances occurred during the evening or early morning and under calm to low wind conditions of between 0.2 m/s and 0.7 m/s

Assessing odour …

Time-series plot showing1-hour mean H_2S (ppb) for 17 March to 18 June 2015



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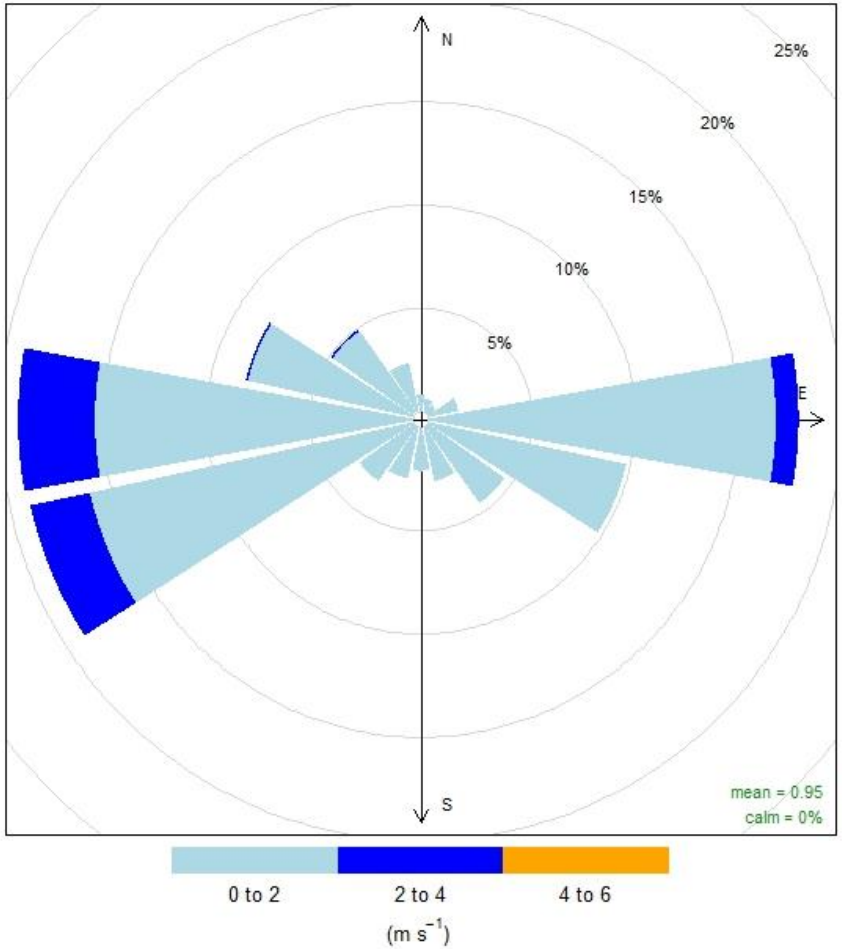
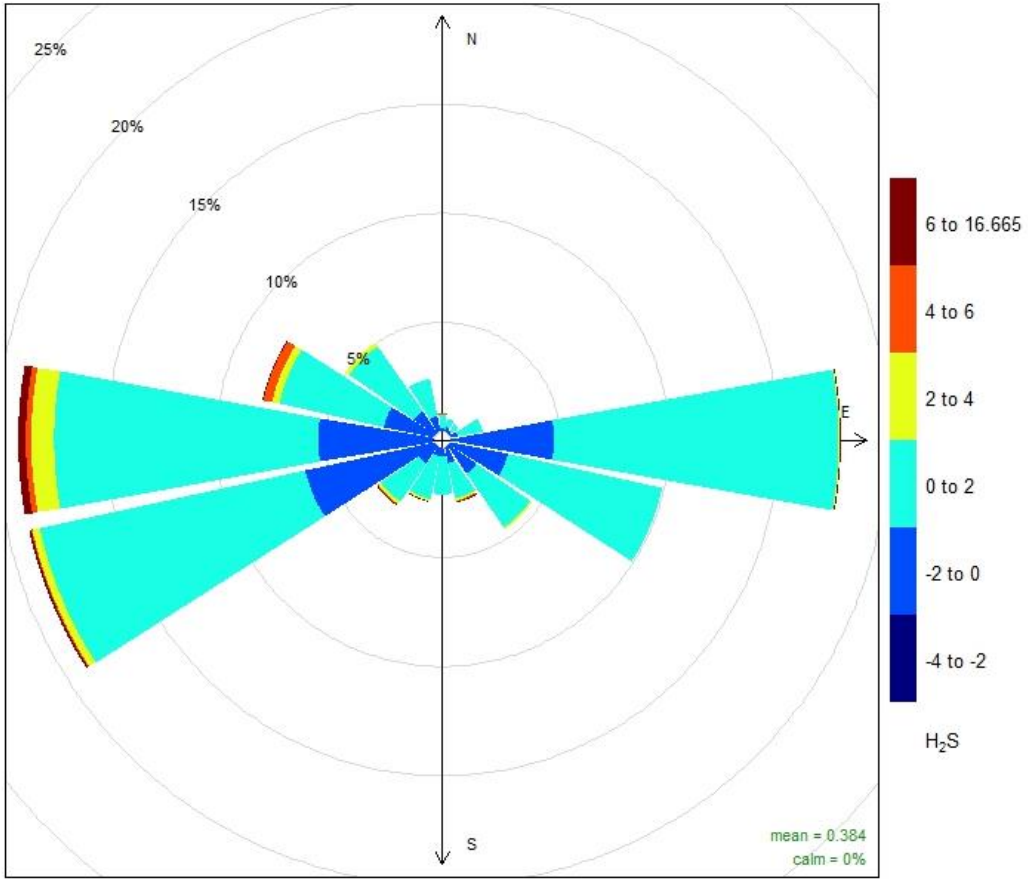
Assessing odour …

Wind rose showing 1-hour mean wind speed and direction for 17 March to 18 June 2015



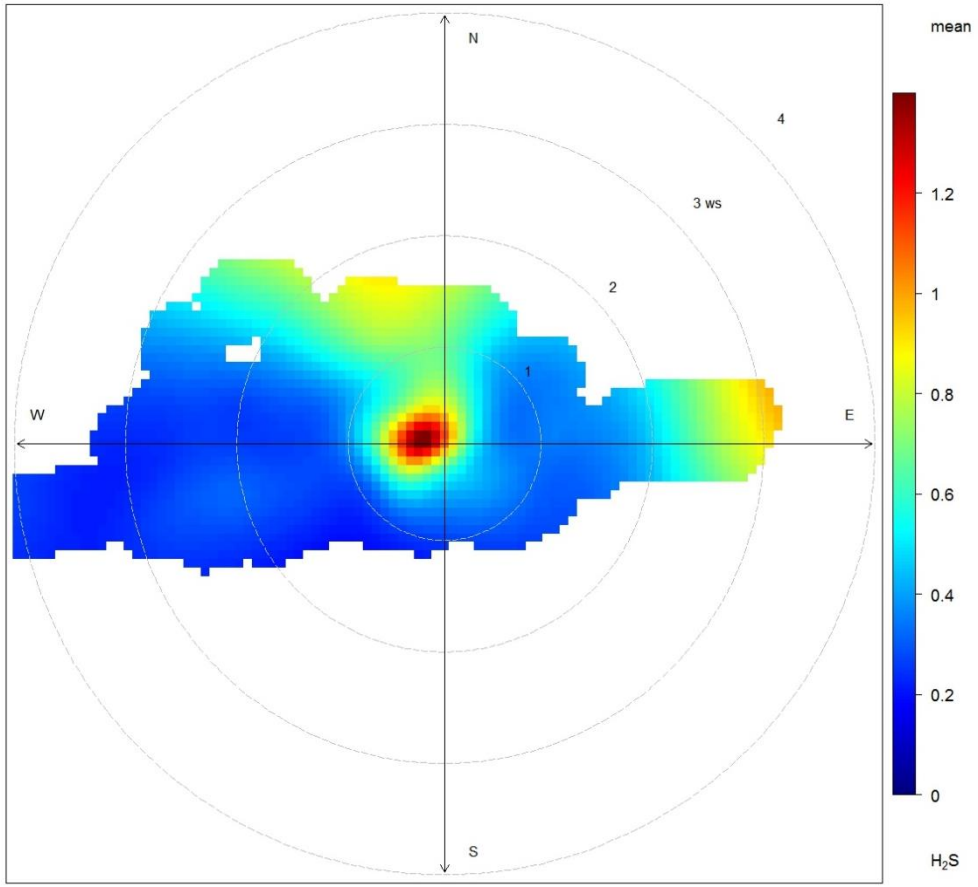
Assessing odour …

Pollution rose for 1-hour mean H_2S (ppb) and wind direction for 17 March to 18 June 2015



Assessing odour …

Polar plot for 1-hour mean H_2S (ppb), wind speed and wind direction



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4 Mitigating odour

Mitigating odour …

- Implement an odour management plan (OMP)
- Apply effective capping over intermediate cover to reduce fugitive odour/LFG emissions
- Expand the existing gas collection system (GCS)
- Treat the LFG by combustion in a new flare
- Treat odorous air from the leachate collection sump in a biofilter or flare

Mitigating odour …

- Control odour at the leachate pond (e.g. reduce residence time, avoid certain wind conditions for planned maintenance, use mechanical aeration)
- Control odour at the working face (e.g. keep an adequate supply of daily cover, regularly inspect cover integrity, deep and prompt burial of malodourous waste)
- Undertake regular monitoring, such as field odour investigations, LFG monitoring and biofilter/flare performance testing
- Update and enhance the odour complaints investigation and recording procedure

5 Conclusions

Conclusions …

- The principal emission sources of odour at the landfill were:
  - The leachate collection manhole
  - Stage 2 emission hotspots (intermediate cover)
- The H_2S monitoring results indicate that there is likely to be another emission source of H_2S located to the NW of the monitoring site, which may have contributed to the past odour nuisance events at receptor 'R1'
- Employing the recommended mitigation measures will reduce the potential for further odour nuisance effects arising in the community

Questions?

Investigating Odour Nuisance Effects at a Landfill

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Relating Odour Impact (or Offensiveness) to Nuisance

The 'FIDOL' Factors		Factors Determining Odour Impact	Comments
F	**FREQUENCY**	Frequency - how often an individual is exposed to odour	Pleasant and unpleasant / background odours
I	**INTENSITY**	Level of odour	Perceived strength, proportional to $\log_{10}$ concentration
D	**DURATION**	Duration	Length of exposure event / duration of exposure
O	**OFFENSIVENESS**	Type of odour	Hedonic tone / character and concentration / intensity
L	**LOCATION**	1. The characteristics of the neighbourhood where odour occurs 2. The sensitivity of the complainant	'Nuisance' uses the concept of the 'average, reasonable person' / hypersensitivity / habituation and adaptation

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Sample ID	Source	Flow Rate (L/min)	Flow Rate (m^3/s)	Odour Concentration (OU/m^3)	Flux Hood Area (m^2)	Odour Emission Rate ($OU.m^3/s/m^2$)	Minimum Odour Concentration (OU/m^3)	Maximum Odour Concentration (OU/m^3)	Range in Odour Concentration (OU/m^3)	Mean Odour Concentration (OU/m^3)	Coefficient of Variation (CV) (as %)
001	**Monitoring Location A** Leachate Pond	3	0.00005	220	0.12	0.09	170	270	100	220	23%
002		3	0.00005	270	0.12	0.11	-	-	-	-	-
003		3	0.00005	170	0.12	0.07	-	-	-	-	-
004	**Monitoring Location B** Leachate Collection Manhole Cover	3	0.00005	57000	0.12	23.75	53000	57000	4000	55667	4%
005		3	0.00005	57000	0.12	23.75	-	-	-	-	-
006		3	0.00005	53000	0.12	22.08	-	-	-	-	-
007	**Blank**	3	0.00005	<16	0.12	-	-	-	-	-	-
008	**Monitoring Location C** Stage 2 Landfill Surface - Open Pipe Near Eastern Boundary of Stage 2	3	0.00005	11000	0.12	4.58	11000	14000	3000	12500	17%
009		3	0.00005	14000	0.12	5.83	-	-	-	-	-
010	**Monitoring Location D** Working Face (Roaming: 4 Separate Monitoring Locations)	3	0.00005	360	0.12	0.15	360	3600	3240	2240	73%
011		3	0.00005	1400	0.12	0.58	-	-	-	-	-
012		3	0.00005	3600	0.12	1.50	-	-	-	-	-
013		3	0.00005	3600	0.12	1.50	-	-	-	-	-
014	**Monitoring Location E** Stage 2 Landfill Surface - Near Eastern Boundary of Stage 2	3	0.00005	2700	0.12	1.13	2400	2700	300	2567	6%
015		3	0.00005	2600	0.12	1.08	-	-	-	-	-
016		3	0.00005	2400	0.12	1.00	-	-	-	-	-
017	**Monitoring Location F** Stage 2 Landfill Surface - Near Southern Boundary of Stage 2	3	0.00005	1200	0.12	0.50	1200	4300	3100	2733	57%
018		3	0.00005	4300	0.12	1.79	-	-	-	-	-
019		3	0.00005	2700	0.12	1.13	-	-	-	-	-

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