ABN 92 160 694 011

Odour Assessment – Te Mata Mushrooms

Report prepared for:
The Te Mata Mushroom Company Limited

19 December 2016

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Appendices

1 Introduction

The Te Mata Mushroom Company (TMM) operates a mushroom growing factory near Havelock North, Hawke's Bay. The factory includes a compost making facility where the compost substrate for growing the mushrooms is prepared.

The composting facility has historically been surrounded by rural-type activities including a camping ground, but in recent times has been subject to urban encroachment with residential subdivision occurring close by.

The operation was granted a new resource consent on 13 April 2011, DP100128A. As part of the technical supporting information for that consent application, a report on odour emissions and mitigation options for the composting operation was prepared by Beca in 2010[1] (herein referred to as the Beca Report (2010)).

The frequency of complaints made to Hawke's Bay Regional Council alleging adverse odour impacts from the TMM site has increased in recent years. During this time, there have been no discernible changes in processes over recent times compared to previous years that an increase in complaints could be attributable to. On the contrary, the site has undertaken a number of odour reduction initiatives. The operation has for some 10 years plus continued to produce up to 120 tonnes of compost per week. However, due to the nearby subdivision, around 160 new dwellings have recently been constructed closer to the site.

The purpose of this report is to identify the current sources of odour at the composting plant on the TMM site, assess complaint information, and to document recent and proposed odour mitigation measures. The potential impact of the proposal by TMM to increase compost production to 500 tonnes per week coinciding with the implementation of odour mitigation measures is also assessed.

[1] Beca Infrastructure Ltd (2010), "Te Mata Mushrooms Odour Source Assessment", prepared for Te Mata Mushrooms Ltd, February 2010.

2 Receiving Environment

2.1 Site Location

The TMM site is located at 174-176 Brookvale Road, Havelock North. The location is shown in Figure 1. The site is bounded by farmland. A recent housing development known as "Brookvale" is located to the southwest.

Figure 1: TMM site location. Image source: Google Earth Pro, image flown 7 September 2015 UTC.

Other activities with potential for odour emissions include a neighbouring farm with a small number of pigs, as shown in Figure 2. Odours from these pigs have the potential to be confused with odours from the composting plant.

The current land use zone map for the area is provided in Figure 3. The TMM site is surrounded by land zoned "Plains Production", with a General Residential zone to the west of Arataki Road. It is understood that the area immediately west of Arataki Road was zoned General Residential in 2007[2], and was previously zoned for rural purposes.

[2] Jacobs (2015). Reverse Sensitivity Assessment for Arataki Re-Zoning Proposal, Phase One Advice on Odour. Prepared for Hastings District Council, Final dated 29 May 2015.

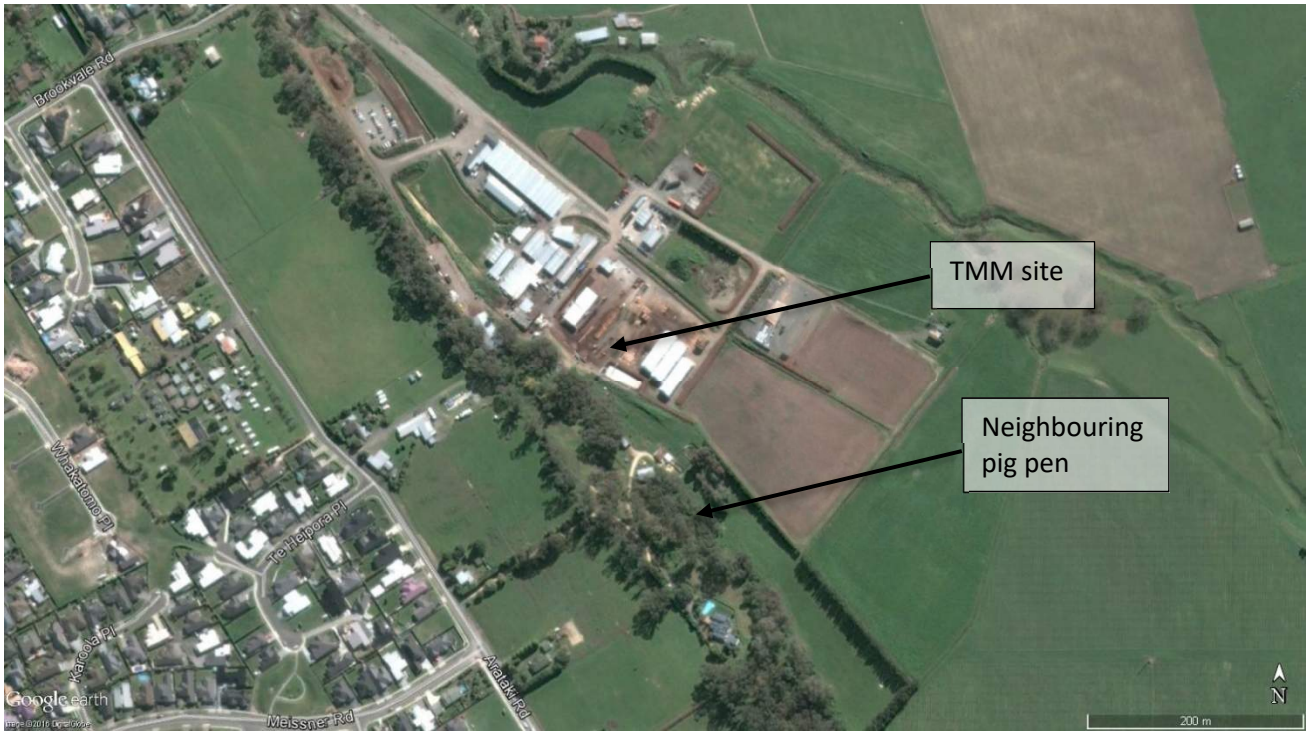


Figure 2: Location of TMM site and neighbouring pig pen. Image source: Google Earth Pro, image flown 7 September 2015 UTC.

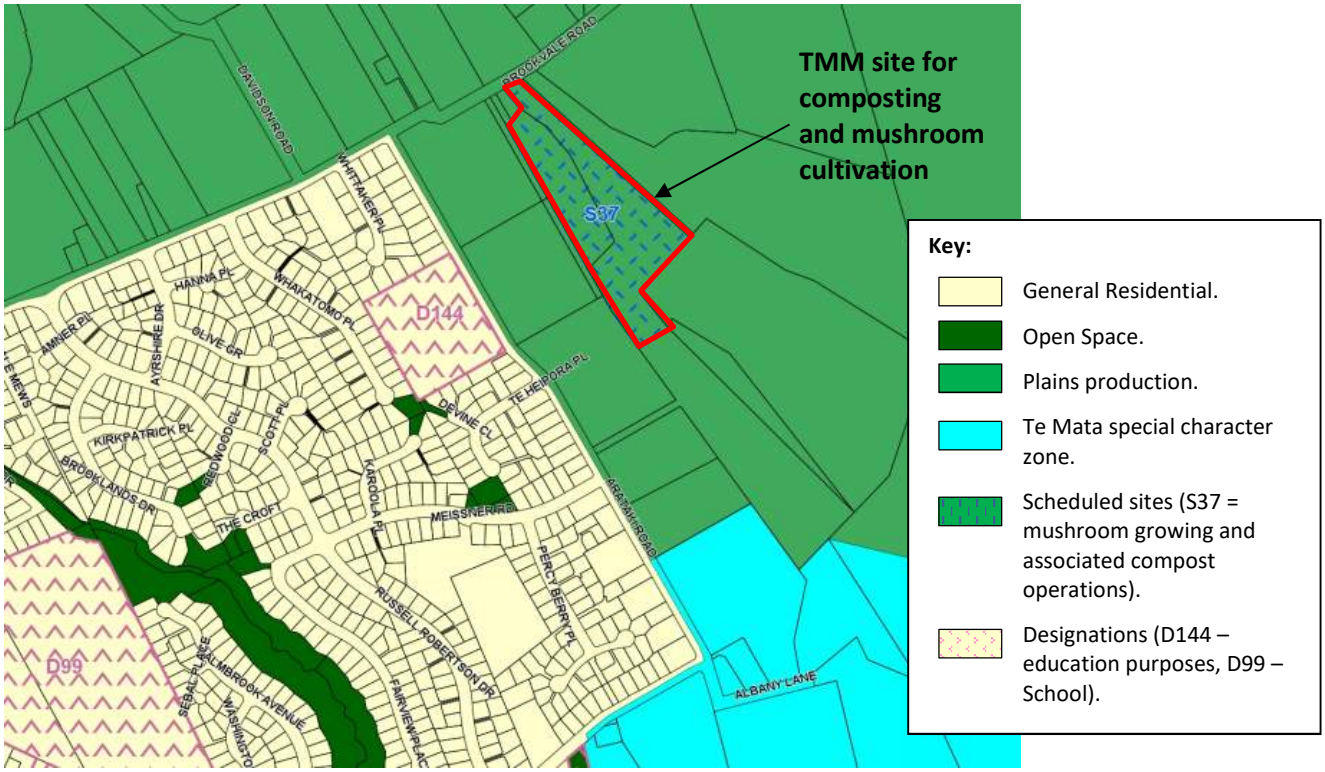


Figure 3: Land use zones around the TMM site, from Map 47 in Proposed Hastings District Plan as Amended by Decisions on Submissions, notified on 12 September 2015.

2.2 Change in Sensitivity of the Receiving Environment

The zoning of land to the west of Arataki Road as General Residential in 2007 has resulted in gradual encroachment of new houses towards the TMM site over the last nine years. The progression of residential development from 2003 to 2016 can be seen in the aerial photos in Appendix A.

The dramatic change in proximity of residential development from 2003 to 2016 shown in Appendix A, has brought about a number of challenges for TMM due to the change in sensitivity of the receiving environment to odour emissions:

- Odour emissions that were once acceptable are no longer acceptable.
- Odour mitigation is possible, but comes at a cost.
- Relocation is not economically viable (nor is it considered to be necessary).
- Increased production rates are required for the economies of scale necessary to compete with other producers and to make odour mitigation affordable.

3 Description of Activities

3.1 Composting

Compost is an essential part of the mushroom growing process and is used as part of the substrate that the mushrooms are grown on. Compost consists of straw, chicken litter and gypsum. Other additives such as maize are also used when available. The key components of the composting process are described in this section. A number of photos illustrating the various processes are included in Appendix B.

The layout of the site is shown in Figure 4.

Figure 4: Site layout. Aerial photo taken 7 September 2015 (Monday) UTC, or 8 September 2015 (Tuesday) in local time. Photo shows Phase 1 compost removed from bunkers into windrows, ready for transfer to Phase 2 tunnels.

Straw is kept on a gravel pad on site until it is required. Chicken litter, premixed with gypsum before delivery to site, is stored in a concrete bunker which consists of a concrete pad, three solid walls, a soft-covered opening on the fourth wall, and a roof (Photo B1, Appendix B). The premixed litter is usually delivered once per week, typically mid-afternoon on a week day.

Mulched maize is stored in a separate bunker to the northeast of the bale-wetting area (Photo B2, Appendix B). This material has a mild sweetish smell.

The composting facility consists of four Phase 1 bunkers which are progressively emptied and filled to facilitate turning of compost via bunker-to-bunker transfer without the need to place compost into an outside windrow for turning. These bunkers have a concrete floor, two concrete walls and insulated panel roof, and the end openings are closed with permanent sliding curtain doors when not in use (Photo B3). The Phase 1 bunker concrete floors have recessed lines which act in parallel as a leachate collection system and aeration lines.

During the composting in Phase 1 air is blown through the composting material to maintain aerobic conditions. Oxygen and temperature probes are placed into the material in each bunker. Temperature probes are also located in the headspace near the roof of the bunker. An oxygen content of 6-8% within the compost is maintained, however this is often higher if extra air is needed for temperature control. Foul air within the bunker is drawn from the top of each bunker and blown through a bark biofilter (refer Section 4.1). The biofilter is visible to the right of the picture in Photo B3.

The bunker is normally operated under a slight vacuum or negative pressure compared to outside air. At the completion of the Phase 1 process, the compost is removed from the Phase 1 bunkers and placed on an outdoor pad, and transferred to the Phase 2 tunnels by front end loader.

The Phase 2 tunnels are roofed with a concrete floor, walls, and solid doors at each end (Photo B4). Oxygen probes and temperature gauges are inserted into the compost at several points. During the Phase 2 cycle, air in the bunker is recirculated at one end of the bunker, and a portion of the air is passively vented to atmosphere via the vents at the other end of the bunker (also shown in Photo B4). During filling of the Phase 2 bunkers, the ends of the bunkers are open to atmosphere.

Approximately 100 tonnes of compost is currently produced per week on average. Phase 1 takes about 12 days to complete, and the whole process from pre-wetting of bales until the compost is ready to grow mushrooms is nearly four weeks. Multiple batches of compost are in various stages of production at any time so that one batch of compost is completed every week. The current composting timeline showing two staggered batches is provided in Table 1.

3.2 Recycled Water Collection and Storage

The composting is all conducted on a concrete pad and all stormwater and leachate from the composting system is collected into the recycled water system through drain lines recessed into the concrete.

The recycled water is pumped to a storage pond, where it is continuously aerated and circulated (Photo B5, Appendix B). Dissolved oxygen is monitored continuously by automatic logger.

The recycled water is used to wet the bales.

Further details about the recycled water storage pond are provided in Section 4.2.

Table 1: Production schedule for two concurrent batches of compost showing staggered starting days.

Day	Batch 1	Batch 2
Thursday	Pre-Wet	
Friday		
Saturday		
Sunday		
Monday		
Tuesday		
Wednesday	Pre-Wet finished	
Thursday	Bale break, bunker filled	Pre-Wet
Friday		
Saturday		
Sunday		
Monday	Bunker-to-bunker transfer	
Tuesday		
Wednesday		Pre-Wet finished
Thursday		Bale break, bunker filled
Friday	Bunker-to-bunker transfer	
Saturday		
Sunday		
Monday		Bunker-to-bunker transfer
Tuesday	Remove, mix, enter Phase 2	
Wednesday		
Thursday		
Friday		Bunker-to-bunker transfer
Saturday		
Sunday		
Monday		
Tuesday	Remove compost from Phase 2	Remove, mix, enter Phase 2
Wednesday		
Thursday		
Friday		
Saturday		
Sunday		
Monday		
Tuesday		Remove compost from Phase 2

Composting Stage:

Pre-Wetting	
Phase 1	
Phase 2	

3.3 Used Compost Disposal

After the compost has been used as a growing medium for mushrooms, it is pasteurised and then transferred by a truck to a storage area. Up to 150m^3 of spent compost is removed from the processing operation every Thursday. The transfer process occurs over the course of about 6 hours, usually commencing at 6.30am.

The storage area is located near Brookvale Road west of the main site access way. The storage area is located within land leased from the Hastings District Council for this purpose.

Each batch of spent compost is stored within the storage area in uncovered piles for a maximum period of two weeks. Up to 300m^3 may be stored at any time. The spent compost is either sold in bulk to various parties over the next few days, or removed by a contractor.

4 Existing Odour Treatment

4.1 Biofilter

A biofilter is used to treat the air ventilated from the compost during Phase 1 (Photos B6 and B7, Appendix B). During two site visits by AirQP in September and October 2015, visual inspection of the biofilter found that it appeared to be in good condition and damp under the surface. The biofilter emitted no recognisable composting odours other than the faint but characteristic earthy odours commonly associated with well-operating biofilters.

The biofilter design specification is provided in Table 2.

Table 2: Biofilter specifications (from Beca (2010))

Design parameter	
Dimensions (external, design)	24.6m x 6.6m
Dimensions (internal, approx)	24m x 6m
Surface area	144m²
Depth	2m (1.5m Bark 10-20mm, 0.25m bark 25-75mm, 0.25m river gravel 20-40mm)
Volume	252 m³ (excludes depth of river gravel)
Biofilter media	Radiata pine bark with washed river gravel base
Maximum air flow	20250 m^3/hr (from fan specification curve)
Maximum hydraulic loading rate	80 m^3/hr per m^3 media

The fan speed is regulated by using an electronic variable speed fan drive and is regulated to keep the "Phase 1" bunkers at approximately 38 – 40°C when the doors are shut. Fresh air is added by manual duct adjustment at the biofilter inlet as required to maintain the inlet air temperature at 40°C or less. The biofilter inlet temperature is measured continuously and automatically logged, as discussed further below. The biofilter moisture is maintained at 50 – 70% using an irrigation system and is tested weekly.

A water spray system is installed in the duct upstream of the biofilter blower. This increases the humidity of the air entering the biofilter and may also act as a partial wet scrubber, removing some ammonia from the air stream.

The performance of the biofilter was independently reviewed by Beca Infrastructure Ltd in 2011. The report on that review is provided in Appendix C. The report concluded that "*the biofilter design is fit for purpose based on the current operating conditions and loading rates. The existing bark media is expected to remain in reasonable condition for the next 3-5 years*".

Maintenance of the biofilter has included the addition of 1 cubic metre of lime in May 2015, and 50 cubic metres of bark in June 2015.

Backpressure across the biofilter bed is recorded usually twice per day from a manometer mounted on the side of the biofilter wall. The backpressure ranges between 0 and 100 Pa (10mm water gauge), varying with the air flow rate applied to the bed. This is within the normal operating range for a bark biofilter (Cudmore & Gostomski, 2005)[3]. Recent measurements show no trend of increasing backpressure. Increasing backpressure over time could indicate media consolidation and time for media replacement.

Biofilter media moisture content and pH is tested regularly by an independent laboratory. Historical test results provided by TMM are listed in Table 3. The biofilter shows consistent moisture content and pH with no significant changes since 2012.

Table 3: Biofilter media test results, moisture content and pH

Date of test	pH	Moisture content*
August 2011	4.2	69.8%
February 2012	7.0	66.1%
August 2012	5.9	68.7%
April 2013	6.1	63.3%
August 2014	6.3	68.8%
September 2015	6.4	63.3%

* Tested fortnightly, selection of results only shown to illustrate trends.

The temperature of the air stream entering the biofilter is closely monitored. A datalogger was installed in October 2015 allowing continuous monitoring and automatic logging of temperature data. Prior to the installation of the datalogger, temperature was manually recorded at least twice per day (morning and afternoon). Temperatures recorded manually from July 2014 to October 2015 are plotted in Figure 5. Temperatures recorded from July 2016 once consistent electronic logging of automatically monitored data was established are plotted in Figure 6. The recommended maximum temperature for a biofilter is less than 40 degrees, although brief excursions above this temperature are usually well tolerated. The biofilter is operating within the optimum range for microbial activity, important for good odour treatment.

[3] Cudmore, R. and Gostomski, P. (2005): *Biofilter Design and Operation for Odor Control – The New Zealand Experience*. In, Shareefdeen, Z. and Singh, A. (Eds): *Biotechnology for Odor and Air Pollution Control*, Springer (2005).

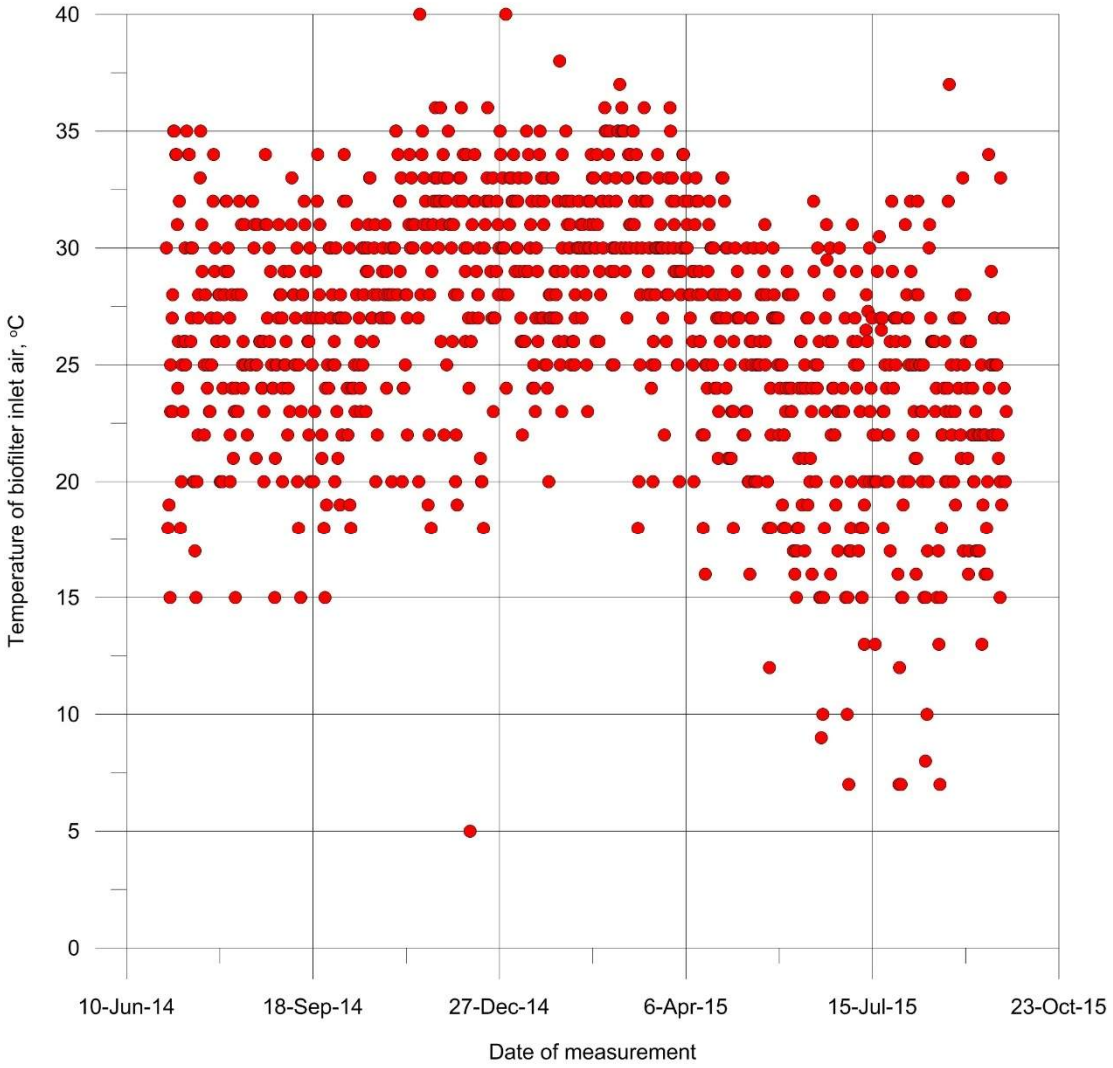


Figure 5: Biofilter temperatures recorded manually at inlet air duct, prior to commissioning of automatic logger in October 2015.

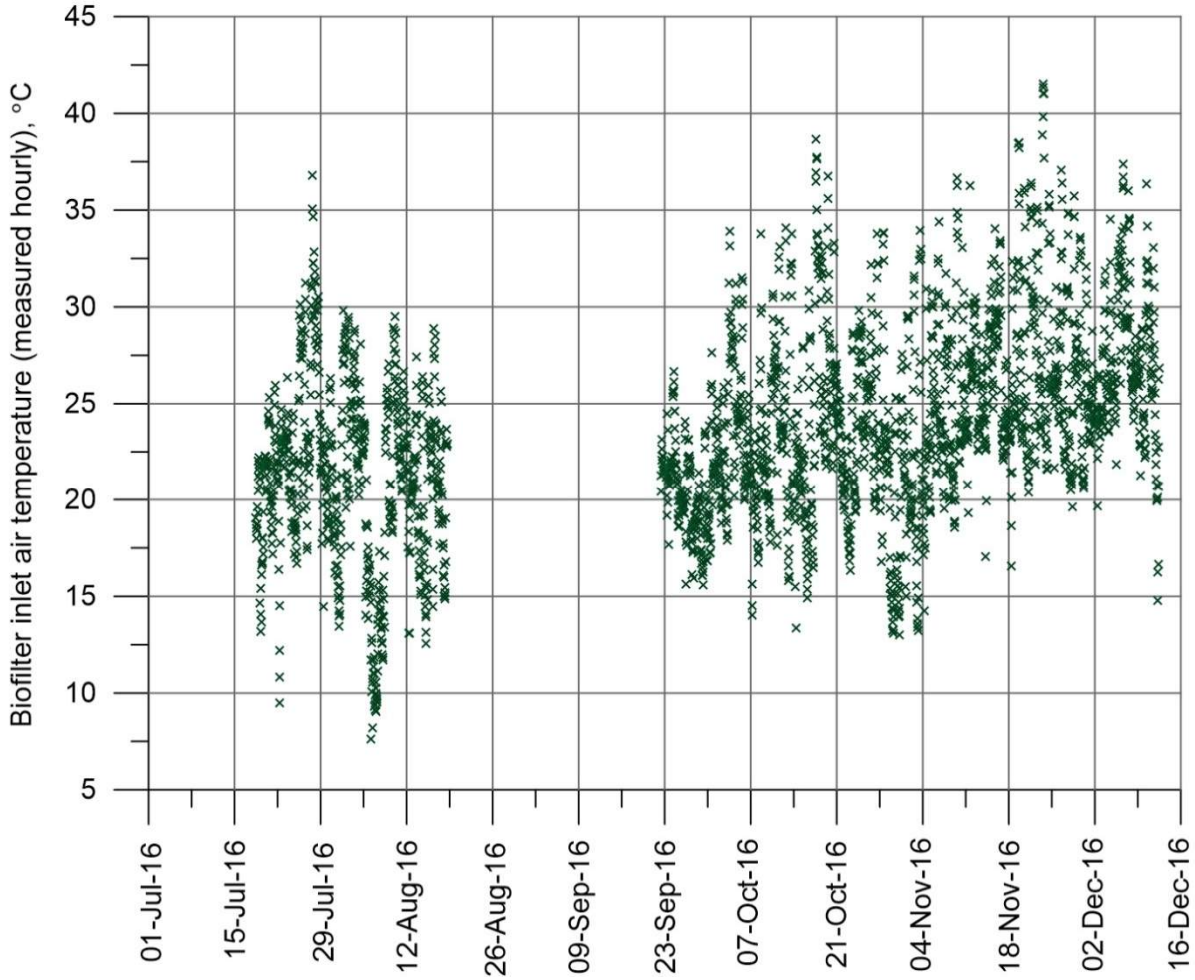


Figure 6: Biofilter temperatures recorded automatically at inlet air duct, from July 2016.

4.2 Recycled Water Storage Pond

At the time of the Beca Report (2010), recycled water collected at the site was aerated by recirculation through a collection sump (Photo B8) and then transferred to a holding pond that was not aerated (Photo B9). The Beca Report (2010) identified some potential issues with this recycled water management system that may lead to odour generation: "*Whilst the recycled water is aerated by recirculation though the sump, the recycled water is highly organically loaded and may be consuming the oxygen rapidly in the pond. The aeration provided in the sump may not be sufficient to maintain the recycled water in the pond in an aerobic state.*" It was recommended that *"Monitoring of dissolved oxygen levels in the pond is required, followed by review of aeration capacity of recycled water system if dissolved oxygen levels are less than approximately 1 mg/L. Degree of mitigation required will depend on the outcomes of this review."*

Monitoring of dissolved oxygen concentrations commenced following the production of that report. Monitoring indicated dissolved oxygen levels frequently below 1 mg/L. Following an internal review of management of recycled water at the site, a new recycled water pond was constructed at the site in 2015

(Photo B5), slightly to the south of the old pond. The new pond was fully commissioned in August 2015, with the old pond subsequently decommissioned and back-filled. Aeration was removed from the collection sump (Photo B10), and a new high-rate aeration system was introduced to the new pond.

The recycled water aeration system used in the new pond is an SAR™ Aerator from Hydro Processing and Mining Ltd (Canada)[4], proven in the field for mushroom composting farms. The aerator design recirculated recycled water through a land-mounted aerator, with the aerated water returned to the pond.

Following installation of an automatic datalogger in October 2015, dissolved oxygen levels in the pond are now monitored continuously. Prior to that installation, dissolved oxygen levels were recorded manually at least two times per day. Monitoring data for the period October 2015 to December 2016 is shown in Figure 7. The new recycled water pond consistently reports dissolved oxygen levels exceeding 2 mg/L, twice the concentration required by the current resource consent. This is considered sufficient to maintain the recycled water in aerobic condition in the pond.

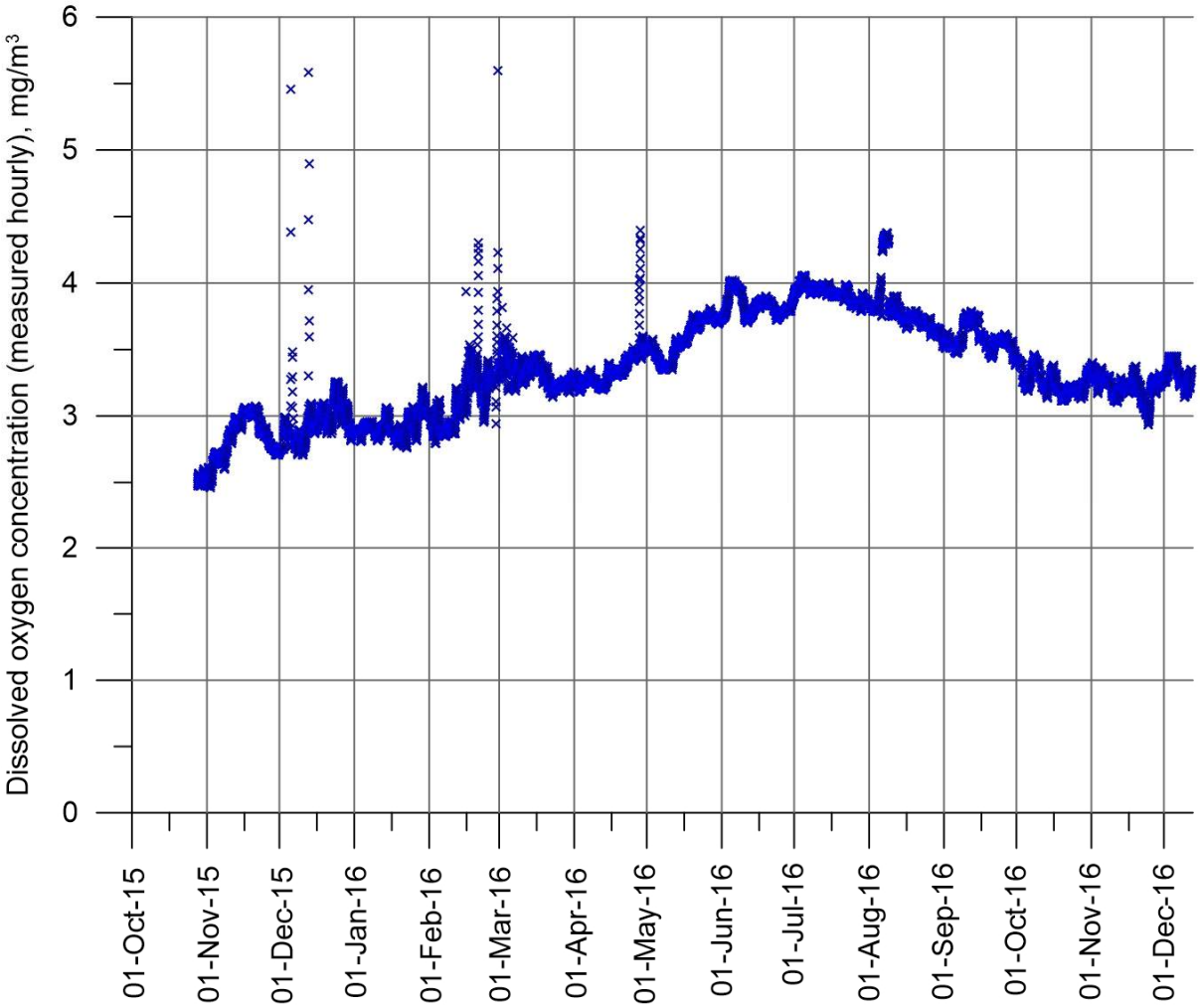


Figure 7: Dissolved oxygen monitoring results in recycled water pond, Oct 2015 – Dec 2016, hourly readings.

[4] http://www.hpmltd.ca/Aeration.html

4.3 Odour Control Sprays

Odour control sprays were historically provided around the composting yard at many fugitive odour emission points. The odour control chemical that was used was called "Super Spice" from Cyndan Chemicals (supplied by Hi-Chem NZ Ltd), and it is understood this was originally recommended by the Hawke's Bay Regional Council.

TMM has ceased to use the odour control sprays in late 2014, as complaints had been attributed to the smell of the "Super Spice" and the sprays were considered by management to be of little benefit in the current form as an odour control mechanism. This decision was made in consultation with, and with the agreement of, HBRC. However, odour neutralising chemicals may be considered for use at air extraction points on the site following the upgrades described in Section 9, provided that the chemicals can be demonstrated to have no negative impact on compost quality and mushroom growth.

5 Additional Odour Mitigation Approach

5.1 Typical Best Practice Approach

When considering any activity that discharges an unacceptable amount of odour, each odour mitigation strategy is unique to the site in question. A strategy that works at one location may not necessarily be the most appropriate or effective at another site.

Best practice for identifying an odour mitigation strategy for any particular site, regardless of the type of product and materials handled at the site, follows the hierarchy of:

1. Identify the various odour sources and rate their contributions to off-site odour impacts, considering all of the FIDO[5] factors that describe any particular odour emission:
    a. Magnitude of odour emission
    b. Character of the odour emission
    c. Time of day when the odour is emitted, especially coinciding with complaints and meteorological conditions that are unfavourable for dispersion
2. Reduce the generation of odour and/or modify the character of the odour where possible by:
    a. Optimising processes and monitoring
    b. Reducing opportunities for anaerobic conditions in processes and wastes (unless this is a critical production requirement)
    c. Upgrading site infrastructure and maintenance to improve site cleanliness and reduce fugitive odours
3. Prevent release of odours from sources considered to have the potential to make a significant contribution to off-site odour impacts, by capturing these odours at the point of release and treating those captured odours to remove odour.
4. Discharge treated or untreated captured odours through a stack designed to optimise the rate of dilution and dispersion of the odours.

It is common when reviewing the relative contributions of various sources under (1) above to have one or more sources that are clearly significant contributors, one or more sources that are clearly minor contributors, and one or more sources that are difficult to categorise as either significant or minor at the outset. Therefore, odour mitigation strategies frequently take the form of a staged odour control approach whereby the most significant sources are dealt with first, then the odour compliance performance of the site is monitored and reviewed to determine whether additional mitigation is still necessary.

[5] FIDO – the frequency, intensity, duration and offensiveness of the odour noticed by a sensitive receptor

Sometimes, a site may decide to just enclose all of the odour sources and operate the enclosed space under negative pressure forced ventilation, with air extracted from the enclosed space treated to remove odour and/or discharged through a stack. Examples of where complete enclosure of Phase 1 composting has occurred or is proposed for sites carrying out composting to prepare mushroom-growing substrate can be found on the internet. However, it is usually not necessary for an established industrial/production site to move directly to a decision of full enclosure as there are significant associated engineering, materials handling, staff health/safety, and cost implications. In addition, complete enclosure results in a very large volume of weak odour requiring treatment in very large and expensive odour control systems, as opposed to targeted capture of odours at source which results in a smaller volume of air with stronger odour concentration which can be more sustainably treated.

5.2 Odour Control Objective

A production site like TMM cannot achieve 100% capture and treatment of odour, however this is not required to meet a “no offensive or objectionable odour” outcome. The objective is not to avoid detection of all odour, but to reduce the frequency, intensity, unpleasant characteristics, and duration of odour occurrence to the extent that any odour noticed at a sensitive receptor is not deemed to be offensive or objectionable.

5.3 Mitigation Approach Used at TMM

The approach used to identify an odour mitigation strategy at the TMM site has focussed on:

1. Changing the way activities are carried out so that the potential for odour generation is minimised, including the hedonic tone of any residual odour (i.e. reducing the potential for that odour to be regarded as offensive or objectionable due to its degree of unpleasantness).
2. Where sufficient reduction of odour generation is not possible, focus is on odour capture and treatment at source.

In order to identify the odour control measures required to achieve this strategy, a full review of local meteorology, complaint patterns, and site odour sources has been carried out and these are presented in the following sections of the report.

6 Meteorology

6.1 Influence of Meteorology in Odour Dispersion

The most important meteorological conditions affecting dispersion of odour after emission are wind speed and direction, and atmospheric stability.

Wind speed: For emissions occurring close to ground or entrained in building downwash eddies, low wind speeds (roughly less than about 2 - 3 metres per second, or 4 - 6 knots) tend to result in noticeable odour at greater downwind distances than at higher wind speeds.

Atmospheric stability: The atmospheric stability is a measure of the vertical mixing, or turbulence, of the atmosphere close to ground. During low wind speeds around sunset and sunrise, and overnight, the atmosphere can be very stable with "inversion" caps keeping pollutants emitted close to the ground from rising high into the atmosphere. If such conditions coincide with odour emissions from sources located close to the ground, such as the odour sources at TMM, the dispersion of odour downwind from the source can be slow with odour nuisance more likely to be noticed by downwind sensitive receptors. These stable atmospheric conditions do not occur during the daytime, so avoiding odour discharges during stable conditions (such as around sunrise) can be a good way of reducing or limiting the risk of odour nuisance.

6.2 Local Wind Records

The nearest long-term meteorological monitoring station with publicly available data is at Whakatu, about 10.5 km north-northwest of the TMM site (refer Figure 8).

Wind patterns at TMM may differ somewhat to those at Whakatu because the TMM site is closer to the hills at the southeastern end of the Bay and is also more distant from the coast. The main significant wind direction for carrying odour towards Brookvale is an easterly/northeasterly, and the frequency of occurrence of these winds are likely to be similar at both the Whakatu and TMM sites. However, overall wind speeds would be expected to be slightly lower at TMM than at Whakatu.

Hourly wind speed and direction data between January 2006 and December 2015 for Whakatu was downloaded from the online National Climate Database (also known as the NIWA Cliflo Database)[6]. Station information provided with the Cliflo data indicates that wind records from this station are expressed as a one-hour average (rather than a 10-minute average recorded once per hour, which is commonly used at airport stations such as Napier).

A windrose for Whakatu is shown in Figure 9. This shows that the prevailing wind is a southwesterly, which would carry odours from the site away from any sensitive receptors. This windrose is also shown overlaid on a site locality map in Figure 10. Any winds recorded from the north through to east-southeast wind directions (segment defined moving clockwise) are considered to have the potential to carry odours from TMM towards sensitive receptors in the Brookvale area.

[6] https://cliflo.niwa.co.nz/.

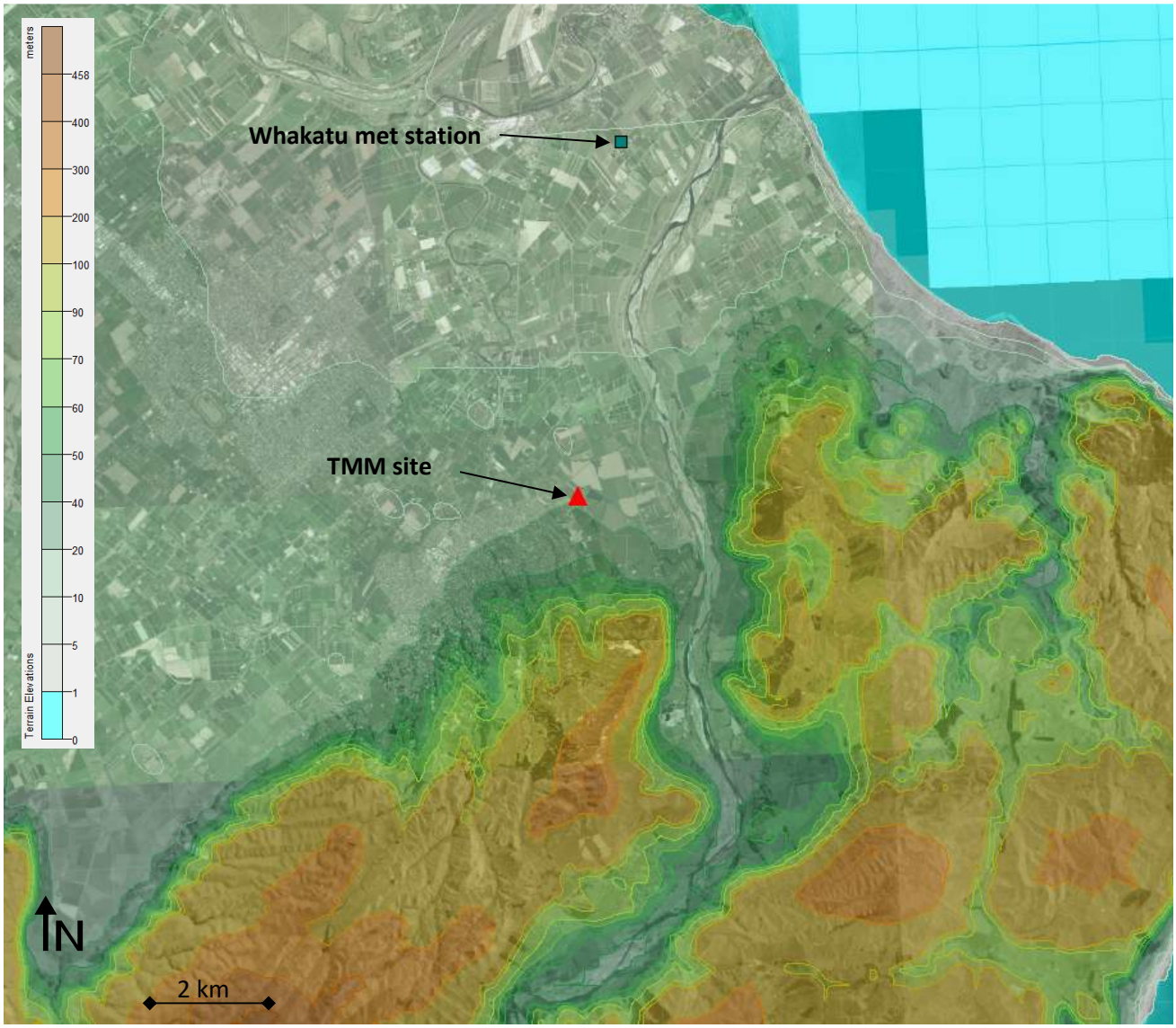


Figure 8: Regional terrain, and location of Whakatu meteorological data station and proximity to TMM site.

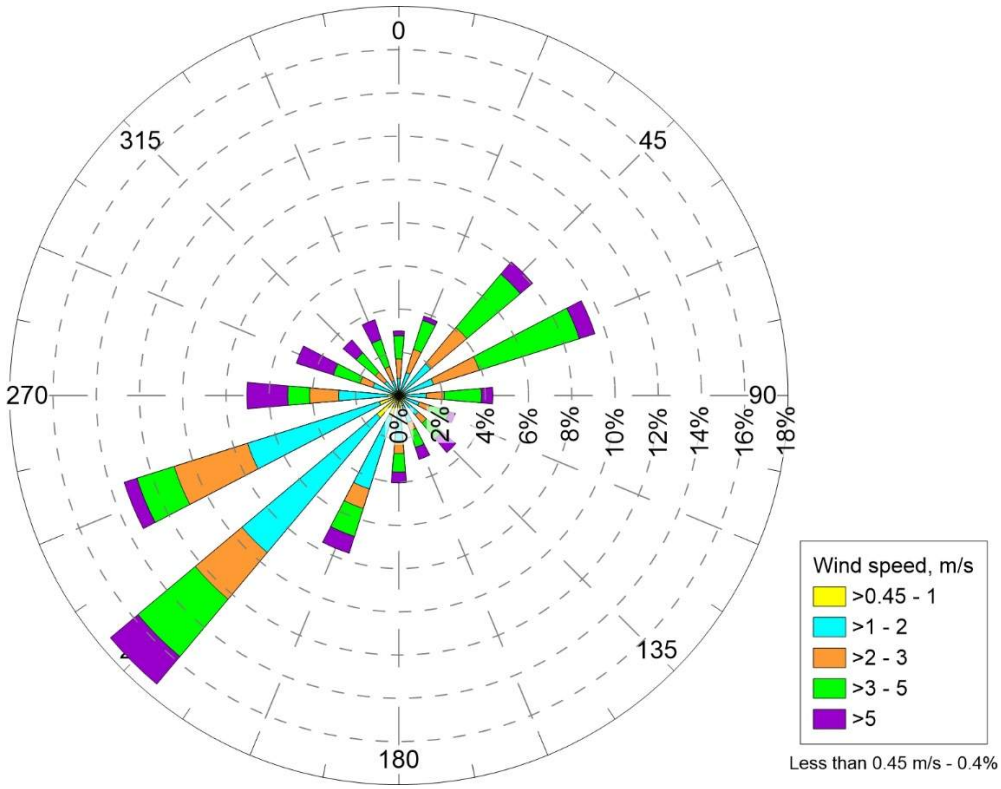


Figure 9: Windrose showing hourly-average wind observations from Whakatu meteorological data station January 2010 to December 2015.

Figure 10: Windrose from Figure 9 (monitoring data from Whakatu), overlaid on aerial map of TMM site and surrounds.

Wind patterns at TMM are also influenced by a ridge which lies along the southwestern boundary of the site (Figure 11). Terrain to the southwest of this ridge, where the new residential subdivision of Brookvale is located, remains at the same height as the ridge several metres higher in elevation than the TMM site. Wind directions are observed to fluctuate and swirl around the site, in response to the presence of the ridge. This ridge, as well as trees planted along the ridge which increase the effective height of the ridge, will help provide some enhanced initial dilution of any odours from the composting plant.

Figure 11: Ridge and trees on southwest boundary of TMM property.

6.3 HBRC Wind Monitoring in Arataki Rd

In 2013, HBRC established a wind monitoring site in Arataki Road. The site and location is shown in Figures 11 and 12. The wind sensor is a ball-and-vane type, mounted 2.4m above ground as confirmed by HBRC.

Whilst the site aims to monitor local wind conditions, which is to be supported, the site location is problematic due to the location and height of the wind monitoring equipment, which is inadequate to avoid interference from trees and nearby obstacles such as parked motorhomes. In addition, the cup-and-vane wind sensor type is not suitable for monitoring low wind speeds (less than about 0.4-1m/s depending on sensor make and model).

Data from the monitoring station was provided by HBRC for the period September 2013 to September 2015. The data is recorded at 10-minute intervals, and reported in units of kilometres per hour (km/h). It is assumed that the speed data is an average over the preceding 10 minutes. The minimum recorded wind speed was 1.26 km/h (0.35 m/s), with no wind speeds recorded as 0 m/s.

A windrose of the wind data records from the site for the full two years of data provided is shown in Figure 11. This windrose includes all data at the minimum reported wind speed, even though the reliability of wind speed and direction records at the minimum wind speed threshold is uncertain. Compared to the Whakatu windrose in Figure 9, the Arataki Road windrose shows a much higher frequency of low wind speeds. The Arataki Road windrose also shows markedly different wind direction trends, particularly for wind directions from the SW and ESE/SE sectors.

Figure 12: Location of HBRC wind monitoring site off Arataki Road.

The differences in wind speed distributions between the Arataki Road and Whakatu monitoring sites are likely to be due in a large part to the height and location of the Arataki Road wind sensor. No meaningful wind speed comparisons are therefore possible.

The windrose from Figure 14 is overlaid on an aerial map in Figure 15. It is considered that the dominant ESE/SE/SSE rays in the windrose, which are not present in the Whakatu data, are caused at least in part by the line of trees on the ridge which runs NNW-SSE between the TMM site and the wind monitoring site, as well as other obstacles in proximity to the monitoring mast. It is also considered likely that the absence of a dominant SW air flow in the monitored data is caused at least in part by the local sheltering of the treeline and obstacles.

Another factor affecting local winds at the Arataki Road site may be the proximity of the Tukituki River valley which opens out to the plains about 2.2km from the TMM site (refer Figure 8). However, air flows draining out of that valley would be expected to continue north/northeast towards the coast rather than swinging west/northwest towards the TMM site, unless regional-scale winds were also blowing from the west/northwest.

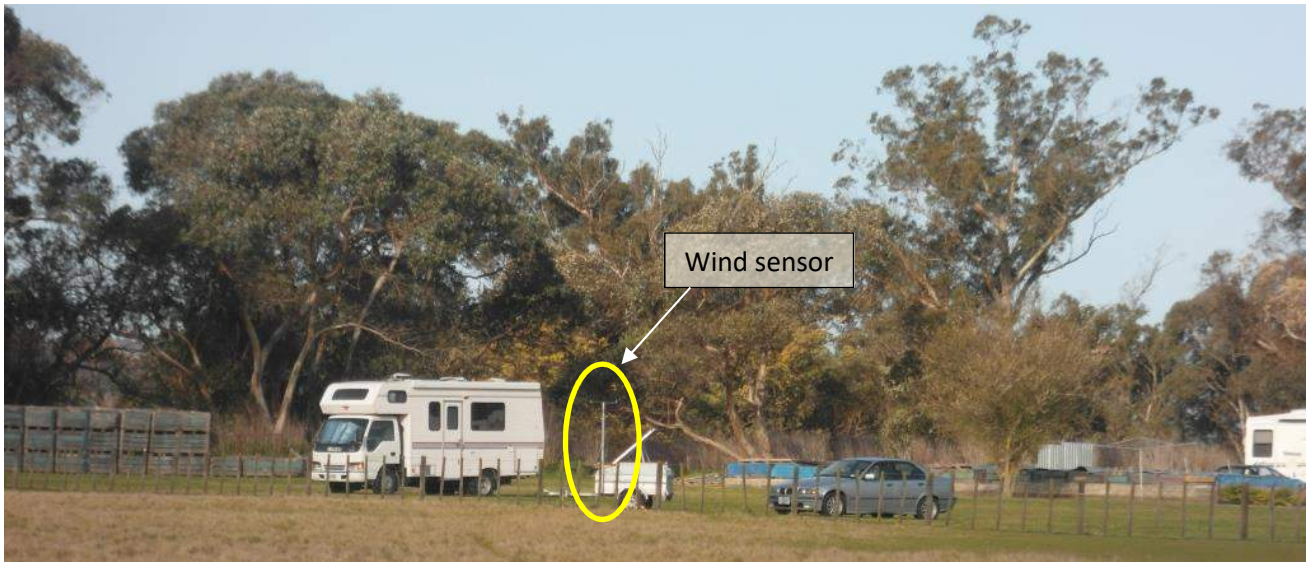


Figure 13a: Arataki Road wind sensor, photo taken from Arataki Road on 14 September 2015.

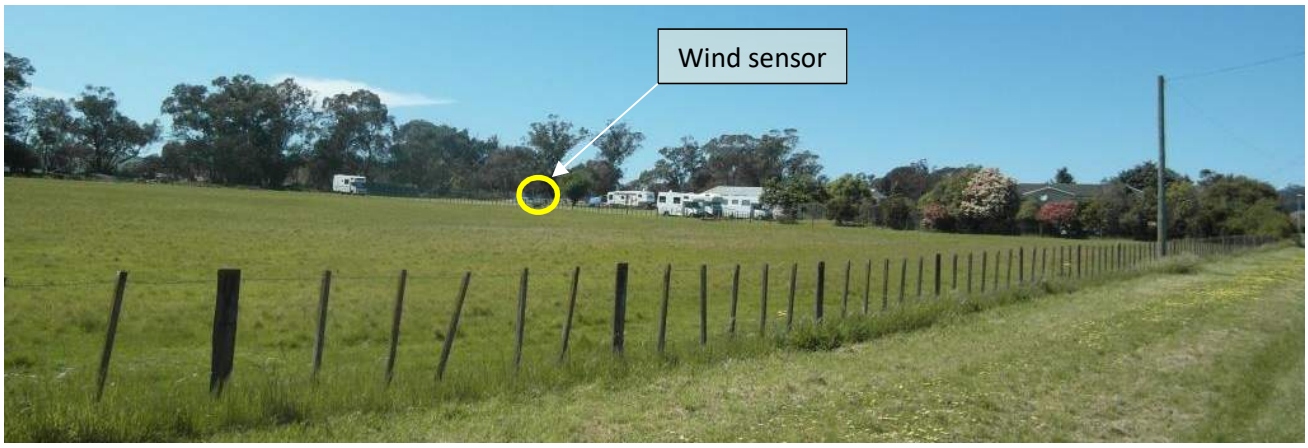


Figure 12b: Arataki Road wind sensor, photo taken from Arataki Road on 15 October 2015.

Figure 12c: Arataki Road wind sensor, photo taken from Arataki Road on 15 October 2015.

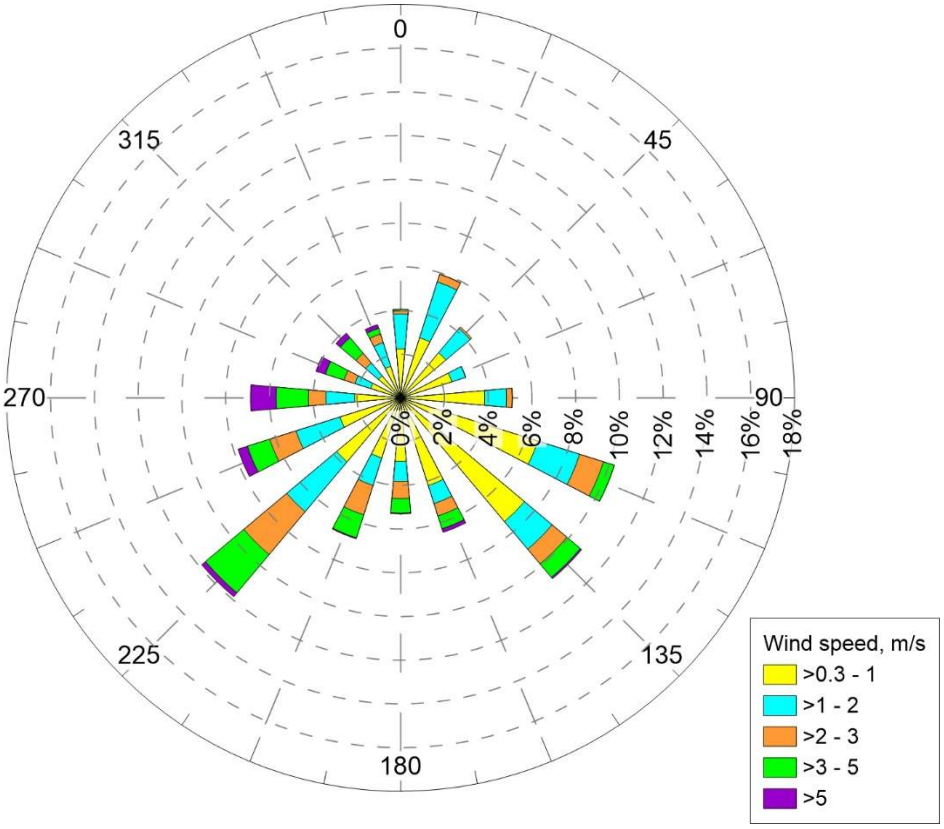


Figure 14: Windrose for wind records from Arataki Road monitoring station, 10-min frequency records September 2013 to September 2015. Raw data supplied by HBRC.

Figure 15: Windrose from Figure 14, overlaid on aerial map of TMM site and surrounds. Windrose centred on Arataki Road monitoring station.

6.4 Current On-Site Wind Monitoring

TMM has operated a wind monitoring station at the composting site for several years. The station is mounted on the roof of the Phase 1 bunker building (see Figure 16). The mast height was raised by several metres in November 2016, after the photo was taken. However, even at the new height the station is compromised due to swirling winds on the site affected by the ridge and tree line, as well as downwash eddies around the bunker building itself. Therefore, the data from the station is not representative of air flows beyond the site boundary and has not been used in the wind analysis contained in this report.

Figure 16: Wind monitoring station at TMM, mounted to Phase 1 bunker building. Mast height was raised by several metres in November 2016, after this photo was taken.

6.5 Regional Windfield Simulation

To provide additional information about wind fields in the vicinity of the TMM site, particularly during low wind speeds, the CALMET meteorological model was used to simulate wind fields in the southern Hawke's Bay area. The CALMET methodology is described in Table 4.

An input file for CALMET summarising key input and model settings for the innermost nested grid is provided in Appendix D.

Figure 17 shows a windrose for the TMM site compiled from hourly-average wind speed and direction records simulated by the CALMET model. The windrose is compared with the same time period for the Whakatu observation data in Figure 18. The simulated data for TMM shows a similar frequency of low wind speeds compared to Whakatu. Wind speed cumulative frequencies for both datasets are summarised in Table 5. Data from the Arataki Road monitoring station is not included in the analysis due to concerns over data reliability, as discussed earlier.

Table 4: CALMET input data

Input parameter	Settings and data sources
Software version	CALMET 6.5.0
User Interface	Calpuff View V8.1.0 and Calpro Plus 7.12.0.03_08_2011
Modelling datum and projection	WGS84, UTM60S.
Number of grids modelled	Three – with grids 1 and 2 being used as initial guess field inputs for grids 2 and 3 respectively. Grid 3 was used as the final CALMET wind field for analysis.
Grid extents and resolution	Grid 1: 90km x 90km, 1 km grid spacing Grid 2: 55km x 55km, 500m grid spacing Grid 3: 20km x 20km, 250m grid spacing
Geophysical data:	Terrain elevations supplied by Geographx Ltd at 8m grid spacing. Land use defined from aerial maps using "Land Use Creator" tool in Calpuff View.
Time period for model:	1 January – 31 December 2012.
Surface meteorological data:	4 stations used for some or all of the following data – wind speed, direction, station pressure, relative humidity, air temperature, cloud cover, ceiling height. The stations used were Napier, Whakatu, Waipawa, and Takapau Plains
Upper air soundings stations	Two stations used – Whenuapai and Paraparaumu.

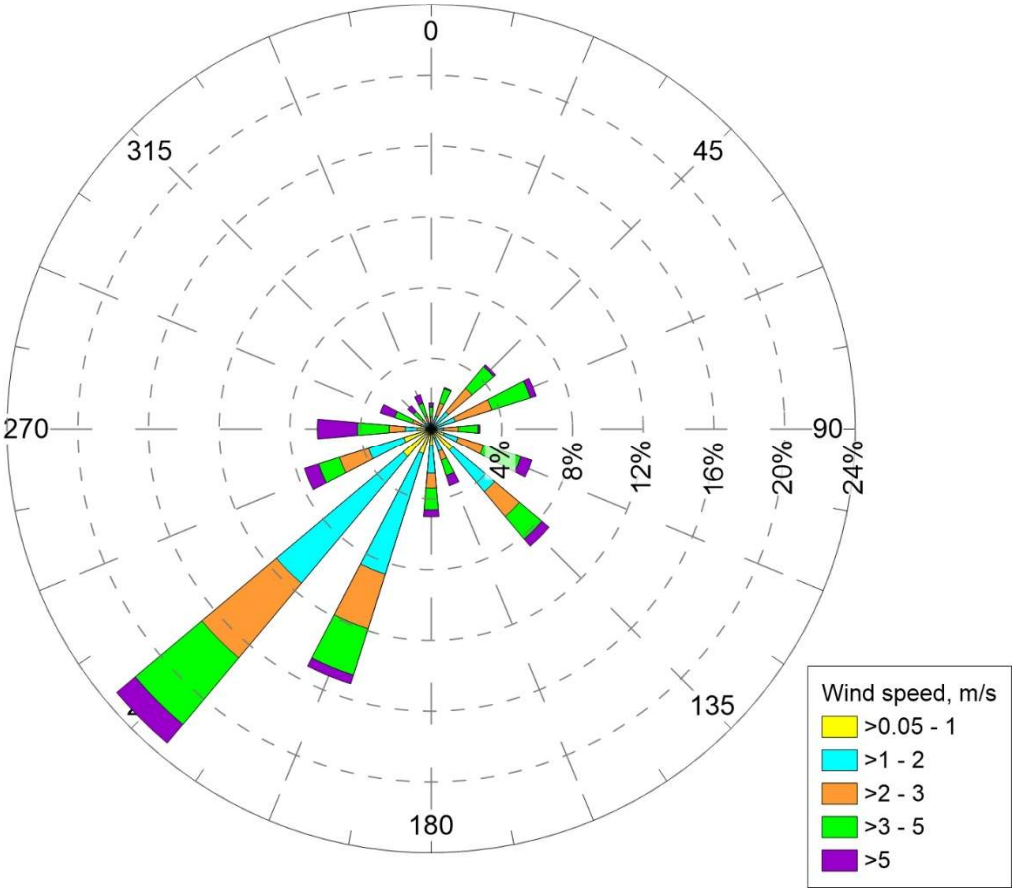


Figure 17: Windrose for CALMET simulation of wind occurrence at TMM site, hourly average winds 2012.

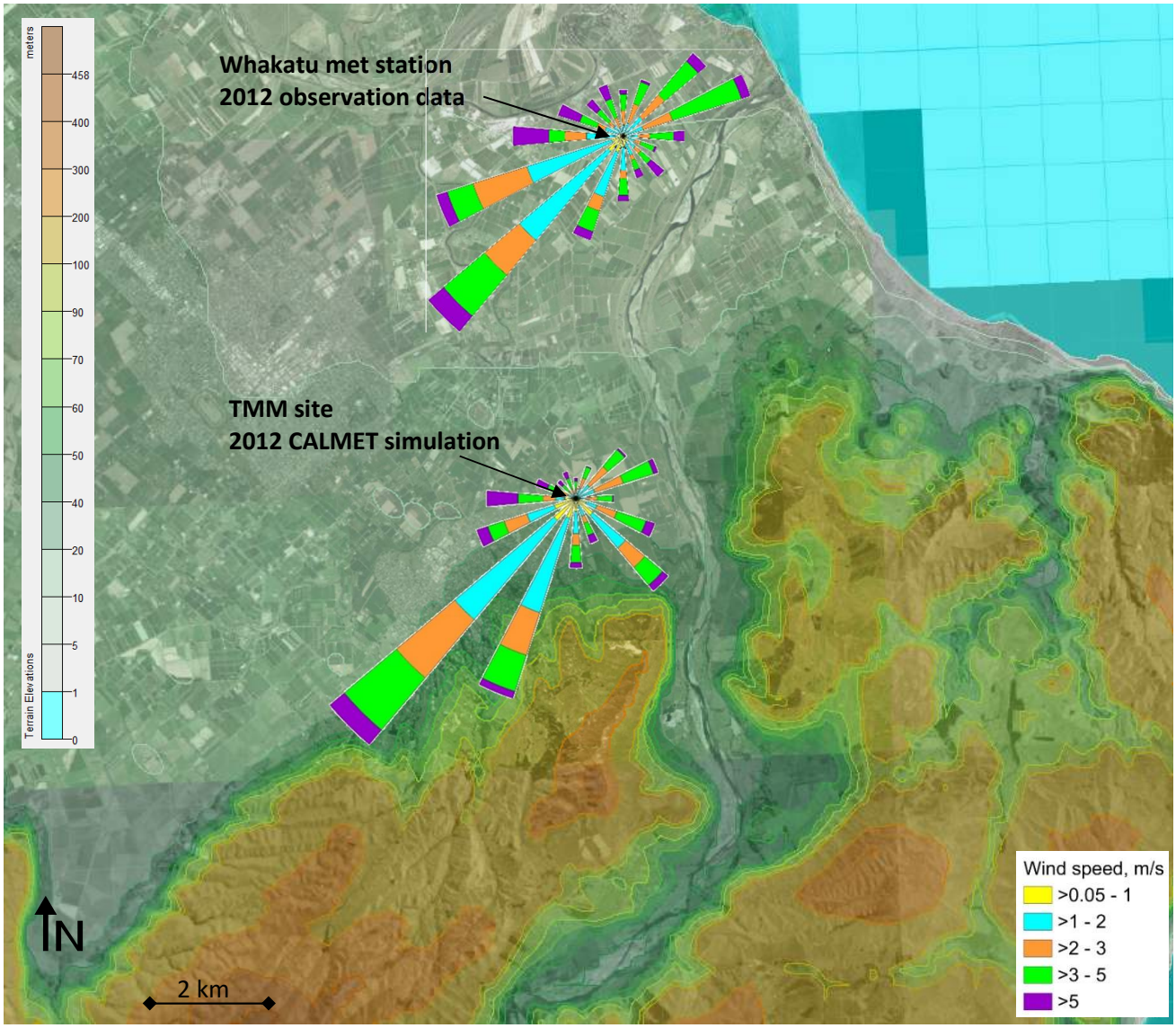


Figure 18: CALMET simulation of wind occurrence at TMM site, compared with observations over same period at Whakatu monitoring station.

Table 5: Comparison of wind speed frequencies at Whakatu monitoring station, versus simulated wind occurrence at TMM site.

Wind speed	Percentage of all wind records less than wind speed	
	Whakatu monitoring station	TMM site from CALMET
1 m/s	10.8%	8.1%
2 m/s	41.6%	39.5%
3 m/s	64.6%	59.6%
4 m/s	80.9%	76.1%
5 m/s	90.2%	87.4%
8 m/s	99.4%	98.6%
13 m/s	100%	100%

Wind directions considered to have the potential to carry any odour from the TMM site towards sensitive receptors are those from the N, NNE, NE, ENE, E, and ESE. The proportions of total winds that are blowing from these directions are similar in both the Whataku monitoring station data and the TMM site simulation data, as well as in the Arataki Road monitoring station data. This breakdown is shown in Table 6, with approximately 30% of all winds putting TMM upwind of a potentially sensitive receptor.

Table 6: Comparison of wind direction frequencies at Whakatu and Arataki Road monitoring stations, versus simulated wind occurrence at TMM site.

Wind direction	Percentage of wind records blowing from direction		
	Whakatu monitoring station, 2012	TMM site from CALMET, 2012	Arataki Road monitoring station, 2013-2015
N	1.5%	2.7%	4.1%
NNE	2.5%	3.7%	6.0%
NE	4.9%	7.1%	4.0%
ENE	6.1%	10.3%	3.3%
E	2.6%	4.3%	5.2%
ESE	8.7%	2.6%	10.6%
SE	6.0%	3.5%	10.4%
SSE	3.4%	3.1%	6.5%
S	5.2%	4.4%	5.2%
SSW	16.2%	7.9%	7.1%
SW	22.3%	17.5%	11.7%
WSW	7.3%	13.6%	7.9%
W	6.5%	8.4%	6.6%
WNW	2.8%	4.6%	4.1%
NW	1.8%	2.9%	3.8%
NNW	2.1%	3.4%	3.6%
Total winds where TMM is upwind of sensitive receptor (i.e. N, NNE, NE, ENE, E, and ESE)	**26%**	**31%**	**33%**
Total other winds	**74%**	**69%**	**67%**

6.6 Recommendation for Future Site Wind Monitoring

It is recommended that a wind monitoring station be installed at or near the TMM site as part of the proposed upgrade. It is important that the wind sensor is able to measure very low wind speeds accurately, that the mast height is at 10m above ground, and the mast is located carefully and consistent with the recommendations of "AS NZS 3580.14-2014 Methods for sampling and analysis of ambient air - Meteorological monitoring" so that wind measurements at the site are not influenced by nearby obstacles. This may require location of the mast away from the composting area, either at a remote location on the TMM site or on a neighbouring site.

The collection of wind data would serve three main purposes:

1. Verification of potential causes of complaints, if any complaints arise.
2. Assessment of odour risk through measurement of frequency and direction of wind patterns with the greatest potential to cause complaints due to offensive odour.
3. Measurement of data required for development of site-specific meteorological data files suitable for atmospheric dispersion modelling, if required in the future.

If a monitoring station is installed, the following measurements should be recorded as a minimum:

- Wind speed and wind direction at 10m above groundlevel, using an ultrasonic-type anemometer which is accurate at very low wind speeds,
- Temperature at both 2m and 10m above groundlevel,
- Relative humidity.

7 Complaints Analysis

7.1 Analysis

In late August 2016, HBRC provided a list of complaints received by the Council regarding odour issues alleged to occur from TMM. The last listed complaint was 9 August 2016.

Complaints for the last 24 months, starting September 2014, were reviewed and are detailed in Appendix E. HBRC stopped investigating complaints in December 2015, however as shown in the table even before that time many of the complaints were not able to be validated by HBRC officers. This report does not speculate as to the specific reasons that those complaints were not able to be confirmed, except to note that any of the following reasons may apply:

- The odour had dissipated by the time the HBRC investigating officer arrived, due to either changing meteorological conditions or the odour source ceasing.
- The odour plume had moved due to changing wind direction.
- The complaint regarded an odour that had been noticed earlier than the time of the call, or the previous day.
- The complaint did not relate to a specific odour event, rather an accumulated stress due to repeated odour exposure.
- The complaint was spurious and prompted by other agendas other than odour nuisance.

A very large number of complaints were received over the summer of 2015/2016 (90 complaints from 1 December 2015 to 31 March 2016, compared with 32 complaints for the same period 12 months earlier). Due to privacy restrictions, HBRC was not able to supply any information about the location of complainants over this latest period, or the number of different complainants involved in making these complaints. Comments recorded in the HBRC complaint logs at the time the complaints were made indicate that at least some of the callers were aware of the upcoming Environment Court hearing for prosecution of TMM for previous odour offences. It is possible that this knowledge influenced the number of complaints made during this period. Due to this, and the absence of HBRC investigations of complaints, the frequency of complaints made over the summer of 2015/2016 should not be taken as an indication of increased odour emissions over that summer compared to the previous summer 2014/2015.

Notwithstanding, the patterns of complaint occurrence, and particularly the day of week when the complaint occurred, can be used to identify activities occurring on the TMM site that contribute significant odour emissions. Assuming that each complaint in Appendix E is a genuine complaint about odour occurring on the day the complaint was made (unless the complaint records indicate it relates to a previous day or no specific day), and counting individual complaints made on the same day, the distribution of complaints in Appendix E by day of week has been tallied and is shown in Table 7.

Table 7: Breakdown of complaint frequency by day of week.

Day of week	Number of complaints in period			Principal odorous activities carried out on this day
	September 2014 – August 2016	September 2014 – 15th December 2015 (last day before HBRC stopped investigating complaints)	1 September 2015 – 15 December 2015 (period after installation of new pond and bunker-to-bunker transfer regime, until HBRC stopped investigating complaints)	
Sunday	1	0	0	Nil
Monday	37	26	6	Bunker-to-bunker transfer
Tuesday	110	66	24	Phase 1 to Phase 2 transfer
Wednesday	19	5	0	Nil
Thursday	35	14	3	Bale break
Friday	67	43	8	Bunker-to-bunker transfer
Saturday	4	4	2	Nil

7.2 Conclusions for Odour Mitigation Strategy

There is a clear trend of complaints being more likely on a Tuesday or Friday, followed by a Monday or Thursday. Complaints are less likely to occur on a Wednesday or weekend. This is consistent with the description of odour emissions by day of week related to site activities discussed in Section 8, and indicates that efforts to reduce the duration and intensity of odour emissions during site activities are likely to be successful at reducing complaint numbers.

8 Odour Sources and Mitigation

There are a number of potentially significant odour sources at the site. These are:

1. Bale wetting.
2. Chicken litter/gypsum storage and handling.
3. Laying out bales and spreading chicken litter/gypsum mix on bales, then breaking and mixing bales and placing mix into bunker.
4. First and second turning of compost in Phase 1 bunkers.
5. Fugitive emissions from Phase 1 bunkers.
6. Removal of compost from Phase 1 bunkers, mixing and placement into Phase 2 tunnels.
7. Phase 2 composting.
8. Emptying of Phase 2 tunnels.
9. Stockpiling and removal of spent compost (after use for mushroom cultivation).
10. Recycled water drainage/collection.
11. Recycled water storage pond.

Each of these sources of odour and associated mitigation options are discussed below.

8.1 Bale wetting

Odour from bale wetting is generated from the spraying of recycled water over the bales and drainage of that recycled water back to the storage pond. This process occurs for a total of about 30 hours over a seven-day period. The spraying action is via a low pressure delivery system from a moving irrigation arm, which minimises aerosol formation (see Photo B11, Appendix B).

The magnitude of odour emissions is highly dependent on the quality of the recycled water, as offensive odours from anaerobic decomposition of the recycled water can be emitted into the air during the spraying process and also from the surface of the bales after the irrigation arm has moved past.

Additional odour minimisation measures for the bale wetting activity are:

1. Storing the recycled water in an aerobic condition.
2. Improving site drainage so that recycled water running off from the bales does not pond over the concrete slab.
3. Minimising the overall time that bales are laid out for wetting and therefore reducing the overall area of bales laid out.

In the last few months, the commissioning of a new recycled water pond (August 2015) and improvements to site drainage (some works carried out, further works in progress) have allowed measures 1 and 2 to be implemented.

Measure 3 will be implemented with the proposed introduction of bale spiking, where recycled water is injected into the middle of the bales prior to laying the bales out for further wetting. The use of bale-spiking improves the quality of straw used in the compost process, whilst reducing the overall time that the bales need to be laid out for wetting. This helps to minimise the footprint required for bale wetting processes.

A further proposed mitigation measure is to carry out pre-wetting of the bales over an aerated pad that will drain to the existing sump. The design of the aerated pad will further reduce the footprint for bale wetting and recycled water drainage back to collection sumps due to the ability to stack bales two or three levels high, with additional odour avoidance being achieved through the proposed aeration lines which will avoid the centre of the bails becoming anaerobic (which is occasionally an issue with the current bale-wetting design). At full future production rates, the footprint for bale wetting will be similar to the current dimensions.

Following the implementation of these proposed measures, it is considered that the method of bale wetting represents the best practicable option for minimisation of both odour emission rates and the potential offensiveness quality of the residual odour emitted. Residual odour emissions are expected to be minor.

8.2 Chicken litter/gypsum storage and handling

Significant changes were made to this activity in 2015, with the chicken litter and gypsum being mixed offsite since April 2015.

Prior to this change, chicken litter was stored at the site separately to gypsum, with the two material mixed onsite and the resultant mix stored until required. Unmixed chicken litter was stored in a bunker with three walls and a roof, but no covering over the opening. The mixed litter was stored in an adjacent bunker consisting of a concrete pad and three half-height concrete walls, and a tarpaulin was used to cover the mix during rain.

Now, the roof over the main chicken litter storage bunker has been extended to cover the adjacent bunker as well, and a tarpaulin cover over the open side of the bunker has been installed. The premixed chicken litter/gypsum is stored in both partitions of the bunker, with the tarpaulin being used to protect the mix from weather at all times except when the premix is brought onto site (once per week) or when it is removed to spread onto the bales (once per week).

The previous and current storage facilities can be compared in Photos B12 and B13 in Appendix B, as well as Photo B1.

Overall, the change in management of the chicken litter/gypsum mixing and storage has resulted in a reduction in opportunity for odour emissions, as follows:

1. The best way to minimise odour emissions from chicken litter is to keep the litter dry in storage. The improved sheltering now provided at the storage bunker minimises the chance of the litter becoming wet.
2. The process of mixing the litter/gypsum used to take about 3 hours, normally on a Wednesday or Thursday.

No additional odour minimisation measures are required for this activity. It is considered that the method of chicken/litter mixing and storage represents best practice for minimisation of both odour emission rates and the potential offensiveness quality of the residual odour emitted. Residual odour emissions are expected to be minor.

8.3 Laying out wetted bales, breaking, mixing, and material placement in bunkers

The current process of mixing the bales and chicken litter/gypsum mix requires the bales to be laid out in long rows prior to the chicken litter/gypsum mix being placed on top of the rows by front end loader. The bales are then broken and mixed with the chicken litter/gypsum using a turning machine that moves slowly down the rows, one row at a time. The mixed material forms a windrow as it leaves the rear of the turning machine, and is then moved into a vacant Phase 1 bunker using a front end loader.

Photos of the current method of mixing the bales are shown in Photos B14 and B15.

This process occurs every Thursday, over the period from 6.30am to about 3pm (approximately 8.5 hours). This process is the main cause of complaints on Thursdays, now that mixing of chicken litter and gypsum onsite has ceased.

Opportunities for odour emissions during this process are driven by the quality of the inner material in the bales, and the chicken litter. If either of these materials has become anaerobic and started to rot, odour emissions can be elevated.

Odour minimisation from this process therefore involves the following:

1. Keeping the chicken litter/gypsum mix dry during storage and only accepting material onto site which has been appropriately stored off-site.
2. Keeping the recycled water aerobic so that odorous by-products of anaerobic decomposition do not accumulate inside the bales.
3. Aerating the bales.

Measures 1 and 2 have been implemented at the site in 2015, and measure 3 is proposed for future development at the site as discussed in Section 8.1.

To further reduce the potential for odour to arise from this process, the site proposes to introduce bale mixing and breaking using a bale breaker machine instead of laying out the chicken litter substrate over lines of bales. This will speed up the mixing process and will reduce the potential odour footprint to the confines of a hopper as opposed to long lines of exposed bales. Furthermore, the change in process will enable the blended inputs to be placed directly (via loader) into a Phase 1 bunker, again reducing the potential odour footprint/time of exposure due to avoiding rows of compost being laid out on the outdoor compost pad and remaining in this form for up to 8 hours as is currently the case.

The blending line will be placed under an extended eave attached to the Phase 1 bunker building. A targeted air extraction system in the eave will extract odour for filtration in the biofilter system – further reducing the potential for odour in relation to this aspect of the process.

Advantages of using a bale breaker for odour mitigation are summarised as follows:

1. There is no need to lay out the bales in rows with chicken litter/gypsum placed on top before mixing.
2. The breaking of bales and mixing with chicken litter/gypsum occurs at a single point that can be sheltered with capture of odour emissions for treatment.
3. The mixed substrate is deposited in a small area and can be picked up immediately by a front end loader for placement in the Phase 1 bunkers.
4. The overall footprint of the bale breaking area is greatly reduced.
5. The duration of the bale breaking activity is reduced as one bale can be processed approximately every minute. At full future production (500T per week), the total duration of processing will still take about 7.5 hours. However, the odour emission from this activity will be smaller than current bale-breaking activities, due to the advantages described above.

The targeted air extraction system in the eave will capture a large proportion of the odours emitted during bale breaking, but not all odours. The design of the air extraction system will require specialist engineering design to optimise the degree of odour capture whilst keeping the volumes of air extracted to manageable levels for treatment. Details of the design of this system are not yet available.

Subject to confirmation of the design of the proposed targeted air extraction and treatment system, the method for bale breaking, mixing and placement into Phase 1 bunkers in combination with the method for bale wetting and chicken litter/gypsum storage is considered to represent the best practicable option for minimisation of both odour emission rates and the potential offensiveness quality of the residual odour emitted.

It is noted that bale break occurs on Thursdays, which is a less common day for odour complaints, so it is likely that the current bale breaking activity is not as significant as some of the other odour sources on the site. With the improvements in odour emissions anticipated by the proposed odour mitigation method for bale breaking, even after production increases to 500T per week, it is considered unlikely that the bale breaking activity will be a frequent cause of odour complaints.

If necessary at a later stage, further measures may include keeping the duration of the bale breaking activity to the shortest number of hours possible and avoiding conducting this activity during early morning (say, before 9am) when atmospheric conditions may be unfavourable for odour dispersion.

8.4 First and second turning of compost in Phase 1 bunkers

The compost is currently turned twice during Phase 1, on Monday and Friday (4 and 8 days after initial mixing). Prior to August 2015, the method of turning the compost involved unloading the compost from the Phase 1 bunker using a front-end loader and forming the compost into long windrows outside that could then be turned, with water added, using the turning machine which moves slowly along the windrows. This was identified in the Beca Report (2010) as a process with high potential for odour emissions causing nuisance impacts offsite.

The preferable method for turning the compost is to remove it from the bunker using a front-end loader and immediately place the compost into a spare bunker; this is known as “bunker-to-bunker” transfer. The front-end loader deposits the compost into the hopper of an in-vessel turning machine inside the spare bunker, which turns the compost and then spreads it evenly inside the bunker.

This method was not possible at the site prior to 2015 because there was no spare bunker. TMM plans to construct a third bunker once consent is granted for increased production, but in the interim, has divided the two existing bunkers into four bunkers of half length, so that one “half” bunker can be spare for bunker-to-bunker compost mixing. Therefore, bunker-to-bunker transfer without using a temporary windrow now can occur. The process takes about 8 hours, starting at 6.30am.

The current method of mixing the compost by bunker-to-bunker transfer is shown in Photo B16.

This has achieved a significant reduction in odour emissions on Mondays and Fridays, due to the outdoor windrow turning process being removed. On Mondays, the duration of activities with odour emission potential has been halved as compost is only moved once. On Fridays, about one third of the duration of activities with odour emission potential has been removed.

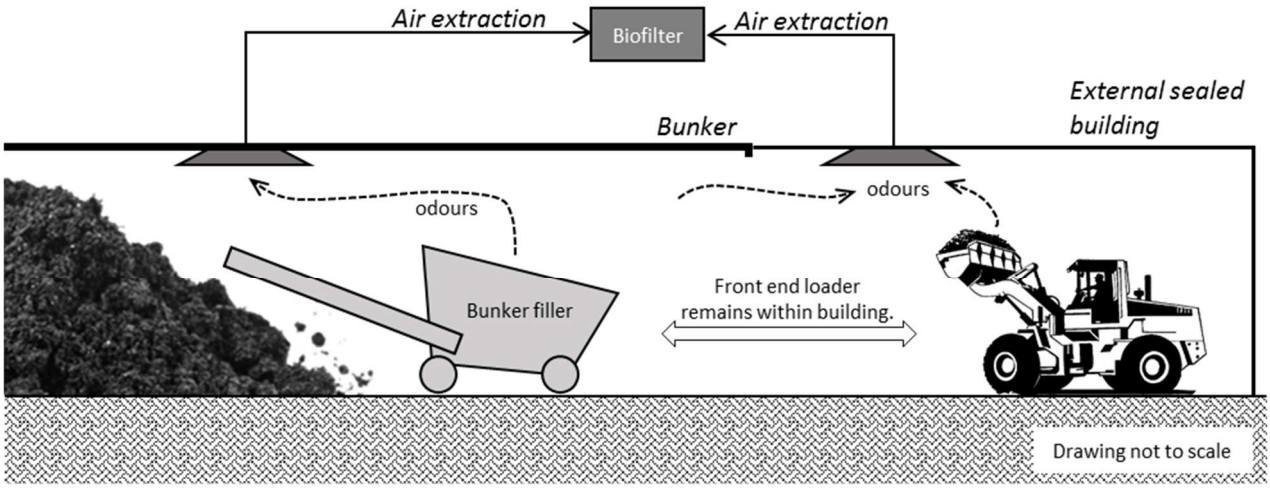
However, whilst the bunker air extraction system is operated at maximum capacity during the bunker-to-bunker extraction process, odour is still emitted during the process from the compost in the bucket on the front end loader whilst the loader is moving from bunker to bunker, and from the bunker filler when the machine is near the bunker entrance (Photo B16). In addition, as each “half” bunker only has one entrance, with two bunker entrances facing east and two bunker entrances facing west, at times a front-end loader must carry a load of compost from one end of the bunker to the other along the length of the building, increasing the total exposure time for odour emissions.

In this project, a distinction is made between the definitions of “full enclosure” and “complete enclosure” of Phase 1 composting:

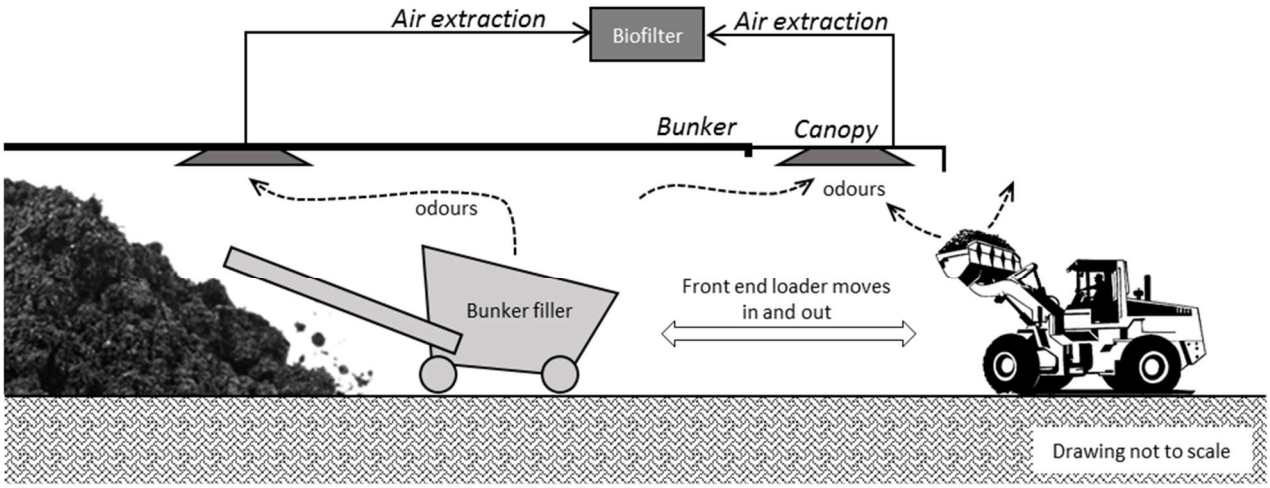
1. “Complete enclosure” implies that all odour sources within Phase 1 are subject to extraction and odour treatment 100% of the time, including when front-end loaders are moving compost between bunkers (image (a) in Figure 19).

2. “Full enclosure” implies that filling and emptying of bunkers is conducted by a turning machine which remains completely within the bunker, but with the door of the bunker open to allow movement of front-end loaders between bunkers. Loader movements between bunkers are outdoors (image (b) in Figure 19).

It is understood that this definition of “full enclosure” represents the intention of the reference to “full enclosure” included in the conditions of TMM’s current resource consent.



(a) Complete enclosure concept



(b) Full enclosure concept

Figure 19: Schematic representation of "complete enclosure" and "full enclosure" ventilation options for Phase 1 composting during bunker-to-bunker transfers. Drawings not to scale, and not necessarily representative of final ventilation design options to be implemented.

In theory, best practice for odour control from this activity would comprise complete enclosure including the loader movement area outside the bunker openings. However, TMM advises that full enclosure of the area outside the bunker entrance where the front-end loader operates is not possible for health and safety reasons, particularly poor visibility due to steam build-up. There are no currently operating mushroom composting facilities in New Zealand using complete enclosure.

Instead, TMM proposes to minimise this odour emission once the third full-size bunker is constructed using full enclosure. The length of each bunker will be extended by 10m and a canopy built over the bunker entrance with additional air extraction. Extending the length of each bunker by 10m will allow room for the

bunker filler and the front-end loader to be contained within the bunker during the bunker-to-bunker transfer process even when the bunker is full.

Once the third bunker is constructed, the current practice of using the front-end loader to move compost from the east end of the bunker to the west end of the bunker during bunker-to-bunker transfers will not be necessary, thereby minimising loader travel distances and the duration of compost exposure outdoors.

Odour capture during the bunker-to-bunker transfer process will comprise operation of the bunker air extraction system at maximum capacity, as well as operation of additional extraction fans within the canopy over the bunker entrance to capture any odours escaping from the mouth of the bunker. The intended extraction system will capture a high percentage of the odour emissions, but not 100% of the odour emissions as some odours are still expected to escape from the canopy due to eddies created by the wind and vehicle movements in and out of the bunker.

This is considered to represent the best practicable option for minimisation of odour emissions from the transfer process. As discussed in the previous section, the design of the air extraction system will require specialist engineering design to optimise the degree of odour capture whilst keeping the volumes of air extracted to manageable levels for treatment. Details of the design of this system are not yet available.

Bunker-to-bunker transfers are the main potentially-odorous activities occurring on Mondays and Fridays, which are common days for odour complaints, so any improvement in odour control for this activity is likely to reduce the occurrence of complaints.

TMM has advised that at full proposed production rates of 500 tonnes per week, the duration of bunker-to-bunker transfers will be no longer than currently used. If necessary at a later stage, further measures may include operational management to keep the duration of the bunker-to-bunker transfer activity to the shortest number of hours possible, and avoiding conducting this activity during early morning (say, before 9am) when atmospheric conditions may be unfavourable for odour dispersion.

8.5 Removal of compost from Phase 1 bunkers, mixing and placement into Phase 2 tunnels

The compost is removed from the Phase 1 bunkers, turned and placed into the Phase 2 tunnels on a Tuesday (12 days after initial mixing). The method of transferring the compost from Phase 1 to Phase 2 currently involves unloading the compost from the Phase 1 bunker using a front end loader, forming the compost into a long windrow outside that is turned, with water added, using the moving turning machine, and then placement of the compost into an empty Phase 2 tunnel.

This process used to be carried out on both Tuesdays and Wednesdays from 6.30am until 1pm, with half of a full-sized bunker removed each day. This was identified in the Beca Report (2010) as a process with high potential for odour emissions causing nuisance impacts offsite.

Now, the full process is carried out on Tuesdays only, from 6.30am until about 4.30-5pm. This change has extended the hours of operation on a Tuesday, but now means there are no operations on the yard on Wednesdays.

TMM proposes to change this process by introducing turning in a new building to the west of the Phase 1 bunkers at the same elevation as the Phase 2 tunnels (a few metres higher elevation than the Phase 1 bunkers). Compost from the Phase 1 tunnels will be carried by front-end loader to a new hopper adjacent to the new building, which will convey the compost up and into the new building. Inside the building, the compost is turned and mixed, and then loaded into the Phase 2 tunnels. The turning operation and the entrance to the Phase 2 tunnels will all be incorporated within the new building. Air from within the new building will be extracted to a dedicated biofilter for treatment. The new hopper adjacent to the building will be covered by an extended eave with targeted extraction, and air extracted from this canopy as well as from the covered conveyor will also be directed to the biofilter for treatment.

Introducing the new turning operation would mean emptying Phase 1 Bunker would start at 11.30am and be finished by 4pm.

Introduction of the new turning operation and new building will substantially decrease the footprint and odour emission potential from the transfer process, as well as removing the potential for odour emissions early in the morning whilst meteorological conditions place odour nuisance at greater risk. Therefore, this proposal is considered to represent the best practicable option for minimisation of odour emissions during the transfer of compost from the Phase 1 bunkers to the new turning shed, and then best practice for the turning/mixing and transfer of compost into the Phase 2 tunnels.

8.6 Phase 2 composting

Once the compost is loaded into one of the two Phase 2 tunnels, the doors at both ends of the tunnel are sealed. The only means of odour emission is from the portion of recirculated air which is passively vented to atmosphere from a vent on the roof of each tunnel. Following the increase in production to 500T per week, the Phase 2 tunnels will be upgraded to a 100T capacity with the existing two tunnels extended and additional tunnels constructed close to the existing tunnels.

Currently there is no treatment of odour vented from the tunnels. This odour source is considered to have a low potential to cause offensive odours beyond the site boundary due to the small volume of air discharged. However, TMM proposes to duct these odour emissions to the new biofilter to be constructed for air extracted from the new building housing the Phase 1 to Phase 2 compost mixing and transfer operations.

8.7 Emptying of Phase 2 tunnels

Compost is removed from the Phase 2 tunnels on Tuesdays, so that the tunnels can be cleaned ready to receive new Phase 1 compost on the same day. As described above, this process used to occur on both Tuesdays and Wednesdays, but is now carried out only on Tuesdays.

The compost is relatively mature by the time it is removed from the Phase 2 tunnels. It is placed directly into a hopper beside the tunnels which conveys the compost into a building for placement into mushroom-growing trays.

Site observations Air Quality Professionals staff have previously found this odour source to be minor compared to other odour sources from the Phase 1 composting process. No additional odour control for this process is currently proposed.

8.8 Stockpiling and removal of spent compost (after use for mushroom cultivation)

Spent compost is sterilised (to kill mushroom spores) and then taken by truck to compost stockpile areas on the site. This activity has been carried out for a number of years with little change. However, in recent months the area has been cleaned up by TMM, with the volume of stored compost reduced and problematic anaerobic piles removed from site.

Odour emissions are only significant from the stockpile area when large volumes of compost in poor condition are disturbed. This can occur after extended periods of wet weather when removal trucks are unable to access the storage piles.

The proposed site management for spent compost is that it will be stored within either of the following areas:

- On a concrete pad in the existing spent compost area located at the front of the site under a canopy to keep the spent compost dry – with any remaining compost being removed from the site within 7 days, or
- On a concrete pad in the centre of the site – with any remaining compost being removed from the site within 7 days.

8.9 Recycled water drainage/collection

A consequence of the outdoor yard operations such as bale wetting and outdoor windrow compost turning is the runoff of excess recycled water and the need to capture that runoff and return it to the storage pond. The recycled water runoff areas have been reduced over previous months, through the installation of additional drainage channels in the concrete slabs and also the removal of the need for outdoor windrows for turning of intermediate Phase 1 compost on days 4 and 8.

Overall, the potential for recycled water to pond on the yard and in drains has been reduced. In addition, the previously aerated sump at the edge of concrete yard has now been decommissioned as a recycled water storage vessel, and is now used only as a common drainage point for immediate pumping of recycled water to the new storage pond.

As similarly discussed in Section 8.1, odour emissions from ponded recycled water (and previously the recycled water in the aerated sump) are dependent on the condition of the recycled water. With the introduction of the new aerated storage pond in August 2015, the recycled water is now retained in aerobic condition which minimises the potential for emission of odours whilst the recycled water is draining on the yard. The decommissioning of the aerated sump is also likely to have removed an odour source.

TMM proposes to further improve yard recycled water drainage through additional drainage channels, and to minimise the footprint for the bale wetting activity. This is unlikely to make a lot of difference to the potential for this odour source to cause adverse effects in the receiving environment, as the source is already well managed and is relatively minor compared to other site sources. However, the goal of minimising the potential for odour emissions from this activity is supported.

8.10 Recycled water storage pond

The design and operation of the new recycled water storage pond was described earlier in Section 4.2. Odour emissions from this source are minor, and no additional mitigation measures, other than maintaining the current monitoring regime and responding to issues identified by the monitoring as soon as possible, are recommended.

The management of recycled water on the site is considered to represent the best practicable option.

8.11 Biofilter

The design, operation and monitoring of the existing biofilter was described in Section 4.1. The monitoring demonstrates that the biofilter is operating within normal parameters for optimum odour treatment efficiency. The biofilter design has also been independently reviewed and found to be fit for current purpose. The odour from the biofilter was found to be a musty, earthy character typical of biofilters during both of the AirQP site visits in September and October 2015.

The use of the biofilter for odour treatment is considered to represent the best practice for the existing composting operation.

When the proposed modifications to the Phase 1 composting system are implemented to increase production, additional volumes of air will be extracted from both the new third bunker, and new extraction points in the canopies over the entrances to the bunkers, the bale breaker, and the static turner. The detailed design process required to identify these air flows and appropriate odour treatment methods has not been carried out. However, TMM has advised that appropriate odour treatment for these additional air flows will be provided.

9 Summary of Recent and Future Proposed Process Modifications

Since the publication of the Beca Report (2010), a number of process modifications have been made to the composting production process at the site. Further changes are also proposed subject to the granting of resource consents.

The modifications made to date are summarised below:

1. A larger recycled water storage and treatment pond and aerator has been installed along with continuous monitoring of recycled water dissolved oxygen levels.
2. Drainage and capture of recycled water from the pre-wetting area has been improved.
3. The chicken litter and gypsum is now mixed off-site and delivered as one substrate. This avoids mixing on-site.
4. The mixed chicken litter and gypsum is stored in a shed to minimise rainwater ingress.
5. The original two-bunker design has been subdivided into four smaller bunkers, allowing for compost mixing by bunker-to-bunker transfer using a Bunker Filler rather than by turning the compost in a temporary outdoor windrow. The previous mode of operation was that after being placed in the first bunker for 5 days, the compost was removed and placed in a windrow for 6 to 8 hours during which it was turned, then placed back into another bunker as a means of turning the substrate.
6. Phase 1 composting processes have been concentrated to a smaller window of time as follows:
    a. Tuesdays previously involved emptying half a Phase 1 bunker, turning and adding water if required and filling one of the Phase 2 tunnels. The remaining Phase 1 bunker was then emptied on a Wednesday together with turning and water being added if required with the second Phase 2 tunnel being filled that day. Alongside this, the chicken litter and gypsum was placed on the hay bales on a Wednesday morning and left overnight until Thursday.
    b. Tuesdays now involve emptying a full Phase 1 bunker, turning and adding water if required and filling both Phase 2 tunnels within the same day.
    c. Similarly, the chicken litter and gypsum is no longer placed on the hay bales on a Wednesday morning to be left overnight until Thursday, rather processes on a Thursday start from 4.30am in order to complete this process within one day over the course of Thursday.
    d. These changes result in activities occurring over a longer period on a Tuesday and commencing earlier on a Thursday, but avoid any potential odour generation activities occurring on a Wednesday.
7. Continuous monitoring and datalogging of dissolved oxygen concentrations in the recycling pond, and temperature in the inlet air entering the biofilter.

Subject to the business being granted resource consent, the following additional modifications are proposed to reduce odour emissions from the site:

- A bale breaking machine being used on each side of the Phase 1 process,
- The establishment of additional Phase 1 bunker capacity plus lengthening of the existing bunkers,
- An upgraded air extraction and biofilter or ozone odour treatment system,
- An extended roof with air extraction over the bale breaking machine, and
- A new building to house turning and conveying operations for transferring compost from Phase 1 bunkers to Phase 2 tunnels. Air from the new building will be ventilated to odour treatment prior to discharge to atmosphere.

Further details of these proposals are as follows:

1. Pre-wetting
    a. Pre-wetting of the bales is now proposed to occur over an aerated pad that will drain to the existing sump.
    b. The footprint required to accommodate this process, and therefore exposure potential for odour, will be reduced, with further odour avoidance being achieved through the proposed aeration lines.
    c. Pre-wetting will also include the practice of “bale-spiking”.
2. Phase 1 Mixing
    a. Rather than laying out the chicken litter substrate over lines of bales, a bale breaking machine/blending line will be established. This will speed up the mixing process and will reduce the potential odour footprint to the confines of a hopper as opposed to long lines of exposed bales.
    b. The blended inputs to be placed directly (via loader) into a Phase 1 bunker, again reducing the potential odour footprint/time of exposure. This will avoid rows of compost being laid out on the outdoor compost pad for up to 8 hours as is currently the case.
    c. The blending line will be placed under an extended eave with a targeted air extraction system to remove odour for treatment.
3. Additional Phase 1 Bunker Capacity and Odour Capture
    a. Additional Phase 1 Bunker capacity is proposed to accommodate bunker-to-bunker transfers mid-way through the Phase 1 composting process. Whilst this already occurs due to the division of the existing two bunkers into four half-sized bunkers, the additional bunker will be needed for the proposed increased compost production.
    b. The length of the existing bunkers will be extended by approximately 10m to contain the turning machine, turned compost and the front-end loader within the bunker during the bunker-to bunker transfer process, and a canopy will be constructed over the extended bunker entrance containing additional air extraction to biofilter treatment. This will enable the footprint of odour emissions from the mixing of compost to be fully retained within the bunkers, and capture odours escaping from the bunker opening.

4. Phase 1 to Phase 2 Transfer
    a. The final step of the Stage 1 composting process is final turning where water is added to the compost substrate prior to it being loaded into the Phase 2 tunnels. This currently involves the compost being laid out in a windrow and turned over a period of 7 to 11 hours.
    b. It is now proposed to establish turning operations enclosed in a new building that allows the compost to be extracted from the Phase 1 bunker in individual loads and immediately turned and placed into the Phase 2 tunnels as one continuous process. This will avoid a windrow being laid out on the pad and will retain the compost substrate within the Phase 1 bunker where odour will be managed by the biofilter system for almost all of the process. This will again significantly reduce the potential odour footprint as well as the time of exposure.
    c. An air extraction system in the new building will extract odour for filtration in a new biofilter system – further reducing the potential for odour in relation to this aspect of the process. Odorous air ventilated from the Phase 2 tunnels will also be treated in this new biofilter.
5. Upgraded Main Biofilter
    a. The existing biofilter is adequate for current ventilation capacity, however with the additional bunker and extended eaves over both the blending machine and static turner, this will be upgraded to capacity requirements or additional biofilter units added. Alternatively, an appropriate ozone system will be installed. If ozone treatment is identified as a cost-effective option, trials would first be carried out to demonstrate the effectiveness of the option compared to biofiltration.

10 Rating of Odour Emissions

Tables 8, 9 and 10 list the odour sources within the composting plant at three stages of the development and evolution of the site, and provide a qualitative rating of the contribution each source makes to the potential for adverse odour effects at sensitive receptors beyond the site boundary.

The three stages represented are:

- Pre-2015 (prior to mitigation and management improvements undertaken at the site in 2015),
- Current (early 2016), and
- Future Upgraded and Expanded, following completion of all site upgrades and increase in compost production to 500 tonnes per week.

The rating given to each day takes into account the quantity and degree of unpleasantness of the odour emission, and the time of day when the activity is carried out (particularly early in the morning whilst meteorological conditions place odour nuisance at greater risk).

The rating system is qualitative, based on Air Quality Professionals' observations of odour strength from each source, size and volumetric flow rates from each source, time of day when sources are present, and the author's experience with the typical rate of downwind dispersion of odours from such sources.

Odour emissions from the site before and after the proposed upgrades are also shown schematically in Figures 17 and 18.

Despite the clear reduction in odour potential anticipated as the site undergoes future upgrades and expansion, there will always remain the potential for some residual odour emissions. It is unrealistic to expect that the site will be able to completely control the emission of all odour, despite the application of the best practice for odour mitigation in some parts of the process (and, in the remaining parts of the process, best practicable option). Overall consideration of the activity is therefore subject to the Planning framework.

Nevertheless, a significant reduction in the potential for offsite odour impacts is expected following the proposed site upgrades.

Table 8: Rating of odour impact potential from different site odour sources, pre-2015 (prior to mitigation and management improvements undertaken at the site in 2015).

	Day of week (rating takes into account time of day when activity is carried out)						
Odour source	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Bale wetting							
Chicken litter/gypsum storage and handling							
Chicken litter/gypsum mixing							
Laying out bales, then breaking, mixing and placing into bunker							
First and second turning of compost in Phase 1 bunkers							
Transfer of compost from Phase 1 bunkers into Phase 2 tunnels							
Phase 2 composting							
Emptying of Phase 2 tunnels							
Recycled water drainage/collection							
Recycled water storage pond							

Potential for adverse odour impacts at sensitive receptors

Low	
Low-Moderate	
Moderate	
Moderate-High	
High	
Source not active	

Table 9: Rating of odour impact potential from different site odour sources, Current (early 2016).

	Day of week (rating takes into account time of day when activity is carried out)						
Odour source	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Bale wetting							
Chicken litter/gypsum storage and handling							
Chicken litter/gypsum mixing							
Laying out bales, then breaking, mixing and placing into bunker							
First and second turning of compost in Phase 1 bunkers							
Transfer of compost from Phase 1 bunkers into Phase 2 tunnels							
Phase 2 composting							
Emptying of Phase 2 tunnels							
Recycled water drainage/collection							
Recycled water storage pond							

Potential for adverse odour impacts at sensitive receptors

Low	
Low-Moderate	
Moderate	
Moderate-High	
High	
Source not active	

Table 10: Rating of odour impact potential from different site odour sources, Future Upgraded and Expanded.

	Day of week (rating takes into account time of day when activity is carried out)						
Odour source	Monday	Tuesday	Wednesday	Thursday	Friday	Saturday	Sunday
Bale wetting							
Chicken litter/gypsum storage and handling							
Chicken litter/gypsum mixing							
Bale break and place into Phase 1 bunkers							
First and second turning of compost in Phase 1 bunkers							
Transfer of compost from Phase 1 bunkers into Phase 2 tunnels							
Phase 2 composting							
Emptying of Phase 2 tunnels							
Recycled water drainage/collection							
Recycled water storage pond							

Potential for adverse odour impacts at sensitive receptors

Low	
Low-Moderate	
Moderate	
Moderate-High	
High	
Source not active	

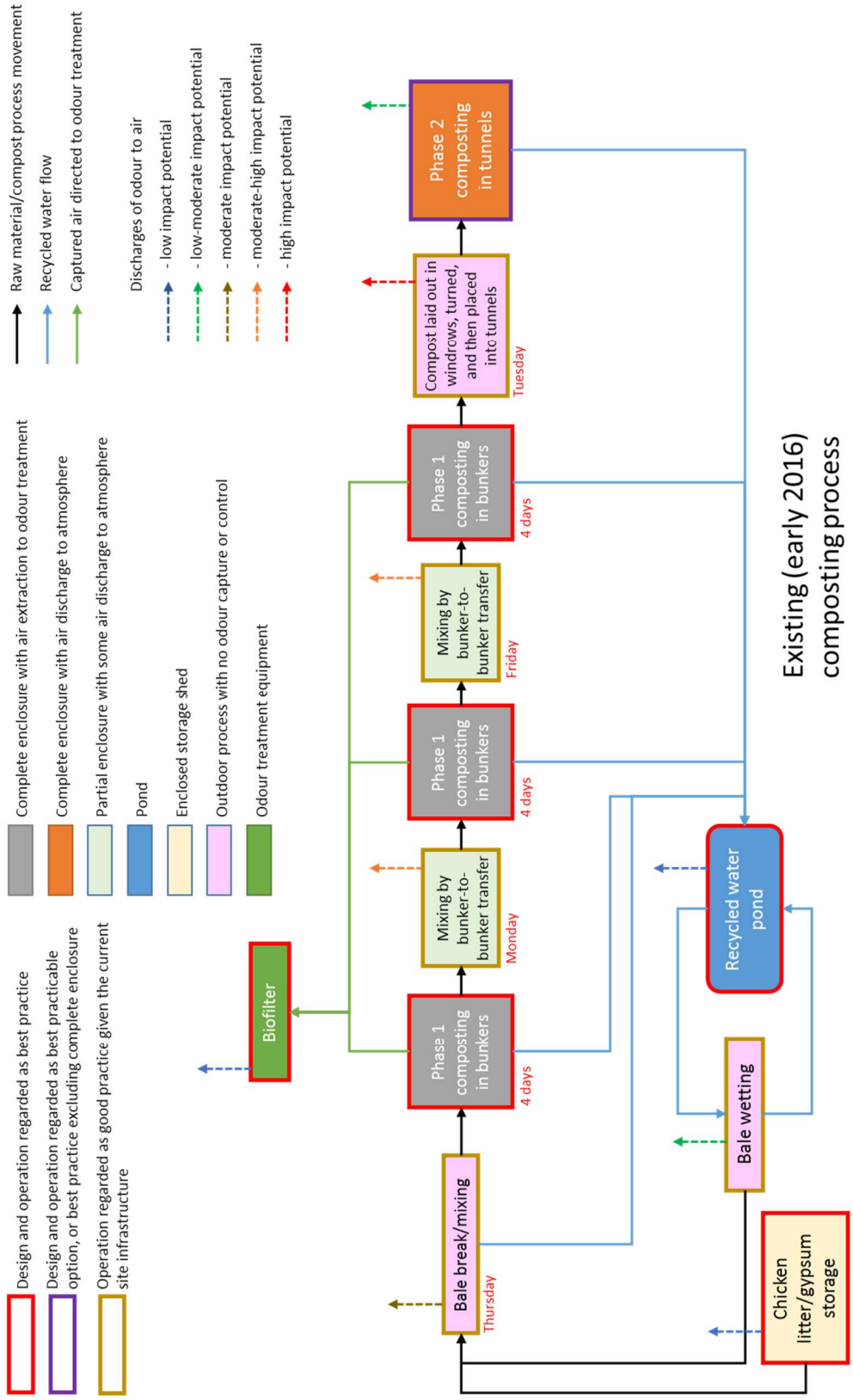


Figure 20: Schematic representation of odour emissions from various stages of the composting process, current (early 2016) site.

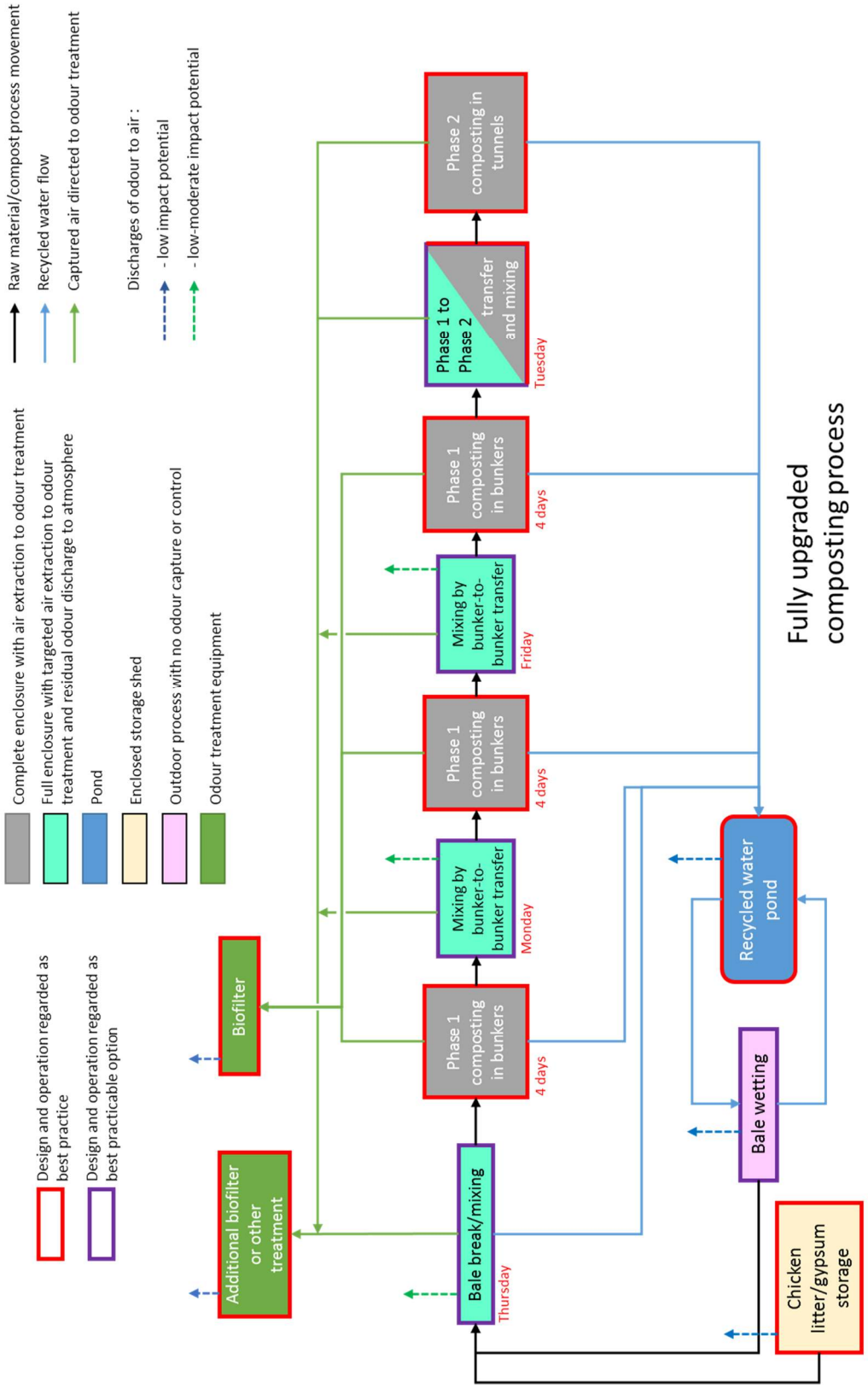


Figure 21: Schematic representation of odour emissions from various stages of the composting process, future site following full proposed upgrades.

11 Summary

Site management has demonstrated a willingness to continuously explore, and implement where feasible, options for management and operational improvements to minimise odour emission potential. This is evident in the improvements to site management implemented over the last 12- 18 months.

Although there will always be the potential for residual odour to occur, the proposed strategy outlined for reduction of odour from the current composting activities at the TMM site is considered to represent the best practice for odour mitigation in some parts of the process and, in the remaining parts of the process, the best practicable option or best practice except for the option of complete enclosure.

In the future after the proposed upgrades are implemented (which includes the proposed increase in production rate), greatly reduced odour emissions are anticipated on Mondays, Tuesdays, Thursdays and Fridays. Where possible, these odours will also be emitted outside of the times of day when meteorological conditions are most conducive to poor atmospheric dispersion (i.e. around sunrise and sunset), further reducing the potential for any residual odour emissions to cause offensive or objectionable odours.

Appendix A

Aerial Photos Showing Residential Encroachment

Land use surrounding TMM site, October 2003. Image from Google Earth Pro.

Land use surrounding TMM site, October 2009. Image from Google Earth Pro.

Land use surrounding TMM site, September 2012. Image from Google Earth Pro.

Land use surrounding TMM site, April 2014. Image from Google Earth Pro.

Land use surrounding TMM site, January 2016. Image from Google Earth Pro.

Appendix B

Photos

Photo B1 – Storage shed for premixed chicken litter/gypsum mix.

Photo B2 – Maize mulch storage.

Photo B3 – Phase 1 bunkers (left of picture). Biofilter with growing sheds in the background is shown at right of picture.

Photo B4 – Phase 2 tunnels with doors closed.

Photo B5 – New effluent storage pond (commissioned August 2015).

Photo B6 – Biofilter

Photo B7 – Biofilter surface

Photo B8 – Old effluent collection sump (aerated), prior to August 2015. Image from Beca Report (2010)

Photo B9 – Old effluent storage pond, now decommissioned (effective August 2015). Image from Beca Report (2010).

Photo B10 – Current mode of operation for effluent collection sump, since August 2015.

Photo B11 – Bale wetting, September 2015.

Photo B12 – Previous storage facility for chicken litter (unmixed) (left bunker) and mixed chicken litter/gypsum (right bunker). Photo taken 2009, published in Beca Report (2010).

Photo B13 – Current (late 2015) storage facility for premixed chicken litter/gypsum.

Photo B14 – Bale breaking and mixing, 15 October 2015. Shows bales laid out in a row with chicken litter/gypsum mix and maize mulch on top of bales, waiting for turning (row turner visible in background).

Photo B15 –Bale breaking and mixing, 15 October 2015. Shows freshly mixed compost (foreground) after passing through row turning, and waiting to be loaded into Phase 1 bunker.

Photo B16 – Phase 1 compost being turned by bunker-to-bunker transfer. Loader (left bunker) places compost into the in-vessel turner (right bunker) which mixes the compost and disperses it into the bunker. As right bunker is nearly full at the time this photo was taken, turner machine is not fully within the bunker.

Appendix C

Biofilter Test Report, Beca Infrastructure Ltd 2011

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Chris Hawley
Te Mata Mushrooms
Brookvale Rd
Havelock North

14 November 2011

Dear Chris,

Te Mata Mushrooms Composting Biofilter Compliance Testing

Scope

Beca Infrastructure Ltd was commissioned by Te Mata Mushrooms Ltd to undertake gas velocity sampling at their Brookvale Road, Havelock North site. This work was undertaken in accordance with our letter of engagement dated 5 September 2011 (and subsequently our email of 16 November 2011), in order to assess compliance with condition 16 of Hawkes Bay Regional Council discharge permit DP100128A. Condition 16 states:

"the loading rate of the biofilter, or biofilters shall not exceed 50m^3 air per hour per m^3 of bark"

If this condition is not complied with, Condition 17 of the resource would be triggered:

"If the biofilter existing at the time this consent was granted does not comply with the loading rate stated in Condition 16, the consent holder shall, by 1 December 2011, engage a professional biofilter designer to provide written evidence, to the satisfaction of the Council (Manager Compliance), that the biofilter design will be fit for purpose over a specified period of time."

This letter outlines the methods used and reports the results of this sampling.

Methods

The references for the testing methods used are as follows:

- Selection of Sampling Positions – AS 4323.1 – 1995
- Determination of Gas Flow Data – ISO 10780:1994(E)

Conditions during testing and calculations

Measurements were taken on Monday 17 October 2011 between 0900 and 1300 during an unloading and loading operation of the compost bunkers. When loading and unloading the composting bunkers, Te Mata Mushrooms run the biofilter extraction fan at full speed (50Hz) to reduce odour discharge from the main bunker entrance. A further set of flow rate data was obtained whilst running the fan at half speed (25 Hz) for comparative purposes. The results for both sets of measurements are presented in Table 1. The higher rate applies to consent compliance testing as this is the standard operating flow rate during this phase of the operating schedule.

The biofilter hydraulic loading rate was calculated by dividing the flow rate through the duct (m^3/hr) by the volume of biofilter bark (m^3).

The biofilter media volume of 252m^3 was calculated using the dimensions of the biofilter enclosure (inner dimensions) minus the layer of gravel which occupies the lower part of the enclosure. The dimensions used for this calculation were obtained from the report "*Te Mata Mushroom Odour Source Assessment*" dated 24 February 2010, prepared for Te Mata Mushrooms by Beca Infrastructure Ltd.

Results

Results for the flow rates measured on 17 October 2011 are presented in **Table 1**. The calculation sheets are attached as appendix A.

Table 1 - Airflow Results

Fan Speed (Hz)	Gas Temp (°C)	Gas Velocity (m/s)	Gas Flowrate (m^3/s)	Gas Flowrate (m^3/s 0°C, dry, 1 ATM)	Gas Flowrate (m3/hr)	Gas Flowrate (m^3/hr/m^3 media)
50	24	14.9	4.1	3.68	14663	58.2
25	24	7.9	2.2	1.95	7769	30.8

Condition 16 - Discussion

When operating at maximum fan speed, the hydraulic loading flow rate for the Te Mata mushrooms biofilter exceeded the limit of 50m^3 /hr/m^3 of bark imposed by condition 16 of Hawkes Bay Regional Council discharge permit DP100128A.

It is noted that the sampling point was not ideal according to the requirements of AS 4323.1 due to an upstream disturbance (a bend) being too close to the sampling plane, and causing an uneven air distribution across the duct at the sampling plane. Despite this, the loading rate limit of 50m^3/ hr/ m^3 of bark is likely to be exceeded when maximum fan speed is used. To comply with the consent limit, the fan could be run slower at about 45 Hz, however there is then a small risk of fugitive odour emissions during unloading of the bunkers.

As Condition 16 was measured to be slightly exceeded during times when the fan operates at maximum speed, Condition 17 is triggered which requires an assessment of whether the biofilter design "*will be fit for purpose over a specified period of time*". The response to this condition is outlined below.

Condition 17 – Biofilter Design

The assessment of "fit for purpose" has been based on the design recommendations in "Biotechnology for Odor and Air pollution Control", Cudmore and Gostomski, 2005.

The biofilter operation was inspected during the site visit on the 17th October 2011.Visual inspection of the biofilter surface indicated the biofilter appeared to be in good condition and the treated air flow appeared humid (visible) and to be fairly evenly distributed across the biofilter surface. The odour

emitted from the biofilter surface was considered to be an organic/ earthy odour, typical of what is commonly emitted from a properly operating biofilter.

The key biofilter design criteria are:

- Loading rate (ratio of gas volume to bed cross sectional area);
- Gas composition;
- Bed depth;
- Bed media specification; and
- Air distribution system.

In addition, the inlet air stream temperature, composition and humidity are important design / operating criteria.

Loading rate

At maximum fan speed the measured loading rate exceeds the typical recommended maximum loading rate of 50 $m^3/hr/m^3$ media, however under normal operation the loading rate was measured to be 30 $m^3/hr/m^3$ media, which is well within the good practice design operating range.

At maximum fan speed, the retention time in the biofilter is 60 seconds, which should be adequate for odour treatment during short term peak flows.

Gas composition

Ammonia is one of the main components of odour generated in the composting process. Nitrogen based odour causing compounds such as ammonia are readily biodegraded in biofilters. Ammonia and Hydrogen sulphide concentrations of the inlet air stream to the biofilter were measured during the loading rate compliance testing on 17th October. A maximum ammonia concentration of 35 ppm was measured at the biofilter inlet with the shutter closed so that 100% of the inlet air to the biofilter was drawn from the closed bunker. It is noted that this shutter arrangement would be infrequently used, as fresh air is required to be introduced to reduce the temperature. Therefore 35 ppm is likely to be at the high end of the ammonia load that the biofilter would typically see.

Hydrogen sulphide levels were measured to be below the limit of detection of the Gastec tubes i.e. <1ppm. An ammonia range of 10 – 30 ppm is sometimes conservatively recommended if pH adjustment is to be avoided. However there are reports of successful operation at higher concentrations in the literature. On this basis, while the ammonia concentration was higher than this range, the pH is monitored twice a year as part of the consent requirement and the current design appears to be sufficient to treat this gas stream composition.

Bed depth and media type

The biofilter bed depth (2 metres, including 0.25 metres river gravel) and use of bark media is considered suitable for the existing application. It is likely that ammonia is the primary source of odour in this air stream. It is acknowledged that there is some evidence that a soil- bark composition

is more effective than straight bark in applications with high ammonia loads[1], however soil-bark biofilters are also more prone to build up in bed pressure which causes insufficient air extraction and treatment. The bark media was first installed in 2003 and replaced in September 2009.

Air distribution

The air distribution system consists of a PVC pipe manifold with 150 mm laterals at 780 mm centres, and holes at 100 mm distance spiralled around the pipe. There is no external access to the central manifold to be able to routinely inspect this for blockages. Ideally, this would have been included in the design, however, in this application it is considered the air stream is relatively clean (i.e. no tars or fats that could build up) and so is considered acceptable. It is recommended that the laterals are inspected for blockage or damage the next time the media is replaced.

Temperature and moisture content

The compost temperature and bunker air temperature can be relatively high if the bunkers are closed for a period of time, however this can be controlled through changing shutter positions and introducing fresh air. The shutter positions are recorded when they are changed and temperatures are measured inside the bunkers and at the inlet to the biofilter. It is recommended that biofilters are operated at less than 40°C. This system is considered fit for purpose.

Moisture content can be controlled by a sprinklers system on the bed surface, mainly used during summer time and also a spray nozzle is installed in the biofilter inlet duct. This spray nozzle is switched on when the bunkers have been closed for 2-3 hours and the gas flow to the biofilter is assumed to have a higher odour concentration. This spray nozzle may also act as a partial wet scrubber , removing some of the ammonia from the air stream.

Summary

Based on the above discussion, it is considered that the biofliter design is fit for purpose based on the current operating conditions and loading rates. The existing bark media is expected to remain in reasonable condition for the next 3- 5 years.

Yours sincerely
Camilla Borger
Associate – Environmental Engineering

on behalf of
Beca Infrastructure Ltd
Mobile 0272 810 856
Email: camilla.borger@beca.com

[1] Biotechnology for Odor and Air pollution Control, Cudmore and Gostomski, 2005

Appendix D

CALMET Input File

```
---------------- Run title (3 lines) ----------------------------------------

                CALMET MODEL CONTROL FILE
                -------------------------

-------------------------------------------------------------------------------

INPUT GROUP: 0 -- Input and Output File Names


Subgroup (a)
------------
Default Name  Type         File Name
------------  ----         ---------
GEO.DAT      input    ! GEODAT = ..\TeMata_UTM_obs_no_Napier_wind\TeMata_UTM_obs_geo\GEO.DAT !
SURF.DAT     input    ! SRFDAT = ..\TeMata_UTM_obs_no_Napier_wind\TeMata_UTM_obs_no_Napier_wind_met\SURF.DAT !
CLOUD.DAT    input    * CLDDAT = *
PRECIP.DAT   input    * PRCDAT = *
WT.DAT       input    * WTDAT = *

CALMET.LST   output   ! METLST = CALMET.LST !
CALMET.DAT   output   ! METDAT = CALMET.dat !
PACOUT.DAT   output   * PACDAT = *

All file names will be converted to lower case if LCFILES = T
Otherwise, if LCFILES = F, file names will be converted to UPPER CASE
       T = lower case      ! LCFILES = F !
       F = UPPER CASE

NUMBER OF UPPER AIR & OVERWATER STATIONS:

   Number of upper air stations (NUSTA)  No default     ! NUSTA = 2 !
   Number of overwater met stations
                        (NOWSTA) No default     ! NOWSTA = 0 !

NUMBER OF PROGNOSTIC and IGF-CALMET FILEs:

   Number of MM4/MM5/3D.DAT files
                        (NM3D) No default      ! NM3D = 0 !

   Number of IGF-CALMET.DAT files
                        (NIGF)   No default     ! NIGF = 0 !

                  !END!
-------------------------------------------------------------------------------
Subgroup (b)
--------------------------------
Upper air files (one per station)
--------------------------------
Default Name  Type       File Name
------------  ----       ---------
UP1.DAT     input   1  ! UPDAT=..\..\..\Models\TeMata\UPPER2~2\03145up.dat!    !END!
UP2.DAT     input   2  ! UPDAT=..\..\..\Models\TeMata\UPPER2~2\01410up.dat!    !END!

-------------------------------------------------------------------------------
Subgroup (c)
----------------------------------------
Overwater station files (one per station)
----------------------------------------
Default Name  Type       File Name
------------  ----       ---------
* OVERWATERFILES = *
-------------------------------------------------------------------------------
Subgroup (d)
-----------------------------------------------
MM4/MM5/3D.DAT files (consecutive or overlapping)
-----------------------------------------------
Default Name  Type       File Name
------------  ----       ---------
```

```
* M3DDATFILES = *
-------------------------------------------------------------------------------
Subgroup (e)
-----------------------------------------------
IGF-CALMET.DAT files (consecutive or overlapping)
-----------------------------------------------
Default Name  Type       File Name
------------  ----       ---------
* IGFDATFILES = *
-------------------------------------------------------------------------------
Subgroup (f)
----------------
Other file names
----------------

Default Name  Type       File Name
------------  ----       ---------
DIAG.DAT      input      * DIADAT = *
PROG.DAT      input      * PRGDAT = *

TEST.PRT      output     * TSTPRT = *
TEST.OUT      output     * TSTOUT = *
TEST.KIN      output     * TSTKIN = *
TEST.FRD      output     * TSTFRD = *
TEST.SLP      output     * TSTSLP = *
DCST.GRD      output     * DCSTGD = *

-------------------------------------------------------------------------------

                    !END!

-------------------------------------------------------------------------------

INPUT GROUP: 1 -- General run control parameters
--------------

   Starting date:   Year   (IBYR)  --   No default   ! IBYR = 2012 !
                    Month  (IBMO)  --   No default   ! IBMO = 1 !
                    Day    (IBDY)  --   No default   ! IBDY = 1 !
   Starting time:   Hour   (IBHR)  --   No default   ! IBHR = 0 !
                    Second (IBSEC) --   No default   ! IBSEC = 0 !

   Ending date:     Year   (IEYR)  --   No default   ! IEYR = 2012 !
                    Month  (IEMO)  --   No default   ! IEMO = 1 !
                    Day    (IEDY)  --   No default   ! IEDY = 2 !
   Ending time:     Hour   (IEHR)  --   No default   ! IEHR = 0 !
                    Second (IESEC) --   No default   ! IESEC = 0 !

    UTC time zone        (ABTZ) -- No default      ! ABTZ = UTC+1200 !
      (character*8)
      PST = UTC-0800, MST = UTC-0700 , GMT = UTC-0000
      CST = UTC-0600, EST = UTC-0500

   Length of modeling time-step (seconds)
   Must divide evenly into 3600 (1 hour)
   (NSECDT)                    Default:3600     ! NSECDT = 3600 !
                           Units: seconds

   Run type          (IRTYPE) -- Default: 1      ! IRTYPE = 1 !

     0 = Computes wind fields only
     1 = Computes wind fields and micrometeorological variables
        (u*, w*, L, zi, etc.)
     (IRTYPE must be 1 to run CALPUFF or CALGRID)

   Compute special data fields required by CALGRID (i.e., 3-D fields of W wind components and temperature)
   in additional to regular          Default: T    ! LCALGRD = T !
   fields ? (LCALGRD)
   (LCALGRD must be T to run CALGRID)

    Flag to stop run after SETUP phase (ITEST)          Default: 2      ! ITEST = 2 !
    (Used to allow checking
    of the model inputs, files, etc.)
```

```
 ITEST = 1 - STOPS program after SETUP phase
 ITEST = 2 - Continues with execution of
             COMPUTATIONAL phase after SETUP


Test options specified to see if they conform to regulatory
values? (MREG)                No Default       ! MREG = 0 !

  0 = NO checks are made
  1 = Technical options must conform to USEPA guidance

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 2 -- Map Projection and Grid control parameters
--------------

Projection for all (X,Y):
-------------------------

Map projection
(PMAP)                  Default: UTM    ! PMAP = UTM !

   UTM :  Universal Transverse Mercator
   TTM :  Tangential Transverse Mercator
   LCC :  Lambert Conformal Conic
    PS :  Polar Stereographic
    EM :  Equatorial Mercator
  LAZA :  Lambert Azimuthal Equal Area

False Easting and Northing (km) at the projection origin
(Used only if PMAP= TTM, LCC, or LAZA)
(FEAST)                 Default=0.0     ! FEAST = 0.0 !
(FNORTH)                Default=0.0     ! FNORTH = 0.0 !

UTM zone (1 to 60)
(Used only if PMAP=UTM)
(IUTMZN)                No Default      ! IUTMZN = 60 !

Hemisphere for UTM projection?
(Used only if PMAP=UTM)
(UTMHEM)                Default: N      ! UTMHEM = S !
   N   :  Northern hemisphere projection
   S   :  Southern hemisphere projection

Latitude and Longitude (decimal degrees) of projection origin
(Used only if PMAP= TTM, LCC, PS, EM, or LAZA)
(RLAT0)                 No Default      ! RLAT0 = 0.00N !
(RLON0)                 No Default      ! RLON0 = 0.00E !

Matching parallel(s) of latitude (decimal degrees) for projection
(Used only if PMAP= LCC or PS)
(XLAT1)                 No Default      ! XLAT1 = 30S !
(XLAT2)                 No Default      ! XLAT2 = 60S !

Datum-region
------------

Datum-region for output coordinates
(DATUM)                 Default: WGS-84     ! DATUM = WGS-84 !

Horizontal grid definition:
---------------------------

Rectangular grid defined for projection PMAP,
with X the Easting and Y the Northing coordinate

     No. X grid cells (NX)     No default     ! NX = 90 !
     No. Y grid cells (NY)     No default     ! NY = 90 !

Grid spacing (DGRIDKM)          No default     ! DGRIDKM = 1 !
                        Units: km
```

```
   Reference grid coordinate of SOUTHWEST corner of grid cell (1,1)

     X coordinate (XORIGKM)        No default     ! XORIGKM = 430 !
     Y coordinate (YORIGKM)        No default     ! YORIGKM = 5560 !
                                Units: km

   Vertical grid definition:
   -------------------------

     No. of vertical layers (NZ)    No default     ! NZ = 10 !

     Cell face heights in arbitrary vertical grid (ZFACE(NZ+1))    No defaults    Units: m
     ! ZFACE = 0.00,20.00,40.00,80.00,160.00,320.00,640.00,1200.00,2000.00,3000.00,4000.00  !

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 3 -- Output Options
--------------

   DISK OUTPUT OPTION

     Save met. fields in an unformatted
     output file ?            (LSAVE)  Default: T     ! LSAVE = T !
     (F = Do not save, T = Save)

     Type of unformatted output file:
     (IFORMO)                        Default: 1    ! IFORMO = 1 !

         1 = CALPUFF/CALGRID type file (CALMET.DAT)
         2 = MESOPUFF-II type file     (PACOUT.DAT)

   LINE PRINTER OUTPUT OPTIONS:

     Print met. fields ?  (LPRINT)       Default: F     ! LPRINT = F !
     (F = Do not print, T = Print)

     Print interval (IPRINF) in hours                Default: 1     ! IPRINF = 1 !

     Specify which layers of U, V wind component to print (IUVOUT(NZ)) -- NOTE: NZ values must be entered
     (0=Do not print, 1=Print) (used only if LPRINT=T)        Defaults: NZ*0
     * IUVOUT = *
     -----------------------

     Specify which levels of the W wind component to print
     (NOTE: W defined at TOP cell face --  6  values) (IWOUT(NZ)) -- NOTE: NZ values must be entered
     (0=Do not print, 1=Print) (used only if LPRINT=T & LCALGRD=T)
     -----------------------------------
                                Defaults: NZ*0
      * IWOUT = *

     Specify which levels of the 3-D temperature field to print
     (ITOUT(NZ)) -- NOTE: NZ values must be entered
     (0=Do not print, 1=Print) (used only if LPRINT=T & LCALGRD=T)
     -----------------------------------
                                Defaults: NZ*0
      * ITOUT = *

     Specify which meteorological fields
     to print
     (used only if LPRINT=T)            Defaults: 0 (all variables)
     -----------------------

       Variable          Print ? (0 = do not print, 1 = print)
       --------        ------------------

    ! STABILITY = 0 ! - PGT stability class
    ! USTAR = 0 ! - Friction velocity
    ! MONIN = 0 ! - Monin-Obukhov length
    ! MIXHT = 0 ! - Mixing height
    ! WSTAR = 0 ! - Convective velocity scale
```

```
    ! PRECIP = 0 ! - Precipitation rate
    ! SENSHEAT = 0 ! - Sensible heat flux
    ! CONVZI = 0 ! - Convective mixing ht.


     Testing and debug print options for micrometeorological module

       Print input meteorological data and
       internal variables (LDB)        Default: F      ! LDB = F !
       (F = Do not print, T = print)
       (NOTE: this option produces large amounts of output)

       First time step for which debug data
       are printed (NN1)              Default: 1      ! NN1 = 1 !

       Last time step for which debug data
       are printed (NN2)              Default: 1      ! NN2 = 1 !

       Print distance to land
       internal variables (LDBCST)      Default: F      ! LDBCST = F !
       (F = Do not print, T = print)
       (Output in .GRD file DCST.GRD, defined in input group 0)

     Testing and debug print options for wind field module (all of the following print options control output to
      wind field module's output files: TEST.PRT, TEST.OUT, TEST.KIN, TEST.FRD, and TEST.SLP)

       Control variable for writing the test/debug wind fields to disk files (IOUTD)
       (0=Do not write, 1=write)       Default: 0      ! IOUTD = 0 !

       Number of levels, starting at the surface,
       to print (NZPRN2)              Default: 1      ! NZPRN2 = 1 !

       Print the INTERPOLATED wind components ?
       (IPR0) (0=no, 1=yes)           Default: 0      ! IPR0 = 0 !

       Print the TERRAIN ADJUSTED surface wind components ?
       (IPR1) (0=no, 1=yes)           Default: 0      ! IPR1 = 0 !

       Print the SMOOTHED wind components and the INITIAL DIVERGENCE fields ?
       (IPR2) (0=no, 1=yes)           Default: 0      ! IPR2 = 0 !

       Print the FINAL wind speed and direction fields ?
       (IPR3) (0=no, 1=yes)           Default: 0      ! IPR3 = 0 !

       Print the FINAL DIVERGENCE fields ?
       (IPR4) (0=no, 1=yes)           Default: 0      ! IPR4 = 0 !

       Print the winds after KINEMATIC effects are added ?
       (IPR5) (0=no, 1=yes)           Default: 0      ! IPR5 = 0 !

       Print the winds after the FROUDE NUMBER adjustment is made ?
       (IPR6) (0=no, 1=yes)           Default: 0      ! IPR6 = 0 !

       Print the winds after SLOPE FLOWS are added ?
       (IPR7) (0=no, 1=yes)           Default: 0      ! IPR7 = 0 !

       Print the FINAL wind field components ?
       (IPR8) (0=no, 1=yes)           Default: 0      ! IPR8 = 0 !

!END!


-----------------------------------------------------------------------------

INPUT GROUP: 4 -- Meteorological data options
--------------

   NO OBSERVATION MODE           (NOOBS)  Default: 0     ! NOOBS = 0 !
       0 = Use surface, overwater, and upper air stations
       1 = Use surface and overwater stations (no upper air observations)
          Use MM4/MM5/3D for upper air data
       2 = No surface, overwater, or upper air observations
          Use MM4/MM5/3D for surface, overwater, and upper air data
```

```
  NUMBER OF SURFACE & PRECIP. METEOROLOGICAL STATIONS

    Number of surface stations   (NSSTA)  No default     ! NSSTA = 4 !

    Number of precipitation stations
    (NPSTA=-1: flag for use of MM5/3D precip data)
                          (NPSTA)  No default     ! NPSTA = 0 !

  CLOUD DATA OPTIONS
    Output option - output a CLOUD.DAT file (yes or no)  0=no, 1=yes
                         (ICLDOUT) Default:999      ! ICLDOUT = 0 !

    Method to compute cloud fields:
                         (MCLOUD)  Default: 999     ! MCLOUD = 1 !
    MCLOUD = 1 - Clouds data generated from surface observations
    MCLOUD = 2 - Gridded CLOUD.DAT read from CLOUD.DAT file (no output
             is possible since already exist)
    MCLOUD = 3 - Gridded cloud cover from Prognostic Rel. Humidity
             at 850mb (Teixera)
    MCLOUD = 4 - Gridded cloud cover from Prognostic Rel. Humidity
             at all levels (MM5toGrads algorithm)

  FILE FORMATS

    Surface meteorological data file format
                         (IFORMS)  Default: 2     ! IFORMS = 2 !
    (1 = unformatted (e.g., SMERGE output))
    (2 = formatted   (free-formatted user input))

    Precipitation data file format
                         (IFORMP)  Default: 2     ! IFORMP = 2 !
    (1 = unformatted (e.g., PMERGE output))
    (2 = formatted   (free-formatted user input))

    Cloud data file format
                         (IFORMC)  Default: 2     ! IFORMC = 1 !
    (1 = unformatted - CALMET unformatted output)
    (2 = formatted   - free-formatted CALMET output or user input)

!END!


------------------------------------------------------------------------------

INPUT GROUP: 5 -- Wind Field Options and Parameters
--------------


  WIND FIELD MODEL OPTIONS
    Model selection variable (IWFCOD)     Default: 1      ! IWFCOD = 1 !
      0 = Objective analysis only
      1 = Diagnostic wind module

    Compute Froude number adjustment
    effects ? (IFRADJ)                Default: 1      ! IFRADJ = 1 !
    (0 = NO, 1 = YES)

    Compute kinematic effects ? (IKINE)   Default: 0      ! IKINE = 0 !
    (0 = NO, 1 = YES)

    Use O'Brien procedure for adjustment
    of the vertical velocity ? (IOBR)     Default: 0      ! IOBR = 0 !
    (0 = NO, 1 = YES)

    Compute slope flow effects ? (ISLOPE) Default: 1      ! ISLOPE = 1 !
    (0 = NO, 1 = YES)

    Extrapolate surface wind observations
    to upper layers ? (IEXTRP)          Default: -4     ! IEXTRP = 4 !
    (1 = no extrapolation is done,
     2 = power law extrapolation used,
     3 = user input multiplicative factors for layers 2 - NZ used (see FEXTRP array)
```

4 = similarity theory used -1, -2, -3, -4 = same as above except layer 1 data
at upper air stations are ignored

Extrapolate surface winds even
if calm? (ICALM) Default: 0 ! ICALM = 0 !
(0 = NO, 1 = YES)

Default: NZ*0
! BIAS = 0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0,0.0 !

Minimum distance from nearest upper air station to surface station for which extrapolation
of surface winds at surface station will be allowed (RMIN2: Set to -1 for IEXTRP = 4 or other situations
where all surface stations should be extrapolated) Default: 4. ! RMIN2 = 4 !

Use gridded prognostic wind field model output fields as input to the diagnostic
wind field model (IPROG) Default: 0 ! IPROG = 0 !
(0 = No, [IWFCOD = 0 or 1]

Timestep (seconds) of the prognostic
model input data (ISTEPPGS) Default: 3600 ! ISTEPPGS = 3600 !

Use coarse CALMET fields as initial guess fields (IGFMET)
(overwrites IGF based on prognostic wind fields if any)
Default: 0 ! IGFMET = 0 !

RADIUS OF INFLUENCE PARAMETERS

Use varying radius of influence Default: F ! LVARY = F !
(if no stations are found within RMAX1,RMAX2,
or RMAX3, then the closest station will be used)

Maximum radius of influence over land
in the surface layer (RMAX1) No default ! RMAX1 = 20 !
Units: km
Maximum radius of influence over land
aloft (RMAX2) No default ! RMAX2 = 20 !
Units: km
Maximum radius of influence over water
(RMAX3) No default ! RMAX3 = 0 !
Units: km

OTHER WIND FIELD INPUT PARAMETERS

Minimum radius of influence used in the wind field interpolation (RMIN) Default: 0.1 ! RMIN = 0.1 !
Units: km
Radius of influence of terrain
features (TERRAD) No default ! TERRAD = 6 !

Units: km
Relative weighting of the first guess field and observations in the
SURFACE layer (R1) No default ! R1 = 8 !
(R1 is the distance from an Units: km
observational station at which the
observation and first guess field are equally weighted)

Relative weighting of the first guess field and observations in the
layers ALOFT (R2) No default ! R2 = 8 !
(R2 is applied in the upper layers Units: km
in the same manner as R1 is used in the surface layer).

Relative weighting parameter of the
prognostic wind field data (RPROG) No default ! RPROG = 0 !
(Used only if IPROG = 1) Units: km

Maximum acceptable divergence in the divergence minimization procedure
(DIVLIM) Default: 5.E-6 ! DIVLIM = 5E-006 !

Maximum number of iterations in the
divergence min. procedure (NITER) Default: 50 ! NITER = 50 !

Number of passes in the smoothing procedure (NSMTH(NZ))
NOTE: NZ values must be entered Default: 2,(mxnz-1)*4 ! NSMTH = 2,9*4 !

Maximum number of stations used in each layer for the interpolation of
data to a grid point (NINTR2(NZ))
NOTE: NZ values must be entered Default: 99. ! NINTR2 = 10*99 !

Critical Froude number (CRITFN) Default: 1.0 ! CRITFN = 1 !

Empirical factor controlling the influence of kinematic effects
(ALPHA) Default: 0.1 ! ALPHA = 0.1 !

Multiplicative scaling factor for extrapolation of surface observations
to upper layers (FEXTR2(NZ)) Default: NZ*0.0
* FEXTR2 = *
(Used only if IEXTRP = 3 or -3)

BARRIER INFORMATION

Number of barriers to interpolation
of the wind fields (NBAR) Default: 0 ! NBAR = 0 !

Level (1 to NZ) up to which barriers
apply (KBAR) Default: NZ ! KBAR = 10 !

THE FOLLOWING 4 VARIABLES ARE INCLUDED ONLY IF NBAR > 0
NOTE: NBAR values must be entered No defaults
for each variable Units: km

X coordinate of BEGINNING of each barrier (XBBAR(NBAR)) * XBBAR = *
Y coordinate of BEGINNING of each barrier (YBBAR(NBAR)) * YBBAR = *

X coordinate of ENDING of each barrier (XEBAR(NBAR)) * XEBAR = *
Y coordinate of ENDING of each barrier (YEBAR(NBAR)) * YEBAR = *

DIAGNOSTIC MODULE DATA INPUT OPTIONS

Surface temperature (IDIOPT1) Default: 0 ! IDIOPT1 = 0 !
0 = Compute internally from hourly surface observations or prognostic fields
1 = Read preprocessed values from a data file (DIAG.DAT)

Surface met. station to use for
the surface temperature (ISURFT) Default: -1 ! ISURFT = -1 !
(Used only if IDIOPT1 = 0)

Temperature lapse rate used in the Default: 0 ! IDIOPT2 = 0 !
computation of terrain-induced circulations (IDIOPT2)
0 = Compute internally from (at least) twice-daily
upper air observations or prognostic fields
1 = Read hourly preprocessed values from a data file (DIAG.DAT)

Upper air station to use for
the domain-scale lapse rate (IUPT) Default: -1 ! IUPT = 1 !
(Must be a value from 1 to NUSTA
or -1 to use 2-D spatially varying lapse rate)
or -2 to use a domain-average prognostic lapse rate (only with ITPROG>0)
(Used only if IDIOPT2 = 0)

Depth through which the domain-scale
lapse rate is computed (ZUPT) Default: 200. ! ZUPT = 200 !
(Used only if IDIOPT2 = 0) Units: meters

Initial Guess Field Winds
(IDIOPT3) Default: 0 ! IDIOPT3 = 0 !
0 = Compute internally from observations or prognostic wind fields
1 = Read hourly preprocessed domain-average wind values from a data file (DIAG.DAT)

Upper air station to use for

```
      the initial guess winds (IUPWND)   Default: -1    ! IUPWND = -1 !
      (Used only if IDIOPT3 = 0 and noobs=0)
      ---------------------------------------

      Bottom and top of layer through which the domain-scale winds are computed
      (ZUPWND(1), ZUPWND(2))       Defaults: 1., 1000. ! ZUPWND= 1.0, 1.00 !
      (Used only if IDIOPT3 = 0, NOOBS>0 and IUPWND>0)    Units: meters
      --------------------------

    Observed surface wind components
    for wind field module (IDIOPT4)  Default: 0     ! IDIOPT4 = 0 !
      0 = Read WS, WD from a surface data file (SURF.DAT)
      1 = Read hourly preprocessed U, V from a data file (DIAG.DAT)

    Observed upper air wind components
    for wind field module (IDIOPT5)  Default: 0     ! IDIOPT5 = 0 !
      0 = Read WS, WD from an upper air data file (UP1.DAT, UP2.DAT, etc.)
      1 = Read hourly preprocessed U, V from a data file (DIAG.DAT)

    LAKE BREEZE INFORMATION

      Use Lake Breeze Module  (LLBREZE)
                              Default: F      ! LLBREZE = F !

       Number of lake breeze regions (NBOX)          ! NBOX = 0 !

     X Grid line 1 defining the region of interest   * XG1 = *
     X Grid line 2 defining the region of interest   * XG2 = *
     Y Grid line 1 defining the region of interest   * YG1 = *
     Y Grid line 2 defining the region of interest   * YG2 = *

      X Point defining the coastline (Straight line)
            (XBCST)  (KM)   Default: none    * XBCST = *

      Y Point defining the coastline (Straight line)
            (YBCST)  (KM)   Default: none    * YBCST = *

      X Point defining the coastline (Straight line)
            (XECST)  (KM)   Default: none    * XECST = *

      Y Point defining the coastline (Straight line)
            (YECST)  (KM)   Default: none    * YECST = *


    Number of stations in the region     Default: none * NLB = *
    (Surface stations + upper air stations)

    Station ID's  in the region   (METBXID(NLB))
    (Surface stations first, then upper air stations)  * METBXID = *

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 6 -- Mixing Height, Temperature and Precipitation Parameters
--------------

   EMPIRICAL MIXING HEIGHT CONSTANTS

    Neutral, mechanical equation
    (CONSTB)                     Default: 1.41   ! CONSTB = 1.41 !
    Convective mixing ht. equation
    (CONSTE)                     Default: 0.15   ! CONSTE = 0.15 !
    Stable mixing ht. equation
    (CONSTN)                      Default: 2400.  ! CONSTN = 2400 !
    Overwater mixing ht. equation
    (CONSTW)                       Default: 0.16   ! CONSTW = 0.16 !
    Absolute value of Coriolis
    parameter (FCORIOL)              Default: 1.E-4  ! FCORIOL = 0.0001 !
                                 Units: (1/s)

   SPATIAL AVERAGING OF MIXING HEIGHTS
```

Conduct spatial averaging
(IAVEZI) (0=no, 1=yes) Default: 1 ! IAVEZI = 1 !

Max. search radius in averaging
process (MNMDAV) Default: 1 ! MNMDAV = 1 !
Units: Grid cells
Half-angle of upwind looking cone
for averaging (HAFANG) Default: 30. ! HAFANG = 30 !
Units: deg.
Layer of winds used in upwind
averaging (ILEVZI) Default: 1 ! ILEVZI = 1 !
(must be between 1 and NZ)

CONVECTIVE MIXING HEIGHT OPTIONS:
Method to compute the convective
mixing height(IMIHXH) Default: 1 ! IMIXH = 1 !
1: Maul-Carson for land and water cells

Threshold buoyancy flux required to sustain convective mixing height growth
overland (THRESHL) Default: 0.0 ! THRESHL = 0 !
(expressed as a heat flux units: W/m3
per meter of boundary layer)

Threshold buoyancy flux required to sustain convective mixing height growth
overwater (THRESHW) Default: 0.05 ! THRESHW = 0.05 !
(expressed as a heat flux units: W/m3
per meter of boundary layer)

Option for overwater lapse rates used in convective mixing height growth
(ITWPROG) Default: 0 ! ITWPROG = 0 !
0 : use SEA.DAT lapse rates and deltaT (or assume neutral conditions if missing)

Land Use category ocean in 3D.DAT datasets
(ILUOC3D) Default: 16 ! ILUOC3D = 16 !
Note: if 3D.DAT from MM5 version 3.0, iluoc3d = 16
if MM4.DAT, typically iluoc3d = 7

OTHER MIXING HEIGHT VARIABLES

Minimum potential temperature lapse rate in the stable layer above the
current convective mixing ht. Default: 0.001 ! DPTMIN = 0.001 !
(DPTMIN) Units: deg. K/m
Depth of layer above current conv.
mixing height through which lapse Default: 200. ! DZZI = 200 !
rate is computed (DZZI) Units: meters

Minimum overland mixing height Default: 50. ! ZIMIN = 50 !
(ZIMIN) Units: meters
Maximum overland mixing height Default: 3000. ! ZIMAX = 3000 !
(ZIMAX) Units: meters
Minimum overwater mixing height Default: 50. ! ZIMINW = 50 !
(ZIMINW) -- (Not used if observed Units: meters
overwater mixing hts. are used)
Maximum overwater mixing height Default: 3000. ! ZIMAXW = 3000 !
(ZIMAXW) -- (Not used if observed Units: meters
overwater mixing hts. are used)

OVERWATER SURFACE FLUXES METHOD and PARAMETERS
(ICOARE) Default: 10 ! ICOARE = 10 !
0: original deltaT method (OCD)
10: COARE with no wave parameterization (jwave=0, Charnock)

Coastal/Shallow water length scale (DSHELF)
(for modified z0 in shallow water) (COARE fluxes only)
Default : 0. ! DSHELF = 0 !
units: km

COARE warm layer computation (IWARM) ! IWARM = 0 !

```
        1: on - 0: off (must be off if SST measured with
        IR radiometer)              Default: 0

        COARE cool skin layer computation (ICOOL)         ! ICOOL = 0 !
        1: on - 0: off (must be off if SST measured with
        IR radiometer)              Default: 0

   RELATIVE HUMIDITY PARAMETERS

      3D relative humidity from observations or
      from prognostic data? (IRHPROG)      Default:0       ! IRHPROG = 0 !

        0 = Use RH from SURF.DAT file      (only if NOOBS = 0,1)
        1 = Use prognostic RH              (only if NOOBS = 0,1,2)

   TEMPERATURE PARAMETERS

      3D temperature from observations or
      from prognostic data? (ITPROG)       Default:0       ! ITPROG = 0 !

        0 = Use Surface and upper air stations           (only if NOOBS = 0)
        1 = Use Surface stations (no upper air observations)
           Use MM5/3D for upper air data            (only if NOOBS = 0,1)
        2 = No surface or upper air observations
           Use MM5/3D for surface and upper air data  (only if NOOBS = 0,1,2)

      Interpolation type
      (1 = 1/R ; 2 = 1/R**2)              Default:1        ! IRAD = 1 !

      Radius of influence for temperature
      interpolation (TRADKM)              Default: 500.     ! TRADKM = 500 !
                                    Units: km

      Maximum Number of stations to include
      in temperature interpolation (NUMTS)  Default: 5       ! NUMTS = 5 !

      Conduct spatial averaging of temp-
      eratures (IAVET)  (0=no, 1=yes)      Default: 1       ! IAVET = 1 !
      (will use mixing ht MNMDAV,HAFANG
       so make sure they are correct)

      Default temperature gradient         Default: -.0098 ! TGDEFB = -0.0098 !
      below the mixing height over         Units: K/m
      water (TGDEFB)

      Default temperature gradient         Default: -.0045 ! TGDEFA = -0.0045 !
      above the mixing height over         Units: K/m
      water (TGDEFA)

      Beginning (JWAT1) and ending (JWAT2)
      land use categories for temperature                  ! JWAT1 = 999 !
      interpolation over water -- Make                     ! JWAT2 = 999 !
      bigger than largest land use to disable

  PRECIP INTERPOLATION PARAMETERS

      Method of interpolation (NFLAGP)      Default: 2       ! NFLAGP = 2 !
       (1=1/R,2=1/R**2,3=EXP/R**2)
      Radius of Influence  (SIGMAP)        Default: 100.0 ! SIGMAP = 100. !
       (0.0 => use half dist. btwn         Units: km
        nearest stns w & w/out precip when NFLAGP = 3)
      Minimum Precip. Rate Cutoff (CUTP)    Default: 0.01 ! CUTP = 0.01 !
       (values <CUTP = 0.0 mm/hr)          Units: mm/hr
!END!


-------------------------------------------------------------------------------

INPUT GROUP: 7 -- Surface meteorological station parameters
--------------

    SURFACE STATION VARIABLES  (One record per station --  12  records in all)
```

```
       Name     ID     X coord.   Y coord.    Time   Anem.
                        (km)       (km)       zone   Ht.(m)
     ------------------------------------------------------------
! SS1  ='S1'    15876   487.870   5632.054      12    10.000  !
! SS2  ='S2'    31620   467.293   5577.556      12    10.000  !
! SS3  ='S3'    25820   437.556   5567.214      12    10.000  !
! SS4  ='S4'     2980   492.358   5617.743      12    10.000  !
-------------------

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 8 -- Upper air meteorological station parameters
--------------

    UPPER AIR STATION VARIABLES     (One record per station --  3  records in all)

       Name    ID      X coord.   Y coord.  Time zone
                         (km)       (km)
     ------------------------------------------------
! US1  ='Para'    3145   330.967   5469.851      12 !
! US2  ='When'    1410   288.527   5925.766      12 !
-------------------

!END!

-------------------------------------------------------------------------------

INPUT GROUP: 9 -- Precipitation station parameters
--------------

    PRECIPITATION STATION VARIABLES  (One record per station --  2  records in all)
    (NOT INCLUDED IF NPSTA = 0)

       Name   Station    X coord.  Y coord.
              Code        (km)      (km)
       ------------------------------------

-------------------

!END!
```

Appendix E

Complaints

19 December 2016

Date odour noticed	Day of week	Time odour noticed	Odour description	Did HBRC attend or validate	Locations where odour found by HBRC	HBRC opinion	Other response comments
10-Sep-2014	Wednesday	Not spec	Raw sewage	Y	115 Arataki Rd	Odour fading	Chook poo/gypsum mix on bales, loading finished by 11.30am. Mixed chook/gypsum for next week, finished by 1.30pm
11-Sep-2014	Thursday	Not spec	Smell	Y	115 Arataki Rd	Not as bad as prev pm	Mixing wetted bales and putting in bunkers 6am - 2pm, all in shed and door closed by 3pm
12-Sep-2014	Friday	Morning?	Odour	Y	115 Arataki Rd	Plume worst outside 115 Arataki Rd.	Breeze shifty NNE. Odour consistent with compost and superspice. Odour identified as from turning activity started at 6am due to finish early afternoon
12-Sep-2014	Friday	Smelled at 6.30am walking the dog, 11am driving	Odour	Y	Cnr Arataki and Te Heipora		Still to complete turning activity, expect to be finished by 3pm
19-Sep-2014	Friday	Morning	Odour, "This morning its bad". Little or no wind	Y	99 Arataki		Very weak at complainants address, stronger elsewhere in neighbourhood. Turning in progress, starting to refill bunker
23-Sep-2014			General complaint about odour, not specific to date or time	N		No odour at time of call	
24-Sep-2014	Wednesday	Not spec			Arataki and at complainant	Barely detectable, not O/O	Still conditions, 360 degree check using Te Mata Rd and te Mata Mangateretere Rd - no odour
14-Oct-2014	Tuesday	Not spec	Not spec	Y	Not spec	Strong odour for 5 of 10 mins surveyed, strong easterly	Turning of bales being undertaken, standard practice, no superspice.
14-Oct-2014	Tuesday	Not spec	Odour	Y, already there	Not spec	2nd complaint for day. Staff already onsite. Odour strong	Turning of bales being undertaken, standard practice, no superspice.
16-Oct-2014	Thursday	Not spec	Strong composting smell	Y	Not spec	Odour not strong at time of visit to complainant	
23-Oct-2014	Thursday	Not spec	Odour	Y	Not spec	Odour not offensive at time of response	
21-Nov-2014	Friday	Not spec	Odour	Y	See next column	No odour along Arataki Rd and Te Heipora Pl, light west breeze. Weak odour plume on Te Mata Mangateretere Rd	
24-Nov-2014	Monday	Not spec	Odour	Y	Not spec	Not O/O	
30-Dec-2014	Tuesday	Not spec	Odour	Y	Not spec	Confirm odour.	2 complaints plus 1 neighbour reported odour also when saw officer doing assessment. Neighbour said started at 0800, strong most of the day.
30-Dec-2014	Tuesday						
30-Dec-2014	Tuesday						
09-Jan-2015	Friday	Not spec	Bad odour	Y	Arataki Rd	Light odour, not offensive	Light wind, shifting, generally NE to E. Complainant said odour had gone by time of assessment, strong an hour earlier.
13-Jan-2015	Tuesday	Not spec	Odour, ongoing issues	Y	Arataki Rd	Odour detected and assessed on Arataki Rd, no odour at	Breeze unstable and shifty. Onsite - minimal aeration odour, DO 1mg/L, clear upwind
16-Jan-2015	Friday	Not spec	Odour	Y	Arataki Rd	Found odour at complainants address. Went to Arataki Rd to conduct assessment. Normal turning activity, returning compost to bunker, some odour from aeration DO 1.0mg/L	
19-Jan-2015	Monday	7.24 am	Odour	Y	Not spec	Visited complainant at 9.15am, no odour. Wind NW	
30-Jan-2015	Friday	Not spec	Odour	Y	Not spec	No odour	No odour at all detected, light wind from W.
02-Feb-2015	Monday	Not spec	Odour	Y	Arataki Rd	Not off	Odour no longer at complainants address, some odour on Arataki Rd. Not offensive
02-Feb-2015	Monday	Not spec	Odour	Y	Arataki Rd		2 more complaints same day as above. Wind variable, unable to detect odour in one place for more than 5 mins. Little to no odour Arataki Rd
02-Feb-2015	Monday						
11-Feb-2015	Wednesday	Not spec	Rotten egg smell	Y	Not spec	Prompt reponse, no odour	
12-Feb-2015	Thursday	Not spec	Strong composting smell	Y	Not spec	Odour confirmed	4 complaints
12-Feb-2015	Thursday						
12-Feb-2015	Thursday						
12-Feb-2015	Thursday						
13-Feb-2015	Friday	Not spec	Strong composting smell	Y	Not spec	Odour confirmed	3 complaints
13-Feb-2015	Friday						
13-Feb-2015	Friday						

Date odour noticed	Day of week	Time odour noticed	Odour description	Did HBRC attend or validate	Locations where odour found by HBRC	HBRC opinion	Other response comments
13-Feb-2015	Friday						
17-Feb-2015	Tuesday	Not spec	Strong smell of compost and sewage	Y	Cnr Arataki and Te Heipora	Odour present by not O/O	Noted odour while talking to complainant, went to take assessment at Ar/TH Rds but wind had died off, odour present by not strong enough to be O/O
17-Feb-2015	Tuesday	1415 hrs	Very strong odour	N			HBRC already been to site today for another complaint
20-Feb-2015	Friday	Not spec	House subject to strong composting odour	N			
24-Feb-2015	Tuesday	Not spec	Odour alleged TMMC and sewage smell, NM wind	Y	Arataki Rd	Not O/O	At complainant, no odour, wind ESE, unsettled breeze, likely wind change. Found plume lower down Arataki Rd Motor camp and below, odour not O/O.
24-Feb-2015	Tuesday	Not spec	Strong smell of compost and sewage	N	Not spec	Odour confirmed	Total 6 complaints this day. See above line also. Visit to another complainant found odour distinct to strong, wind shifty so odour came and went. Site mixing chook poo for applic Thurs morning.
24-Feb-2015	Tuesday						
24-Feb-2015	Tuesday						
24-Feb-2015	Tuesday						
24-Feb-2015	Tuesday						
27-Feb-2015	Friday	Not spec	Odour on and off all day, wind dir at time of call ENE	Y	Not spec	Not O/O	Odour present at time of visit, fluctuating wind consistently changed location of odour plume.
02-Mar-2015	Monday	Not spec	Quite strong odour, wind light and from the east	Y	Not spec	Not O/O	Initial distinct odour detected, not consistent. Odour considered light when present, but not detectable for most of the inspection.
02-Mar-2015	Monday	Not spec	Odour	Y	Arataki Rd cnr	Not spec	4 complaints this day including the line above. Paraphrased - HBRC could only find slight odour/very weak odour in neighbourhood, wind dir changeable made odour hard to find but very weak when did find it
02-Mar-2015	Monday						
02-Mar-2015	Monday						
03-Mar-2015	Tuesday	Not spec	Odour	Y	Not spec	Not O/O	6 complaints this day. Breeze light and shifty through 90 degrees NE-SE. Smell considered weak at worst except for last inspections, see next line
03-Mar-2015	Tuesday	Not spec	Odour	Y	Outside camp ground	Confirmed O/O	Consistent disctinct/strong impressions at camp ground. This was not where the complaint was though (Devine Close).
03-Mar-2015	Tuesday						
03-Mar-2015	Tuesday						
03-Mar-2015	Tuesday						
03-Mar-2015	Tuesday						
05-Mar-2015	Thursday	Not spec	Odour	Y	Outside camp ground	Light intensity odour	Not detected at complainant, odour plume detected at camp ground area, wind fluctuation and odour intensity light
06-Mar-2015	Friday	Not spec	Odour	Y	Arataki Rd	Slight odour, not O/O	No odour detected on Russell Robinson Rd, slight odour on Arataki Rd but not O/O
06-Mar-2015	Friday	Morning see comments	Odour	Y	Arataki Rd		8 complaints this day including line above. 8.40am - odour detected on Arataki Rd wind from NE. Wind shifting to N then NE. Compost in 2 stacks out on yard at 9.10am.
06-Mar-2015	Friday						
06-Mar-2015	Friday						
06-Mar-2015	Friday						
06-Mar-2015	Friday						
06-Mar-2015	Friday						
06-Mar-2015	Friday						
09-Mar-2015	Monday	Morning see comments	Odour	Y	Not spec	No odour	3 complaints this morning between 0810 and 0830 hrs, 4th complaint 1217hrs from 107 Arataki Rd. HBRC on site at 0845 to 0910 hours, wind nil to very light, from W to NW, no odour detected. Contacted 107 Arataki Rd at 1430 hrs, no odour reported, wind now from the west.
09-Mar-2015	Monday						
09-Mar-2015	Monday						
10-Mar-2015	Tuesday	Morning see comments	Odour	Y	Not spec	No odour	2 complaints, 2nd at 0835 was a neighbour of the 1st complainant. Wind nil to very light when responded, from SW. No odour detected. Spoke to locals who confirmed an odour earlier at about 0830.
10-Mar-2015	Tuesday						
13-Mar-2015	Friday	Not spec	Odour caused by fans	Y	Te Heipora Pl	Not strong enough to warrant assessment	Light odour found at TH Place, plume very narrow and only occasionally detected, onsite 25-30 mins. Complainant called who confirmed fans had switched off and odour dissipated.
23-Mar-2015	Monday	Not spec	Wind E, light, odour coming and going	Y	Te Heipora Pl	Not O/O	2 complaints. Odour not detected at complainants, odour plume located around TH Rd, not
23-Mar-2015	Monday						
24-Mar-2015	Tuesday	Not spec	Odour very strong, Wind light NE.	Y	Not spec	Odour confirmed	2 complaints. Odour source identified onsite (but not specified)

Date odour noticed	Day of week	Time odour noticed	Odour description	Did HBRC attend or validate	Locations where odour found by HBRC	HBRC opinion	Other response comments
24-Mar-2015	Tuesday						
25-Mar-2015	Wednesday	Morning	Odour very strong, Wind light, odour on and off all morning	Y	111 Arataki Rd	Not O/O	Odour not detected at complainants address, plume located across from 111 Arataki Rd, odour detected for 1-2 min on and off over 10 min period at low intensity. Not O/O
26-03-2015	Thursday	Morning	Odour, quite putrid, on and off all morning, Wind dire NNW	Y	Not spec	Odour found	Initial assessment 1310hrs, odour found, wind light and shifty NNW to E. Odour mainly weak to very weak sometimes distinct for a few secs. Short period of strong odour. Depart approx 1.50pm. Typical Thursday, no site visit. Very shifty breeze
31-03-2015	Tuesday	Not spec	Strong odour, wind light from NE	Y	Devine Place	Confirmed O/O	2 complaints (2nd from 2 Devine Place asked to be added when saw officer conducting assessment). Odour obvious, full assessment made. 360 deg assessment on site. Nil odour upwind. Compost blending and restacking in progress.
2-04-2015	Thursday	Not spec	Strong odour	N	Not spec		
6-04-2015	Monday	Not spec	Odour	Y	Not spec	Odour confirmed	2 complaints. Identified source as compost in open air for turning, standard Monday ops. Wind blowing from E-NE.
6-04-2015	Monday						
7-04-2015	Tuesday	Not spec	Odour bad today.	Y	Not spec	Confirmed O/O	2 complaints, one from Devine Close. Visited TMM, odour source confirmed but not specified
7-04-2015	Tuesday						
7-04-2015	Tuesday	Not spec	Odour, strong, wind NE light, odour present for a few hours	Y	Not spec	Confirmed O/O	Further complaint this day. Odour assessments established a confirmed off odour. Odour due to compost being stored outside in rows and machinery disturbing the piles.
17-04-2015	Friday	Not spec	Shocking smell	Y	Not spec	Odour detected, not O/O	4 complaints. Found odour type compost and deodoriser. TMM advised now finished for the day, doors shut and would turn off deod.
17-04-2015	Friday						
17-04-2015	Friday						
17-04-2015	Friday						
20-04-2015	Monday	Not spec	Composting odour	Y	Not spec	Not O/O	Low level of odour, light wind.
21-04-2015	Tuesday	Not spec	Composting odour	Y	Not spec	Distinct to strong	Odour bouncing frm distinct to strong, standard Tues ops, Superspice also being used. Complainant called back at 1551 hrs to notify that odour was still present. Another complaint (different complainant?) later in the day, record only. No other complaints during the evening or night.
24-04-2015	Friday	Not spec	Odour	Y	Arataki Rd	Not spec	Light wind, variable mostly NNE almost parallel to Arataki Rd. Also a smoky fire in the area, could smell deodoriser and compost but smoke was strongest but only distinct. Called TMM, 1507hrs now finidhed turning, would turn down deodoriser.
27-04-2015	Monday	Not spec	Odour	Y	Not spec	Not spec	Distinct compost odour picked up on arrival for approx 1 min then dissipated. Wind shifty and plume variable. Deod detected but very light to light intensity, onsite 35mins. No assessment undertaken
1-05-2015	Friday	Not spec	Odour	Y	Arataki Rd	Not spec	2 complaints. Detected odour at complainants. Returned to Arataki Rd, walked up and down Arataki rd. Odour from compost and deodoriser, deodoriser worse. Phoned TMM, finished Friday turning and would turn off deod.
1-05-2015	Friday						
5-05-2015	Tuesday	Not spec	Composting odour	Y	Not spec	Not spec	3 complaints. Slight air drift from TMM to complainant, odour distinct and different tone to usual; more sour. On light breeze, distinct odour but mostly weak to v.weak. Called TMM, at 1645hrs had 45min to finish, was not using deodoriser.
5-05-2015	Tuesday						
5-05-2015	Tuesday						
8-05-2015	Friday	Not spec	Composting odour, was strong for 20mins, has now dulled	N			
11-05-2015	Monday	Not spec	Composting odour, light NE wind	Y	Not spec	Not spec	Confirmed odour present. Odour light, varying intensity 2-3 out of 5 but steady, some odour present most of the time. Nil odour upwind of TM
12-05-2015	Tuesday	Not spec	Composting odour. Smelled at 4.15pm when out walking dog, 5pm on Meissener Rd, also 2pm on cnr Brookvale and Arataki	Y	Arataki Rd	No odour detected	No odour detected on Arataki Rd.
19-05-2015	Tuesday	Not spec	Composting odour drifing to Nimon St	N			Call not received till next morning. Unclear whether odour occurred on 18 or 19th.
6-06-2015	Saturday	Not spec	Composting odour, considered offensive. Same last weekend too	Y	Not spec	Not O/O	Very light odour detected near complainants. Sweet compost with some smoke odour. Occasional light ammonia smell. Odour assessment primarily 1-2, occasional 3.
8-06-2015	Monday	Not spec	Composting odour	Y	Arataki Rd		No compost odour found in Arataki Rd to Meissener or Te Heipora. Fires in area, only faint smell of smoke
13-06-2015	Saturday	Not spec	Composting odour "over the weekend" when walking near TMM	N			No other complaints received Saturday

Date odour noticed	Day of week	Time odour noticed	Odour description	Did HBRC attend or validate	Locations where odour found by HBRC	HBRC opinion	Other response comments
26-06-2015	Friday	Not spec	Composting odour in Arataki Rd. Wind very light, mainly from NW but shifty	Y	Arataki Rd	Not O/O	Visited Arataki Rd, light but infreq odour due to wind dir changing. On TMM site, 360 degree check no odour upwind. Straw bales being irrigated.
3-07-2015	Friday	Not spec	Strong TMM odour	Y	Not spec	Not spec	Strong odour detected but far too windy and shifting to be a problem.
14-07-2015	Tuesday	Not spec	Composting odour	Y	Not spec	Not spec	3 complaints. Odour confirmed from stockpile of spent anaerobic compost being loaded onto a truck
14-07-2015	Tuesday						
14-07-2015	Tuesday						
23-07-2015	Thursday	Not spec	Composting odour	Y	Not spec	Not O/O	Odour not a problem, detected but not O/O
5-08-2015	Wednesday	Not spec	Composting odour	Y	Not spec	Not O/O	Odour strong on arrival, scored distinct to weak when assessed. Not quite O/O
18-08-2015	Tuesday	Not spec	Strong odour	Y	Not spec		4 complaints, all of bad odour. One complaint said noted odour yesterday too (17th). Another complainant said present from yesterday (Monday) lunchtime, again today all morning. Site visit confirmed odour.
18-08-2015	Tuesday						
18-08-2015	Tuesday						
18-08-2015	Tuesday						
25-08-2015	Tuesday	Not spec	Odour	Y	Not spec	Not O/O	Northerly wind
28-08-2015	Friday	Not spec	Composting odour	Y	Not spec		3 complaints. Odour assessment 113 Arataki Rd "earlier in the afternoon". Odour confirmed but inconsistent and weak for much of the 10 mins. One complainant said odour was dreadful all week. Another complainant said was home at lunchtime, noticed quite a compost odour for >30min, also at weekend (presume last weekend)
28-08-2015	Friday						
28-08-2015	Friday						
5-09-2015	Saturday	Not spec	Composting odour	Y	Not spec		2 complaints. Very light wind drift from W, away from Arataki Rd. No compost type odour detected. Any other odour detected very light. No compost odour detected along Te Mata Mangateretere Rd. 2nd complaint said currently strong odour off an on since 2pm, light winds. Check of met service says Napier and Hastings both SW wind (but Hastings doesnt record wind?). Trailer wind data said light and shifty, from N quadrant.
5-09-2015	Saturday						
15-09-2015	Tuesday	Morning	Strong odour, before work.	Y	Not spec	No odour detected	New complainant. House is further 500m back from trailer. No smell at trailer at 8am, no air movement which seems contradictory with complaint.
6-10-2015	Tuesday	Not spec	Compost smell getting bad again, has a 'sting' in it at present	Y	Arataki Road	Not spec	Confirmed odour on Arataki Rd. Spoke to 2 neighbours, 'worst day for months', 'good lately', and 'not as bad as last year'. Site visit 'normal Tuesday', turning and loading tunnels. Breakdown of spreader had caused delay. Clear upwind
6-10-2015	Tuesday	Not spec	Upset and embarrassed as has house guests exposed to odour		Not spec	Not spec	Occasional weak odour over 10 minutes
6-10-2015	Tuesday	Not spec	Strength 3-4 out of 5		Te Heipora Pl.	Not spec	Odour not up higher in Arataki Rd. Odour similar to earlier in afternoon. At least 1 hr to go with site activities still due to spreader breakdown
9-10-2015	Friday	Morning and afternoon	Similar odour to yesterday. Was light this morning but progressively got worse.	Y	115 Arataki Rd	Not spec	Light wind. Odour found at 1540hrs. 10min odour assessment. Odour present for most of the time, intensity 3-4 most of the time. Character described as chook manure/compost leachate. Only site activities were bale wetting. Odour downwind of leachate pond and collection sump were very similar to that detected in Arataki Rd.
9-10-2015	Friday		Putrid sewage odour. Complainant did not think it was TMM. Light to no wind		Toward Russell Robinson end of Meissener Rd.	Not spec	HBRC officers confirmed odour as originating from TMM.
9-10-2015	Friday		Guest visiting, odour in air is awful.				Grouped with earlier investigation
12-10-2015	Monday		Complaint of odour thought to be TMM.	N			Caller failed to give name, address or any contact. Not responded to.
16-10-2015	Friday	Late morning	Thought to be from TMM. Odour 4.75/5, leaving house due to the odour.	Y		Complaint not upheld	HBRC arrived 35mins after complaint. Occasional weak odour consistent with TMM detected now and then for short durations. No discernible odour for most of the 30mins they were there. Site operations had finished (shut doors) at 1210hrs.
20-10-2015	Tuesday	All day	Strong odour going all day	Y	Arataki Rd	Not O/O	2 complaints from same person. Confirm initial strong odour band in Arataki Rd. At complainants property, slight odour only, 3 assessments carried out in Arataki Rd, none of which resulted in sufficient FIDOL to warrant visit to TMM. Site advised had a couple of breakdowns, filling tunnels, almost finished.
20-10-2015	Tuesday	All day	Strong odour going all day (same complainant as above)				
27-10-2015	Tuesday	Early morning	Arataki Rd resident; Distinct odour 2-3am, bad odour 7am, not bad by 8.45am	N			

Date odour noticed	Day of week	Time odour noticed	Odour description	Did HBRC attend or validate	Locations where odour found by HBRC	HBRC opinion	Other response comments
29-10-2015	Thursday		Sewage type odour smell	Y	Brookvale Rd (moving with wind)	Not O/O	No odour at complainant's address, unable to locate plume on Arataki Rd, some odour on Brookvale Rd, but odour was not O/O
3-11-2015	Tuesday	Not spec	"Sickening" odour starting 1 hr ago. Time not spec	N			4 complaints. Unable to respond
3-11-2015	Tuesday	Not spec	Foul odour, not noticeable 2 hrs ago before complainant went out.	N			
3-11-2015	Tuesday	1820	Very bad, 5/5.	N			
3-11-2015	Tuesday	Not spec	Totally unacceptable odour	N			
9-11-2015	Monday	Not spec	Bad smell	Y	115 Arataki Rd	Odour acceptable	3 complaints. First complaint response says odour acceptable, passed FIDOL test. 2nd complaint says confirmed odour. On site, odour from leachate pond considered to be the
9-11-2015	Monday	Not spec	Strong composting/sewage odour			Unclear	
9-11-2015	Monday	Morning	Odour at its worst around 10am				
19-11-2015	Thursday	Not spec	Odour 4-5 out of 10	Y	117 Arataki Rd	Not O/O	Light odour found, rated varying 0 to 3, mainly 0 or 1 majority of time. Not O/O
20-11-2015	Friday	Early morning	Bad odour this morning, complaint at 0705 hrs	Y		Not O/O	2 complaints. Found light odour, occasional stronger wafts. Not O/O. Plume stronger further up road towards Arataki Honey.
20-11-2015	Friday		Presently 10/10. Had been out for walk this morning but particularly bad now				
23-11-2015	Monday	Not spec	Strong smell from TMM	N			Checked wind data. Wind shift coincided with complaint time. Turning about finished for the day. NFA unless another complaint
24-11-2015	Tuesday	Not spec	Odour currently consistently bad, has been odorous on and off but has started again with the warmer weather.	Y	Arataki Rd campground	Not O/O	Light odour consistent with TMM at campground entrance, no wind. No odour detected by complainants. Walked from 83-149 Arataki to find plume, only by campground and very light and intermittent
24-11-2015	Tuesday	Evening	Complaint received at 2107 hrs.				Complaint received while still attending above
24-11-2015	Tuesday	Evening	Strong compost smell tonight, also on Friday and Sat nights (last week?)				
26-11-2015	Thursday	Not spec	No details	Y	Not spec	Unclear	Inconsistent wind, plume moving in and out of assessment location. Strong when detected but small periods of time.
30-11-2015	Days deleted	Morning	Horrendous smell at Te Mata school which making a drop off. Sewage type smell, school said it was TMM.	Y			Odour confirmed, real sewage not earthy musty composty. Wind shifty, difficult to assess as O/O.
30-11-2015	Days deleted						
1-12-2015	Tuesday	Morning	No details	Y		Unclear	5 complaints. Seems to be several assessments carried out over the day. Composty odour present, 10min assessment, 2's mainly. No site insp. Odour plume from Te Haeipora Pl to top of Arataki Motor Camp site
1-12-2015	Tuesday	Not spec	No details	Y			
1-12-2015	Tuesday	Not spec	No details	Y		Confirmed O/O	Breeze stronger than earlier inspection, more consistent dir. Odour confirmed as
1-12-2015	Tuesday	Not spec	No details	Y		Unclear	Odour confirmed but wind too shifty to get consistent smell during 10min assessment
1-12-2015	Tuesday	Not spec	No details	Y		Not O/O	Located plume, odour detected but not O/O.
4-12-2015	Days deleted	Not spec	No details	Y			Property long distance from TMM, no odour detected at property or along Arataki Rd.
8-12-2015	Tuesday	Night	Extremely bad odour at 174 Brookvale Rd. Tonight worst it has ever been, first time complained even though they put up with it usually	N			Odour had gone when officer called complainant
11-12-2015	Friday	Not spec	No details	Y		Not O/O	2 complaints in 30 mins. Full assessment made, odour detected on average weak 2/6 but distinct now and then. Not considered O/O but marginal at times
11-12-2015	Friday						
14-12-2015	Monday	Not spec	Strong sewage odour, suspects TMM	Y		Not O/O	Odour not O/O, odour strength verring between distinct and not detected
15-12-2015	Tuesday	Not spec	No details	Y	Arataki Rd	Not O/O	4 complaints. Odour consistent with TMM, wind light and shifty, odour detected on and off, odour generally weak to distinct during full assessment, not O/O due to fickle conditions and light intensity
15-12-2015	Tuesday	Not spec	No details				
15-12-2015	Tuesday	Not spec	No details				
15-12-2015	Tuesday	Not spec	No details	N			After hours call
24-12-2015	Thursday	Not spec	Smells strong today, 5/6	N			Until Court date, recording calls only but encouraged to call when odour is strong
24-12-2015	Thursday	Not spec	Strong odour	N			
24-12-2015	Thursday	Morning	Strong odour all morning	N			
30-12-2015	Wednesday	Not spec	Strong again today	N			

Date odour noticed	Day of week	Time odour noticed	Odour description	Did HBRC attend or validate	Locations where odour found by HBRC	HBRC opinion	Other response comments
30-12-2015	Wednesday	Not spec	Worst odour ever, going right through house	N			
5-01-2016	Tuesday	All day	Odour off and on all day, now very strong, odour makes you want to vomit, close doors and windows	N			
6-01-2016	Wednesday	All day	On and off all day, stronger now	N			
8-01-2016	Friday	Not spec	Strong odour, first time caller	N			
8-01-2016	Friday	Not spec	Odour bad today, went to work early to get out of smell	N			
7-01-2016	Thursday	Not spec	Strength 5/5 at time of call	N			
11-01-2016	Monday	Not spec	Odour has got increasingly worse over last 90	N			
11-01-2016	Monday	Not spec	Odour on and off all day, past half hour some 'strong blasts'	N			
12-01-2016	Tuesday	Not spec	Odour on and off all day, but really strong at the moment	N			
12-01-2016	Tuesday	Not spec	Odour on and off all day, but really strong at the moment	N			
12-01-2016	Tuesday	Not spec	Strong odour, suspect TMM	N			
14-01-2016	Thursday	Not spec	Odour over last 5-6 days has been really strong, complainant does not normally ring	N			
18-01-2016	Monday	Not spec	Odour 5/5, believed it was 'feral'	N			
19-01-2016	Tuesday	Not spec	Really bad odour, 11/10	N			
21-01-2016	Thursday	Not spec	Particularly strong odour today, strong all week but on and off dep on wind dir	N			
21-01-2016	Thursday	Not spec	Odour as bad as it has ever been, sickly sweet musty smell	N			
21-01-2016	Thursday	Not spec	Putrid smell, like vomit	N			
21-01-2016	Thursday	Night	Persistent odour over 8 hour period, worst he had smelt.	N			
22-01-2016	Friday	Not spec	Strong today, also noticeable past week	N			
26-01-2016	Tuesday	Not spec	Strong odour, 5.5/6	N			
26-01-2016	Tuesday	Not spec	New complainant just bought house. Woke up to smell had to close all windows.	N			
26-01-2016	Tuesday	Not spec	Smell consistent all day over last 12 months	N			
26-01-2016	Tuesday	Morning	Nauseous odour this morning. TMM has been bad at nights, needs to close windows	N			
26-01-2016	Tuesday	Not spec	Need to close windows, consistently offensive for a week	N			
26-01-2016	Tuesday	Not spec	Odour is foul today, worst it has ever been. Been at house 6 years, never called before	N			
26-01-2016	Tuesday	Not spec	House needs to be closed up, odour lingering in rooms	N			
26-01-2016	Tuesday	Not spec	Odour 4/5 intensity, kids had to close windows for whole day	N			
26-01-2016	Tuesday	Not spec	Regular strong odour	N			
26-01-2016	Tuesday	Not spec	TMM very foul today.	N			
2-02-2016	Tuesday	Not spec	Strong odour	N			
2-02-2016	Tuesday	Evening	Very bad smell	N			
2-02-2016	Tuesday	Evening	Very bad smell	N			
2-02-2016	Tuesday	Not spec	Strong odour	Y		Unclear	Odour confirmed. No 10min assessment
3-02-2016	Wednesday	Evening	Odour increased in intensity and freq, could not have BBQ outside, walkers past house cover noses	N			
3-02-2016	Wednesday	Not spec	Strong 'sulphury' odour, odour detected regularly often outside normal working hours in the evenings	N			
3-02-2016	Wednesday	Not spec	Very strong today, grandchild noticing the	N			
3-02-2016	Wednesday	Not spec	No details	N			

Date odour noticed	Day of week	Time odour noticed	Odour description	Did HBRC attend or validate	Locations where odour found by HBRC	HBRC opinion	Other response comments
3-02-2016	Wednesday	Not spec	No details	N			
3-02-2016	Wednesday	Not spec	Worst its ever been (5 years at house), could not have BBQ outside	N			
3-02-2016	Wednesday	Not spec	First time caller, lived in house many years, odour has gotten worse for longer periods	N			
3-02-2016	Wednesday	Not spec	Odour has been a lot worse over last 2 months, seems to keep getting worse	N			
4-02-2016	Thursday	Not spec	Lived at house for 11 years, farm is the worst its ever been. Its been putrid and consistent	N			
4-02-2016	Thursday	Not spec	Consistent odour last 2 days, kids say smells like dog crap. Cannot go outside in the	N			
4-02-2016	Thursday	Not spec	Odour really bad at the moment, been home for last 30mins odour stayed consistent	N			
4-02-2016	Thursday	Not spec	Strong odour, has been strong for the last few days	N			
4-02-2016	Thursday	Not spec	Strong odour	N			
5-02-2016	Friday	Not spec	Terrible putrid smell, could smell at home, on Romanes Rd and Napier Rd. Could not site outside and have a coffee, smell was around for hours	N			
5-02-2016	Friday	Not spec	Odour from TMM is strong at the moment	N			
5-02-2016	Friday	Morning	Very strong odour	N			
5-02-2016	Friday	Not spec	Strong odour	N			
5-02-2016	Friday	Not spec	Complainant was gagging from the odour	N			
9-02-2016	Tuesday	Not spec	Odour so bad complainant said he was gagging	N			
9-02-2016	Tuesday	Morning	6-8am this morning	N			
9-02-2016	Tuesday	Not spec	Odour was revolting, could not site outside. Does not normally ring unless its very bad	N			
11-02-2016	Thursday	Not spec	Smells like chicken manure	N			
11-02-2016	Thursday	Not spec	Smells like sewage, rated 8/10 for	N			
12-02-2016	Friday	Not spec	Ammonia type odour, no wind	N			
16-02-2016	Tuesday	Morning	Heinously bad this morning between 7.30am and 8am. Odour is not as strong at time of complaint. Present yesterday also, on and off	N			
16-02-2016	Tuesday	Evening	1950hrs smelt like fish, strong enough to burn nose. Lives some distance from TMM, drove in car to Arataki Rd, smelt same odour there.	N			
16-02-2016	Tuesday	Not spec	Lived in area 30 years, first time odour detected, first time caller. Poultry/sewage smell, ammonia. (Unknown if this is confirmed TMM)	N			
16-02-2016	Tuesday	Not spec	Odour absolutely terrible	N			
17-02-2016	Wednesday	Night	Smell bad tonight, sickening	N			
18-02-2016	Thursday	Not spec	Smelt like rotten fish	N			
19-02-2016	Friday	Not spec	Odour very strong	N			
19-02-2016	Friday	Not spec	Smell like toilets in his back yard	N			
19-02-2016	Friday	Not spec	Smell of poo and vomit and ammonia and fertilizer	N			
29-02-2016	Monday	Prev evening and this morning	Smells like a portaloo that is full and been sitting around for a week	N			
4-03-2016	Friday	Not spec	First time it has been smelly in 3 weeks	N			
15-03-2016	Tuesday	Not spec	Incredible bad odour. Bunker activities being carried out, thinks this makes odour worse	N			
22-03-2016	Tuesday	Not spec	Odour 4/5, smells like a sewer	N			
22-03-2016	Tuesday	Not spec	No details	N			

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31-03-2016	Thursday	Not spec	Strong yesterday, worse today. Intensity 8.5/10. Smells like human excrement	N			
31-03-2016	Thursday	Not spec	No details	N			
1-04-2016	Friday	Prev evening	Really bad odour at 1.30am. Similar odour type and intensity to yesterday	N			
1-04-2016	Friday	Not spec	Foul like rotten fish, disgusting and putrid. Complainant was concerned the Judge would go soft on TMM at the hearing.	N			
3-04-2016	Sunday	Not spec	Offensive smell	N			
13-04-2016	Wednesday	Prev evening	Very strong odour last evening	N			
19-04-2016	Tuesday	Not spec	Putrid odour, 3-4 out of 6	N			
19-04-2016	Tuesday	Not spec	Strong odour	N			
19-04-2016	Tuesday	Not spec	Strong odour	N			
19-04-2016	Tuesday	Not spec	No details	N			
6-05-2016	Friday	Not spec	Rotten meat smell from TMM, strength 2.5-3 out of 5	N			
16-05-2016	Monday	Not spec	Odour 4/5 in badness	N			
26-05-2016	Thursday	Not spec	Pungent manure/ammonia smell. This has been bad at times for the last few days, partic in the mornings	N			
26-05-2016	Thursday	Morning	7am to 8.25am. Odours have gotten worse over time, now have isues at night 10-11pm and 2-3am type of thing	N			
27-05-2016	Friday	Not spec	Really bad manure smell	N			
27-05-2016	Friday	Not spec	Has only phoned once before, it is really bad today	N			
27-05-2016	Friday	Morning	Strong odour this morning, still lingering	N			
30-05-2016	Monday	Prev evening	Strong odour last night from 10.30pm - midnight, chook run odour, very nauseating, strong enough to wake complainant up.	N			
6-06-2016	Monday	Evening	7pm, strongest odour I have smelt for a while noticed when I stepped outside, calm winds, no breeze.	N			
8-06-2016	Wednesday	Not spec	Strong tar-like spent compost smell	N			
10-06-2016	Friday	Morning	Very bad odour	N			
10-06-2016	Friday	Morning	Really bad odour this morning	N			
10-06-2016	Friday	Not spec	No details	N			
10-06-2016	Friday	Not spec	Odour noticeable last 3 days	N			
14-06-2016	Tuesday	Not spec	Odour strong today.	N			
14-06-2016	Tuesday	Afternoon	Fairly normal Tues pm odour, odour strong so worth a call, very light wind drift.	N			
17-06-2016	Friday	Not spec	No details	N			
20-06-2016	Monday	Not spec	Strong mushroom farm smell	N			
21-06-2016	Tuesday	Not spec	Strong smell	N			
21-06-2016	Tuesday	Not spec	Stinky, almost rotten meat type smell, odour 3/5 intensity	Y		Unclear	Confirmed odour in 107 Arataki - Meissener Rd cnr area at about 2.40pm
21-06-2016	Tuesday	Day	Brookvale Rd. Smell rates a 3-4, not as strong as yesterday.	N			Confirmed by HBRC earlier that afternoon
21-06-2016	Tuesday	Not spec	Horrible smell from the mushroom farm, happens constantly and fluctuates. Also horrible yesterday.	N			
28-06-2016	Tuesday	Not spec	Distinct odour, rated 3/5	N			
28-06-2016	Tuesday	Not spec	Pungent smell, 4/5 in strength	N			
4-07-2016	Monday	Not spec	Odour has just started and is strong	N			
12-07-2016	Tuesday	Not spec	No details	N			
12-07-2016	Tuesday	Not spec	Odour 3.4-4 out of 5	N			

Date odour noticed	Day of week	Time odour noticed	Odour description	Did HBRC attend or validate	Locations where odour found by HBRC	HBRC opinion	Other response comments
12-07-2016	Tuesday	Not spec	Ammonia smell, extremely bad.	N			
1-08-2016	Monday	Not spec	Odour is as bad as it has ever been	N			
1-08-2016	Monday	Not spec	Odour described primarily as tri-methyl and tetramethylenediamines and sulphur dioxide. Not nice, both toxic.	N			
9-08-2016	Day deleted s	N/A	Caller rang to say the smell had not been bad over the last 2 months. Reduced frequency and intensity of odour.	N			