

FINAL REPORT



ODOUR POLLUTION STUDY

PROJECT CONSULTANTS



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1st: 18th October 2019

2nd: 1st November 2019

This study was commissioned and funded by the Department of Environment Malaysia
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EXECUTIVE SUMMARY

Protecting the environment from pollution resulting from the release of odourous substances is one of the most challenging aspects for odour regulators. The assessment and identification of this type of pollution can be subjective and the impact highly variable. These factors all contribute to the challenge faced by the Department of Environment to be a fair and proportionate regulator whilst at the same time ensuring that the interests of affected people are protected.

This report is intended to support the regulating of potentially odourous activities. This document aims to provide practical guidance on how and why odours occur, how they can be investigated, how they can be mitigated and the future planning towards the progression of relevant legislation. A total of 32 industries/facilities were involved in the odour data collection, resulting in 243 odour data which comprised of 134 odour concentrations at the point of emission and 104 readings at the facilities' boundary and at nearby residences.

As a result from the sample collections, odour limit values for both point of emission and the boundary is proposed based on the seven categories of industrial odour emitters; natural rubber industry, animal/poultry farms, palm oil mills, fishmeal/feedmill plants, palm oil mills, waste management facilities, sewerage systems as well as other premises capable of emitting malodour. Even so, the odour limit value proposed here still require further review and justification due to the limited number of datasets underlying the derivation of these values.

The presented 4-Step Action Plan in Odour Management will help local stakeholders including regulatory bodies, environmental consultants and facility/industry owners to improve the understanding of odour driven public concerns in odour exposure, and improve their ability to assess and plan the remedial measures to be undertaken to reduce odour pollution. The field of odour measurement and control is very wide in scope and is continually developing. This report has been executed and prepared according to the Terms of References commissioned by the Department of Environment Malaysia. It aims to highlight the common practices and approach to the regulation of emissions of odourous substances which may be implemented or adapted to best suit our local circumstances.

CHAPTER 1:

BACKGROUND OF THE STUDY

1.1 PROJECT TITLE

Odour Pollution Study (*Kajian Pencemaran Bau*)

1.2 INTRODUCTION

This report is jointly prepared by Usains Holdings Sdn. Bhd. and associated Consultants to present the technical proposal, quoted fees and costs of consultancy services to carry out research works related to the “Odour Pollution Study” in Malaysia. This accounts for critical odour emitting industries and activities including from the raw natural rubber and rubber based industry, fishmeal/feed mill, palm oil mill, animal/poultry farm, solid waste and sewerage management facilities, as well as other potential premises. The project is offered by the Department of Environment Malaysia under the care of its Air Division.

Odour pollution is considered to be a function of emission, dispersion and exposure to the surroundings, which often leads to the occurrence of odour nuisance and annoyance and the registration of odour complaints. Individuals have the right to live in a clean and odour-free environment, thus an odour regulation and management guideline is necessary for a constructive control over odour pollution. Odour, being a subjective parameter, must be monitored and assessed with reference to an established standard such as the MS1963 2007. The identification of problematic sources and their odour emission levels would be a useful information used by authorities and decision makers to interact with industries as well as the public and local community. Given the importance of addressing odour pollution in Malaysia, this project consortium has taken a significant move and looks forward to establishing the suitable limit value and best framework for an odour regulation and guideline needs to holistically manage the odour in a changing environment.

One of the most critical steps towards implementing an odour regulation is the determination of the threshold limit values. Limit values indirectly becomes the guide for both the industries and authorities for understanding odour emissions that could cause an impact to the surrounding community. Having clear permissible limits to comply with means odour management strategies could be better priorities by targeting critical sources of emissions. Furthermore, such values, established by regulations, provide to the public an understanding of the degree of protection against odours as society increasingly demands transparent and uniform environmental regulations.

In this project, an appropriate methodology and strategy for establishing the industry specific odour limits along with the recommended framework was proposed to assist the Department of Environment in developing an odour regulation and guideline for Malaysia. Combination of odour data measured at the source as well as at the boundary of the industry or facility is capable of providing crucial input to the degree of odour pollution with an estimation of its impact to the neighbouring community. The suggested limit values maybe be defined by either at-source value or perhaps a combination of both at-source and boundary, taking into consideration the reliability of the data and feasibility of the assessment method.

In addition, the relevant standards e.g. MS 1963 2007 and the VDI3880 was be referenced to and appraised during the odour survey work for possible inclusion or adaptation in an odour guideline for Malaysia. The guideline would be purposed at providing guidance on methodology acceptable to the Department of Environment for odour sampling and analysis using dynamic olfactometry, in-field odour assessment, computer modelling of odour impacts, and the reporting format required by DOE. This project promotes a realistic and effective approach rather than an ambitious and enthusiastic one which aims at integrating efforts in managing odour pollution that is doable and understandable by the various stakeholders, yet, would be successful in reducing community exposure to environmental odour.

1.3 STATUS OF ODOUR LEGISLATION DEVELOPMENT IN MALAYSIA

Development of the Malaysia's Odour Act began in 2002, and culminated in the production of two drafts of the regulation; Environmental Quality (Odour) Regulations 201X, as shown in Figure 1.1 and Figure 1.2 below. In the draft regulations, an owner or occupier of any premises shall comply with the odour concentration at point of emission and/or boundary as specified in the Schedule (Figure 1.1) and the First Schedule (Figure 1.2). Both of the documents was circulated online on the Department of Environment's official website for 14 days to allow general public to give opinion and feedback to the Department of Environment on the proposed new regulations. A stakeholders meeting on the draft regulation on 15 June 2015 at the Department of Environment's headquarters in Putrajaya, presented the chronology behind the development of the odour regulation, attached here as Appendix 1. It was highlighted in the meeting that that the first Public Consultation (17 October – 1 November 2012), did not receive any feedback, meanwhile comments regarding odour limits on chemical compounds was raised in the second Public Consultation (15 April – 30 April 2013).

SCHEDULE
(Regulation 3)

ODOUR CONCENTRATION

Emission sources of objectionable odour	Measured Point	Odour Concentration (ou/m ³)
1. Raw natural rubber industry;	Point of emission	25,000
	Boundary	9
2. Fishmeal/feed mill plant;	Point of emission	12,000
	Boundary	7
3. Animal farm/ poultry farm;	Point of emission	10,000
	Boundary	7
4. Solid waste management facility	Point of emission	6,000
	Boundary	7
5. Sewerage system	Point of emission	1,200
	Boundary	7
6. Any other premises that emits or capable of emitting objectionable odour into atmosphere	Point of emission	1,000
	Boundary	7

Figure 1.2 The draft of odour concentration measured at the point of emission and boundary (source:<http://www.doe.gov.my/eparticipation/bahasa-inggeris-online-public-engagement-feedback-for-environmental-quality-odour-regulations-201x/>)

During the progression of the odour regulation, concerns were raised regarding the proposed limits and its underlying sample data. Issues with the proposed limit values were debated by various stakeholders, calling for further investigation which resulted in the retract of the draft odour regulation. As a result, this project entitled “Odour Pollution Study” was initiated by the Department of Environment in early 2019 and hence the outcomes presented in the report.

FIRST SCHEDULE

[Regulation 3]

ODOUR CONCENTRATION AT POINT OF EMISSION

Emission sources of objectionable odour	Odour Concentration by Measurement (ou/m ³)
1. Raw natural rubber industry	25,000
2. Fishmeal/feed mill plant	12,000
3. Animal farm/ poultry farm	10,000
4. Palm Oil Mill	12,000
5. Solid waste management facility	6,000
6. Rubber Based Industry	1,500
7. Sewerage system	1,200
8. Any other premises that emits or capable of emitting objectionable odour into atmosphere	1,000

Figure 1.2 Draft Odour Concentration at Point of Emission, having omitted the boundary limit values (source: *Minit Mesyuarat Kumpulan Tenaga Pakar Bagi Peraturan-Peraturan Kualiti Alam Sekeliling (Bau)*, 15 Jun 2015, Bilik Ixora, Ibu Pejabat Jabatan Alam Sekitar, Putrajaya)

1.4 OBJECTIVES

The main objectives of this project are:

- a) To determine suitable limit values for the emission of odour source from industries and activities such as:
 - i) raw natural rubber industry;

- ii) fishmeal/feed mill plant;
 - iii) animal farm/poultry farm;
 - iv) palm oil mill;
 - v) solid waste management facility;
 - vi) rubber based industry;
 - vii) sewerage system; and
 - viii) any other premises that emits or capable of emitting objectionable odour into atmosphere
- b) proposal for determining legislative requirements for odour pollution and guidelines for odour pollution control

1.5 SCOPE OF WORK

The duration of the study is for 7 months beginning 18th April until 18th November 2019. The scope of work for this study includes:

- a) set the methodology to be applied in determining the appropriate limit value for odour emission from the sources
- b) to carry out the odour sampling from the identified sources
- c) analyze and identify the level of odour that affects or disturbs the comfort of the public
- d) identifying precautionary measures and monitoring on activities that contribute to odour pollution suggesting legislative requirements for odour pollution and guidelines for odour pollution control
- e) suggesting legislative requirements for odour pollution and guidelines for odour pollution control

1.6 STRUCTURE OF THE REPORT

This report is presented in a series of chapters with the sequence of the chapters being arranged according the Outputs required from this project as stated in the Terms of Reference. All together four outputs are emphasized:

- Output 1: Set of sampling data conducted at several selected locations;
- Output 2: Suitable limit values for source odour emission from identified in industry and activity;
- Output 3: Action plan for reducing odour pollution, implementation measures for improving the air quality especially in areas often affected by this issue, including the feasibility of developing legislation regarding odour pollution and guideline for odour pollution control; and

- Output 4: Literature review comparing sampling methods and odour pollution legislation in other countries.

This report begins by first describing the background of the project in Chapter 1, followed by an introduction regarding odour as an environmental stressor in Chapter 2. In Chapter 3, the raw odour monitoring data from all the study locations can be assessed, which includes a total of 243 odour concentration measured at the point of emission, the boundary and nearby residential area. These data were further analysed in Chapter 4 using a box-and-whisker plot to illustrate the spread of the data and to better understand the choice for limit values. The proposed odour limit values for both the point of emission and boundary given here. Chapter 5 further explains on the future planning to address the odour pollution issue in Malaysia. A 4-Step Action Plan in Odour Management is described in this chapter, which stresses on the measures to be taken including addressing knowledge gaps, establishing and verifying proposed odour limits, the development of guideline and finally the establishment of odour regulation. In order to come out with a legislation and guidelines that is suitable for the Malaysian scenario, Chapter 5 reviews the current literature on these topics by comparing current practices in the world including several Asian countries. Finally, this report concludes the lessons gained from this project in Chapter 6: Conclusion. Issues that deserve further attention and help with improvements relating to odour management are also presented in this concluding chapter.

CHAPTER 2:

INTRODUCTION TO ODOURS AS AN ENVIRONMENTAL POLLUTION

2.1 WHAT IS ODOUR?

Odores are increasingly the cause of complaints to the Department of Environment, as more and more homes are encroaching industrial areas as well as processing facilities such as wastewater treatment plants and landfills due to a lack of buildable land. In addition, most of the animal farming activities are large scale operations but do not really have significant odour control strategies in place, thus contributing to the rise in complaints relative to animal feeding operations in Malaysia. People nowadays are becoming more aware of their living environment, and many residents have become less tolerant to even occasional odours or other nuisance conditions that are perceived to have an impact on their lifestyle and property values.

Odour is a sensory response to the inhalation of air containing chemicals. When the sensory receptors in the nose come into contact with odorous chemicals, they send a signal to the brain, which interprets the signal as an odour. The olfactory nerve cells in humans are highly sensitive instruments, capable of detecting extremely low concentrations of a wide range of odorous chemicals. The type and amount (or intensity) of odour are both important in processing the signal sent to the brain. Most odours are a complex mixture of many odorous compounds.

The main effect of environmental odour is nuisance, but in more serious cases it may lead to feelings of nausea and headache, and other symptoms that appear to be related to stress. Repeated exposure to odour can lead to a high level of annoyance, and the receiver may become particularly sensitive to the odour. Complaints are most likely to come from individuals who are either physiologically or psychologically sensitive to the odour, and certainly a combination of both types of sensitivity will increase the likelihood of complaint.

2.2 CHARACTERISING ODOUR IMPACTS

The FIDOL factors (frequency, intensity, duration, offensiveness and location) encompass the pattern of odour impacts and the receiving environment where these occur. These are the factors that influence the extent to which odours adversely affect individuals, and this information can be utilised to assist with odour investigation and assessment.

2.2.1 *Frequency, intensity and duration*

The *frequency* of the odour occurrence is how often an individual is exposed to odour in the ambient environment. Frequency is influenced by the odour emission source and characteristics, the prevailing wind conditions, the location of the source in relation to the individual affected, and

the topography of the area. The frequency of odour exposure is generally greatest in areas that are most often downwind of an odour source, especially under stable conditions with low wind speeds (provided that the odour is not emitted at a significant height above the ground). The *intensity* of odour refers to an individual's perception of its strength. Perceived intensity at each presentation can be valued to a five-point intensity scale:

0	no odour
1	very weak odour
2	weak odour
3	distinct odour
4	strong odour
5	very strong odour
6	extremely strong

This is different from the odour's character, or quality. Finally, the *duration* of exposure to the odour is related to the type of odour source, the local meteorology and the location of the odour source. These three factors should be considered concurrently. Odours may occur in frequent short bursts or for longer less-frequent periods.

2.2.2 *Offensiveness*

Offensiveness, or 'hedonic tone', is the subjective rating of pleasantness or unpleasantness of an odour. The members of a panel of assessors are asked to indicate perceived hedonic tone at each presentation as a value from the nine-point hedonic tone scale:

4	very pleasant
+3	pleasant
+2	moderately pleasant
+1	mildly pleasant
0	neutral odour / no odour
-1	mildly unpleasant
-2	moderately unpleasant
-3	unpleasant
-4	offensive

2.2.3 *Location*

Location is an essential factor when assessing the likelihood of adverse effects from odours. It accounts for the type of area in which a potentially affected person lives, the type of activity they are engaged in, and the sensitivity of the receiving environment. These factors determine the likelihood of a person being adversely affected to the point where they find an odour to be offensive or objectionable. The absence or presence of background odours also has a significant effect. People living in and visiting rural areas generally have a high tolerance for rural type odours, such as from chicken rearing or decomposing cow manure, which are acceptable to most rural people and fit the description of a rural odour in a rural area.

CHAPTER 3:

OUTPUT 1: SET OF SAMPLING DATA CONDUCTED AT SEVERAL SELECTED LOCATIONS

3.1 INTRODUCTION

One of the objectives of this study (Objective 1) is to determine suitable limit values for the emission of odour source from industries and activities, which also coincides with the study's first output. This chapter provides the outcome of Objective 1 and Output 1, by presenting the dataset from the odour monitoring activities comprising of both at point of emission and boundary data. A brief description of the selected study locations as well as the methodology involved with the data collection, is presented prior.

3.2 DETERMINATION OF ODOUR CONCENTRATION AT POINT OF EMISSION

“Point of emission” has been defined in the draft Environmental Quality (Odour) Regulations 201X as *emission of waste after treatment in the form of gas to the environment through canalized duct of dimension and air flow rate, or a surface-emitting source whether in a solid or liquid form*. The Terms of Reference of this project made reference to the First Schedule [Regulation 3] of the draft Environmental Quality (Odour) Regulations 201X, and listed eight categories of odour contributors to be studied in this project. These categories comprised of the raw natural rubber industry; fishmeal/feed mill plant; animal farm/poultry farm; palm oil mill; solid waste management facility; rubber based industry; sewerage system; and any other potentially odourous premises in Malaysia.

3.2.1 Sampling Locations for “Point of Emission” Odour Data

Due to the concerns of possible hazardous compounds raised during *Mesyuarat Jawatankuasa Teknikal Bagi Projek Kajian Pencemaran Bau* at Jabatan Alam Sekitar Putrajaya on 25th April, 2019, the rubber based industry has been omitted from the listing. Instead, gaseous emissions from rubber based industries will be governed under the Environmental Quality (Clean Air) Regulations 2014. Thus, the odour monitoring proceeded with only seven categories of odour sources with a brief description of the selected industries and activities shown in Table 3.1.

Table 3.1 Details of the locations and sampling activities of various industries/facilities involved in this study.

No	Industry Name	Odour Complaint Year	Type	Capacity	Unit	Sampling Date	No. of samples	
							S*	B*
Raw natural rubber industry								
1	Lee Rubber Bukit Mertajam, Penang	n/a	n/a	n/a	n/a	20/6/19	4	3
2	Hevea KB Sdn Bhd, Perak	n/a	n/a	n/a	n/a	24/6/19	4	3
3	Euroma Rubber Industry, Kedah	n/a	n/a	n/a	n/a	25/6/19	4	3
Fishmeal/feed mill plant								
4	Gold Coin Feedmills (M) Sdn Bhd, Penang	n/a	n/a	n/a	n/a	3/7/19	2	3
5	PW Nutrifeed Sdn Bhd, Penang	2019	n/a	n/a	n/a	4/7/19	2	3
6	Fuxing Enterprise (M) Sdn Bhd., Perlis	2018, 2019	n/a	n/a	n/a	7/8/19	6	3
7	Bintawa Fishmeal Factory Sdn Bhd, Sarawak	2018, 2019	n/a	n/a	n/a	17/9/19	4	3
Palm oil mill								
8	Setiakawan Kilang Kelapa Sawit, Kedah	2016	Covered lagoon	90	ton/hr	5/8/19	4	3
9	Kok Foh Palm Oil Mill, Negeri Sembilan	n/a	Open pond	90	ton/hr	1/7/19	4	1
10	Sykt. Cahaya Muda Perak (Oil Mill) Sdn. Bhd, Perak	n/a	CSTR	90	ton/hr	19/9/19	4	3
Animal farm/poultry farm								
11	QL Anson Poultry Farm Sdn Bhd, Kedah	2018	Chicken broiler	990,000	birds	18/7/19	4	3
12	PWF Poultry, Kedah	n/a	Chicken layer	1,000,000	birds	3/9/19	4	3
13	Dinding Poultry Processing Sdn Bhd, Perak	n/a	Chicken processing facility	n/a	n/a	5/9/19	4	3
14	QL Poultry Farms Sdn. Bhd., Negeri Sembilan	2016, 2017 & 2018	Chicken layer	1,500,000	birds	26/9/19	2	3

Solid waste management facility									
15	TP Sg Udang, Melaka	n/a	Sanitary	19.4	ha	22/7/19	4	4	
16	TP Sg Udang, Melaka	n/a	Sanitary	19.4	ha	23/7/19	4	4	
17	TP Sg Udang, Melaka	n/a	Sanitary	19.4	ha	24/7/19	4	4	
18	TP. Ulu Maasop, Negeri Sembilan	n/a	Unsanitary	8.1	ha	26/6/19	4	3	
19	TP. Rimba Mas, Perlis	n/a	Sanitary	48.5	ha	8/8/19	4	3	
20	Kulim Anaerobic digestion, Kedah	n/a	Anaerobic Digester	n/a	n/a	11/7/19	2	3	
21	MRF Sg. Udang, Melaka	n/a	Materials Recovery Facility	0.81	ha	25/7/19	4	3	
22	TS Taman Beringin, Kuala Lumpur	n/a	Transfer Station - Horizontal	5.2	ha	28/8/19	4	3	
Sewerage system									
23	MTH492- Sungai Udang CSTF (JBIC), Melaka	n/a	CSTF – with odour control system	300,000	Design PE	22/7/19	4	3	
24	MTH492- Sungai Udang CSTF (JBIC), Melaka	n/a	CSTF – with odour control system	300,000	Design PE	23/7/19	4	3	
25	MTH492- Sungai Udang CSTF (JBIC), Melaka	n/a	CSTF – with odour control system	300,000	Design PE	24/7/19	4	3	
26	SPI519- Taman Kelisa Emas, Penang	2019	NPS	3379	Current PE	1/8/19	4	3	
27	PJA381- Seksyen 8, PJ, Selangor	n/a	NPS with odour control	3360	Current PE	16/7/19	4	3	
28	SPI576- Taman Sejati, Penang	2019	EA	2583	Current PE	17/7/19	4	3	
29	SPI504- Taman Cowin, Penang	2019	NPS	3166	Current PE	29/8/19	4	3	
30	IPH240- Taman Pakatan Jaya, Perak	n/a	OD	10,815	Current PE	4/9/19	4	3	

31	PTG238- Batu 14 Puchong, Selangor	n/a	EA with odour control	2850	Current PE	11/9/19	4	3
32	SPI411- Tmn Perindustrian Bukit Minyak, Penang	2019	OD	10,030	Current PE	12/9/19	4	3
Any other premises that emits or capable of emitting objectionable odour into atmosphere								
33	Jimat Jaya Sdn Bhd, Kedah	2014	Poultry Processing	n/a	n/a	6/8/19	4	3
34	Aik Cheong, Melaka	n/a	Coffee	n/a	n/a	15/7/19	2	3
35	Wilmar Edible Oil, Penang	n/a	n/a	n/a	n/a	22/8/19	4	3
36	Tong Heng Coffee, Melaka	2017	n/a	n/a	n/a	27/8/19	2	3
Total Samples							134	109

Note: S* At source samples, B* In-field odour samples

A total of 32 locations were visited for the seven industries or activities as below:

- Raw natural rubber industry, 3 sites
- Fishmeal/feedmill plant, 4 sites
- Pam oil mill, 3 sites
- Animal farm/poultry farm, 4 sites
- Solid waste management facility, 6 sites
- Sewerage system, 8 sites
- Any other premises, 4 sites

Overall, 243 odour data was obtained with 134 data covering the at-source emission and another 109 data for boundary data.

With the exception of the two sites in Sg. Udang, Melaka, all of the study locations were monitored once. The TP Sg Udang (Landfill) and MTH492- Sungai Udang CSTF (JBIC) (Sludge treatment facility) were instead monitored over three consecutive to better understand the odour emission from these facilities and the subsequent conflicting reports of odour due to their close vicinity.

The selection of the sites in Table 1 were partly based on the information provided by each governing agencies (e.g. MPOB, IWK, MRB, DOE, DVS) as well as consideration for the logistics and budgetary constraints. As specified by MS1963: 2007, all samples must complete odour analysis within 30 hours of sampling. Considering this requirement and for budgetary purposes, approximately 70 % of the selected sites were less than 2 hours from the Odour Laboratory located at Universiti Sains Malaysia, Penang. A remaining 30 % of sites were located further away to

cover a wide ranging of odour emitting industries. In addition, the distant locations of these sites will help exercise the logistics aspects of sampling, and sample transportation to enable odour testing within the stipulated timeframe. The records of complaints history were also referred during the site selection process. As a result, about 33% of the study locations comprised of industries or activities with prior odour issues.

3.2.2 Procedure of Odour Sampling and Laboratory Assessment

Odour sampling at the point of emission and its subsequent analysis were performed according to *MS 1963: 2007 Air Quality – determination of odour concentration by dynamic olfactometry*. Figure 3.1 shows flux hood, vacuum chamber and sweep air (nitrogen gas) being used for odour sampling of area sources. These area sources included surfaces of landfills, biofilter, products, wastewater/effluent treatment ponds and chicken droppings, where a total of four samples each were taken at the most odourous source in the facility or industry.

On the other hand, some emissions only required the vacuum chamber for sampling (without the flux hood and sweep air) as the emission already contained its own air flowrate. Examples of these point source emissions included wet scrubbers and chimneys as shown in Figure 3.2. Generally, two samples were taken for the point sources, except when an odour treatment system is available. If the latter is the case, an additional two samples were taken after undergoing the treatment system. All odour samples were collected into 10 L Nalophan sampling bags and transported to the odour laboratory at USM Engineering Campus for laboratory olfactometry analysis.



Biofilter



Chicken droppings



Landfill



Sewage

Figure 3.1 Odour sampling from area sources using flux hood and vacuum chamber



Chimney

Figure 3.2 Odour sampling from point source using a vacuum chamber

The Scentroid SS400 dynamic olfactometer shown in Figure 3.3 were used for the determination of the odour concentration from samples collected at the locations listed in Table 3.1. All samples were tested within 30 hours of sample collection as stipulated in the Malaysian Standard. For some, sample pre-dilution was carried out prior to olfactometry analyses, especially for highly odorous

samples. Determination of odour concentration by dynamic olfactometry was based on the binary mode and 4 odour panelists.



Figure 3.3 Scentroid SS400 dynamic olfactometer for at Universiti Sains Malaysia Odour Laboratory for the determination of odour concentration

3.3 DETERMINATION OF ODOUR CONCENTRATION AT THE BOUNDARY

The draft Environmental Quality (Odour) Regulations 201X defined “boundary” as *the fencing area of the premise or maximum distance of five hundred metres from the point of emission*. Thus, in this study, in addition to boundary values, odour at nearby residential area was also assessed, to identify the possibility of odour nuisances to the general public.

3.3.1 Locations for “Boundary” Odour Data

The selection for the locations of boundary assessment was based on one (1) location at the front entrance of the facilities or industries followed by two (2) locations at nearby residences. As a rule of thumb, at best, the two residences was located at two opposite ends, one location each at the east and west side. The distances when possible was set to be around 500 m from the odour source, except for the sewerage systems which were set at around 150 m. However, these criteria for the locations of nearby residences could not be adhered to at times, due to the lack of nearby residences or inaccessibility of the locations. As a result, the placement of the locations was not consistent throughout this study. The exact locations for the boundary assessment including the coordinates can be referred in Section 3.4.2.

3.3.2 Procedure of Boundary Odour Assessment

Odour at the boundary of the industries or activities was assessed at the site itself, or also known as an in-field odour assessment. The method of in-field odour assessment was conducted according to Balch et. al. (2015) and Bakhtari and Medina (2016) which were enhanced procedures adapted from the VDI3940 Grid Method (2006). The assessment involved the determination of odour intensity, odour characters (descriptors) and odour concentration.

Odour intensity were recorded every 10 seconds for 10 minutes to a scale of 0 to 6 following UK Environment Agency (2007) guideline as described in Table 3.2. Predominant odour characters and source of emission were also noted for each location when odour intensity of 2 (weak) and above was observed. The odour descriptor of UK Environment Agency (2007) shown in Table 3.3 was referred to as a guide which was summarized into the simpler odour descriptor codes for use during the boundary assessment (refer Figure 3.4). The in-situ odour concentration was determined using an in-field olfactometer (SM 100 Scentroid Olfactometer, Canada), with a detection limit of 3.5 – 11,355 OU/m³ as shown in Figure 3.5.

Table 3.2 Description of odour intensity levels (source: UK Environment Agency, 2007)

Intensity level	Odour strength	Description
0	No odour	No odour
1	Very weak	There is probably some doubt as to whether the odour is actually present
2	Weak	The odour is present but cannot be described using precise words or terms
3	Distinct	The odour character is barely recognizable
4	Strong	The odour character is easily recognizable
5	Very strong	The odour is offensive. Exposure to this level would be considered undesirable
6	Extremely strong	The odour is offensive. An instinctive reaction would be to mitigate against further exposure

Table 3.3 Odour descriptors for commonly encountered compounds (source: UK Environment Agency, 2007)

Substance	Odour	Substance	Odour
Acetaldehyde	Apple, stimulant	Dimethyl sulphide	Rotten vegetable
Acetic acid	Sour vinegar	Diphenylamine	Floral
Acetone	Chemical/sweetish/solvent	Diphenyl sulphide	Burnt rubber
Acetonitrile	Ethereal	Ethanol	Pleasant, sweet
Acrylaldehyde	Burning fat	Ethyl acetate	Fragrant
Acrolein	Burnt sweet, pungent	Ethyl acrylate	Hot plastic, earthy
Acrylonitrile	Onion, garlic, pungent	Ethylbenzene	Aromatic
Aldehydes C9	Floral, waxy	Ethyl mercaptan	Garlic/onion, sewer, decayed cabbage, earthy
Aldehydes C10	Orange peel	Formaldehyde	Disinfectant, hay/straw-like, pungent
Allyl alcohol	Pungent, mustard like	Furfuryl alcohol	Ethereal
Allyl chloride	Garlic onion pungent	n-Hexane	Solvent
Amines	Fishy, pungent	Hydrogen sulphide	Rotten eggs
Ammonia	Sharp, pungent odour	Indole	Excreta
Aniline	Pungent	Iodoform	Antiseptic
Benzene	Solvent	Methanol	Medicinal, sweet
Benzaldehyde	Bitter almonds	Methyl ethyl ketone	Sweet
Benzyl acetate	Floral (jasmine), fruity	Methyl isobutyl ketone	Sweet
Benzyl chloride	Solvent	Methyl mercaptan	Skunk, sewer, rotten cabbage
Bromine	Bleach, pungent	Methyl methacrylate	Pungent, sulphide like
Sec-Butyl acetate	Fruity	Methyl sulphide	Decayed vegetables
Butyric acid	Sweat, body odour	Naphthalene	Moth balls
Camphor	Medicinal	Nitrobenzene	Bitter almonds
Caprylic acid	Animal like	Phenol	Sweet, tarry odour, carbolic acid
Carbon disulphide	Rotten vegetable	Pinenes	Resinous, woody, pine-like
Chlorine	Irritating, bleach, pungent	Propyl mercaptan	Skunk
Chlorobenzene	Moth balls	Putrescine	Decaying flesh
2-Chloroethanol	Faint, ethereal	Pyridine	Nauseating, burnt
Chloroform	Sweet	Skatole	Excreta, faecal odour
Chlorophenol	Medicinal	Styrene	Penetrating, rubbery, plastic
p-Cresol	Tar-like, pungent	Sulphur dioxide	Pungent, irritating odour
Cyclohexane	Sweetish when pure, pungent when contaminated	Thiocresol	Rancid, skunk-like odour
Cyclohexanol	Camphor, methanol	Toluene	Floral, pungent, moth balls
Cyclohexanone	Acetone-like	Trichloroethylene	Solventy
Diamines	Rotten flesh	Triethylamine	Fishy, pungent
1,1-Dichloroethane	Ether-like	Valeric acid	Sweat, body odour, cheese
1,2-Dichloroethylene	Chloroform-like	Vinyl chloride	Faintly sweet
Diethyl ether	Pungent	Xylene	Aromatic, sweet

Odour Descriptors:

1	Burnt rubber	10	Earthy
2	Tar/asphalt	11	Pungent, urine
3	Exhaust	12	Rotten egg
4	Smokey	13	Putrid, decay
5	Solvent	14	Sewer
6	Sweet	15	Rotten cabbage
7	Bleach	16	Fecal/Manure
8	Sour vinegar	17	Fishy
9	Oil/Gasoline	18	Other

Figure 3.4 Odour descriptor codes adapted from Table 3.3 and used during the boundary odour assessment in this study



(a)



(b)

Figure 3.5 In-situ odour assessment at the (a) receptor using the (b) SM100 In-field olfactometer

3.4 RESULTS OF ODOUR CONCENTRATION AT POINT OF EMISSION

The odour concentration of the various industries and activities is reported as OU/m³ in Table 3.4. This included categories of emissions from raw natural rubber, fishmeal/feedmill, palm oil mill, animal farm/poultry farm, waste management facility, sewerage and other potential odourous emissions.

Table 3.4 Odour concentration at point of emission of selected industries and activities

No.	Industry Name	Source of emission	Sample ID	Sampling date	Sampling time (24-hr)	Analysis date	Analysis time (24-hr)	OU/m ³
Raw natural rubber industry								
1	Lee Rubber Bukit Mertajam	Wet scrubber	Inlet 1A	20/6/19	1504	21/6/19	1205	85012
			Inlet 1B	20/6/19	1508	21/6/19	1226	75967
			Outlet 1A	20/6/19	1434	21/6/19	1044	9292
			Outlet 1B	20/6/19	1440	21/6/19	1101	11778
2	Hevea KB Sdn Bhd	Wet scrubber	Inlet 1A	24/6/19	1429	25/6/19	0943	10626
			Inlet 1B	24/6/19	1434	25/6/19	1013	10362
			Outlet 1A	24/6/19	1441	25/6/19	1029	3250
			Outlet 1B	24/6/19	1447	25/6/19	1055	1726
3	Euroma Rubber Industry	Wet scrubber	Inlet 1A	25/6/19	1332	26/6/19	1120	13984
			Inlet 1B	25/6/19	1336	26/6/19	1024	20769
			Outlet 1A	25/6/19	1344	26/6/19	1047	9495
			Outlet 1B	25/6/19	1349	26/6/19	1149	10057
Fishmeal/feedmill plant								
4	Gold Coin Feedmills (M) Sdn Bhd	Biomass boiler	Boiler 1A	3/7/2019	14.34	4/7/19	10.24	17264
			Boiler 1B	3/7/2019	14.41	4/7/19	09.56	19524
5	PW Nutrifeed Sdn Bhd	Cyclone	Cyclone 1A	4/7/19	14.20	5/7/19	10.56	25381
			Cyclone 1B	4/7/19	14.28	5/7/19	11.12	26000
6	Fuxing Enterprise (M) Sdn Bhd.	Product storage	Product 1A	7/8/19	15.30	8/8/19	09.51	7899
			Product 1B	7/8/19	15.38	8/8/19	12.08	13796
		Scrubber	Inlet 1A	7/8/19	14.59	8/8/19	11.16	174580
			Inlet 1B	7/8/19	15.06	8/8/19	11.38	167048

			Outlet 2A	7/8/19	15.10	8/8/19	12.29	142856
			Outlet 2B	7/8/19	15.13	8/8/19	12.46	174580
7	Bintawa Fishmeal Factory Sdn Bhd	Scrubber	Inlet 1A	17/9/19	14.38	18/9/19	10.23	4276
			Inlet 1B	17/9/19	14.44	18/9/19	10.36	3994
			Outlet 2A	17/9/19	14.52	18/9/19	10.50	3255
			Outlet 2B	17/9/19	14.58	18/9/19	11.03	2840
		Ambient	Boundary	17/9/19	15.18	18/9/19	10.24	ND
			Point 1	17/9/19	16.13	18/9/19	11.17	ND
			Point 2	17/9/19	15.30	18/9/19	11.32	ND
Palm oil mill								
8	Setiakawan Kilang Kelapa Sawit	Anaerobic pond	AD 1A	6/8/19	13.50	7/8/19	08.43	106596
			AD 1B	6/8/19	14.02	7/8/19	09.08	122164
			AD 2A	6/8/19	14.07	7/8/19	09.25	91000
			AD 2B	6/8/19	14.11	7/8/19	09.41	152936
9	Kok Foh Palm Oil Mill	Anaerobic pond	AD 1A	1/7/2019	14.10	2/7/19	10.11	55838
			AD 1B	1/7/2019	14.15	2/7/19	10.28	64701
			AD 2A	1/7/2019	14.30	2/7/19	11.47	115164
			AD 2B	1/7/2019	14.34	2/7/19	12.04	127680
10	Sykt. Cahaya Muda Perak (Oil Mill) Sdn. Bhd	Cooling pond	CP1A	19/9/19	14.22	20/9/19	10.39	29532
			CP1B	19/9/19	14.25	20/9/19	10.59	40078
			CP2A	19/9/19	14.44	20/9/19	11.12	46863
			CP2B	19/9/19	14.49	20/9/19	11.36	24070
Animal farm/poultry farm								
11	QL Anson Poultry Farm Sdn Bhd	Droppings	Poultry 1A	18/7/19	14.36	19/7/19	10.59	11903
			Poultry 1B	18/7/19	14.48	19/7/19	11.27	9464
			Poultry 2A	18/7/19	14.59	19/7/19	11.49	6287
			Poultry 2B	18/7/19	15.07	19/7/19	12.09	14258
12	PWF Poultry	Self-Made Filter	Inlet 1A	3/9/19	15.30	4/9/19	10.01	2653
			Inlet 1B	3/9/19	15.35	4/9/19	10.28	3731
			Outlet 2A	3/9/19	15.45	4/9/19	10.14	3564
			Outlet 2B	3/9/19	15.50	4/9/19	10.40	4469

13	Dindings Poultry	Pit	Pit1	5/9/19	15.05	6/9/19	09.51	4174
			Pit2	5/9/19	15.11	6/9/19	10.02	4174
			Pit3	5/9/19	15.16	6/9/19	10.16	3994
			Pit4	5/9/19	15.21	6/9/19	10.29	3731
14	QL Poultry Farms Sdn. Bhd.	Barn Exhaust	Exhaust1A	26/9/19	14.34	27/9/19	10.22	889
			Exhaust1B	26/9/19	14.38	27/9/19	10.34	438
Solid waste management facility								
15	TP Sg Udang	Equalization Pond	Equal 1A	22/7/19	16.16	23/7/19	12.26	26000
			Equal 1B	22/7/19	16.20	23/7/19	11.48	23806
			Equal 2A	22/7/19	16.26	23/7/19	12.42	29682
			Equal 2B	22/7/19	16.31	23/7/19	12.55	32422
16	TP Sg Udang	Equalization Pond	Equal 1A	23/7/19	14.39	24/7/19	12.07	108581
			Equal 1B	23/7/19	14.41	24/7/19	12.28	105997
			Equal 2A	23/7/19	14.44	24/7/19	12.42	105997
			Equal 2B	23/7/19	14.48	24/7/19	12.56	108581
17	TP Sg Udang	Equalization Pond	Equal 1A	24/7/19	13.43	25/7/19	11.55	26000
			Equal 1B	24/7/19	13.47	25/7/19	12.19	25381
			Equal 2A	24/7/19	13.49	25/7/19	12.33	32120
			Equal 2B	24/7/19	13.52	25/7/19	12.56	21190
18	TP. Ulu Maasop	Active Cell	Waste 1A	26/6/19	14.26	27/6/19	10.24	1064
			Waste 1B	26/6/19	14.33	27/6/19	09.49	1061
			Waste 2A	26/6/19	14.4	27/6/19	11.24	10496
			Waste 2B	26/6/19	14.35	27/6/19	11.4	11240
19	TP. Rimba Mas	Active Cell	Waste 1A	8/8/19	14.37	9/8/19	09.49	24174
			Waste 1B	8/8/19	14.43	9/8/19	10.12	24763
			Waste 2A	8/8/19	14.50	9/8/19	10.35	27708
			Waste 2B	8/8/19	14.55	9/8/19	11.07	22339
20	Anaerobic digestion (Kulim)	Digestate	Digestate 1A	11/7/19	14.25	12/7/19	10.21	4213
			Digestate 1B	11/7/19	14.32	12/7/19	10.37	4765
21		Waste Pile	Waste 1A	25/7/19	14.43	26/7/19	10.39	317

	MRF Sg. Udang		Waste 1B	25/7/19	14.46	26/7/19	10.55	257
			Waste 2A	25/7/19	14.50	26/7/19	11.18	386
			Waste 2B	25/7/19	14.53	26/7/19	11.33	631
22	TS Taman Beringin	Pond	Leachate 1A	28/8/19	15.02	29/8/19	10.28	15813
			Leachate 1B	28/8/19	15.05	29/8/19	10.44	14451
			Leachate 2A	28/8/19	15.08	29/8/19	11.02	23239
			Leachate 2B	28/8/19	15.11	29/8/19	11.21	18491
Sewerage system								
23	MTH492-Sungai Udang CSTF (JBIC)	Aeration pond	Aeration 1A	22/7/19	13.01	23/7/19	10.47	489
			Aeration 1B	22/7/19	13.06	23/7/19	11.00	380
			Aeration 2A	22/7/19	13.19	23/7/19	11.15	455
			Aeration 2B	22/7/19	13.24	23/7/19	11.33	517
24	MTH492-Sungai Udang CSTF (JBIC)	Aeration pond	Aeration 1A	23/7/19	11.51	24/7/19	10.27	677
			Aeration 1B	23/7/19	11.55	24/7/19	10.44	399
			Aeration 2A	23/7/19	12.08	24/7/19	10.59	800
			Aeration 2B	23/7/19	12.13	24/7/19	11.13	371
25	MTH492-Sungai Udang CSTF (JBIC)	Aeration pond	Aeration 1A	24/7/19	11.33	25/7/19	10.34	408
			Aeration 1B	24/7/19	11.37	25/7/19	10.59	439
			Aeration 2A	24/7/19	11.46	25/7/19	11.25	378
			Aeration 2B	24/7/19	11.49	25/7/19	11.39	366
26	SPI519-Taman Kelisa Emas	Raw intake pond	Raw 1A	1/8/19	14.20	2/8/19	10.19	1526
			Raw 1B	1/8/19	14.25	2/8/19	10.33	1410
			Raw 2A	1/8/19	14.36	2/8/19	11.04	1492
			Raw 2B	1/8/19	14.39	2/8/19	11.21	1723
27	PJA381-Seksyen 8, PJ	Woodchip biofilter	Outlet 1A	16/7/19	14.42	17/7/19	10.30	60
			Outlet 1B	16/7/19	14.58	17/7/19	10.44	182
			Outlet 2A	16/7/19	15.08	17/7/19	10.57	209
			Outlet 2B	16/7/19	15.17	17/7/19	11.14	182
28	SPI576-Taman Sejati		GNG 1A	17/7/19	14.45	18/7/19	10.18	6436
			GNG 1B	17/7/19	14.48	18/7/19	10.48	14764

		Grit & grease pond	GNG 2A	17/7/19	14.59	18/7/19	11.10	7652
			GNG 2B	17/7/19	15.03	18/7/19	11.26	14924
29	SPI504-Taman Cowin	Raw intake pond	Raw 1A	29/8/19	14.36	30/8/19	09.36	3994
			Raw 1B	29/8/19	14.38	30/8/19	09.53	3994
			Raw 2A	29/8/19	14.42	30/8/19	10.08	4578
			Raw 2B	29/8/19	14.48	30/8/19	10.22	3485
30	IPH240-Taman Pakatan Jaya	Oxidation Pond	OD 1A	4/9/19	14.12	5/9/19	10.07	2217
			OD 1B	4/9/19	14.15	5/9/19	10.22	3485
			OD 2A	4/9/19	14.20	5/9/19	10.35	2624
			OD 2B	4/9/19	14.25	5/9/19	10.50	3041
31	PTG238-Batu 14 Puchong	Incoming Sump Pond	Sump 1A	11/9/19	14.4	12/9/19	10.14	917
			Sump 1B	11/9/19	14.46	12/9/19	10.35	1410
			Sump 2A	11/9/19	14.51	12/9/19	10.48	1410
			Sump 2B	11/9/19	14.49	12/9/19	11.04	945
32	SPI411- Tmn Perindustrian Bukit Minyak	Pond	Pond 1A	12/9/19	12.08	13/9/19	11.00	759
			Pond 1B	12/9/19	12.11	13/9/19	10.11	660
			Pond 2A	12/9/19	12.15	13/9/19	10.27	415
			Pond 2B	12/9/19	12.18	13/9/19	11.31	945
Any other premises that emits or capable of emitting objectionable odour into atmosphere								
33	Jimat Jaya Sdn Bhd	SBR	SBR 1A	6/8/19	11.27	7/8/19	09.24	2265
			SBR 1B	6/8/19	11.30	7/8/19	09.42	2840
			SBR 2A	6/8/19	11.36	7/8/19	10.06	1669
			SBR 2B	6/8/19	11.41	7/8/19	10.23	1748
34	Aik Cheong	Roaster (Chimney)	Roaster 1A	15/7/19	15.27	16/7/19	11.51	19140
			Roaster 1B	15/7/19	15.33	16/7/19	12.03	17876
35	Wilmar Edible Oil	Pond	Pond 1A	22/8/19	15.12	23/8/19	09.46	4578
			Pond 1B	22/8/19	15.15	23/8/19	10.10	4578
			Pond 2A	22/8/19	15.18	23/8/19	10.24	5000
			Pond 2B	22/8/19	15.21	23/8/19	10.56	4578
36			Roaster 1A	27/8/19	14.37	28/8/19	11.08	87087

	Tong Heng Coffee	Roaster (Filter)	Roaster 1B	27/8/19	14.39	28/8/19	11.22	83320
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3.5 RESULTS OF ODOUR CONCENTRATION AT BOUNDARY

The following data includes the odour concentration, intensity and character of odour determine at the site. The in-field odour assessment was conducted at 3 locations, including one at the boundary of the facility and the remaining at the nearby residential area.

(Note:

- (i) *The odour concentration (OU/m^3) in the black box is the representative odour value for the data point, calculated as the geometric mean of individual threshold estimates, following the procedure for data reporting in MS1963:2007. All values were screened and complied with the criterion of $-5 < \Delta Z < 5$*
- (ii) *0 OU/m^3 means that odour concentration is less than 3.5 OU/m^3 which is the minimum detection limit of the instrument (SM100 Olfactometer)*

IN-SITU ODOR ASSESSMENT

PROJECT:
Lee Rubber Co. Pte. Ltd., Bukit Mertajam, Penang

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.407927, 100.475882	1 min	130.0	1.6	3 3 3 3 3 3	8	Rubber processing
		2 min			3 3 3 3 3 3		
		3 min			3 3 3 3 3 3		
		4 min			3 3 3 2 2 2		
Date & time of analysis	Wind condition	5 min	44.0	1.8	2 2 2 3 3 3		
		6 min			2 2 2 2 2 2		
20/6/2019 & 2.22pm	South-southwest, 1.4 MPS	7 min	80		1 2 0 2 2 2		
		8 min			2 2 2 2 2 2		
		9 min			2 3 3 3 3 3		
		10 min			3 3 3 3 3 3		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Kubang semang	5.406222, 100.471611 500 m W	1 min	11.0	1.3	2 2 0 0 0 0	-	-
		2 min			0 1 0 0 0 1		
		3 min			0 0 0 0 1 1		
		4 min			0 0 0 1 0 0		
Date & time of analysis	Wind condition	5 min	7.5	1.1	1 1 1 1 0 0		
		6 min			7.5		
20/6/2019 & 3.35 pm	North-northeast, 0.9	7 min	8.5		0 0 0 0 0 1		
		8 min			0 0 1 0 2 2		
		9 min			0 0 0 0 0 1		
		10 min			0 0 1 1 2 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Kubang semang	5.408218, 100.480456, 500 m	1 min	15.0	1.1	0 1 1 2 2 2	-	-
		2 min			1 0 1 2 0 1		
		3 min			1 2 1 0 0 0		
		4 min			0 1 1 1 0 0		
Date & time of analysis	Wind condition	5 min	20.0	1.2	0 0 1 0 0 1		
		6 min			1 0 2 2 1 0		
20/6/2019 & 4.03 pm	East-southeast, 1.2 MPS	7 min	16.5		2 2 0 0 1 1		
		8 min			0 2 2 1 2 2		
		9 min			2 2 2 2 2 2		
		10 min			2 2 2 2 2 2		

Odour Descriptors:

1 Burnt rubber	10 Earthy/Grassy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
Hevea KB Sdn Bhd, Chemor, Perak

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	4.748379, 101.104286	1 min	29.0	2.0	1 2 2 2 2 2	8	Rubber processing
		2 min			2 2 2 2 2 2		
		3 min			2 2 2 2 2 2		
		4 min			2 2 2 2 2 2		
Date & time of analysis	Wind condition	5 min	9.0	1.6	2 2 2 2 2 2	8	Rubber processing
		6 min			1 2 2 2 2 1		
24/6/2019 & 2.28pm	South, 3.0 MPS	7 min	14		1 1 2 2 2 2	8	Rubber processing
		8 min			1 2 2 2 2 2		
		9 min			2 2 2 2 2 2		
		10 min			2 2 2 2 2 2		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Restoran D' Taman Kanthan	4.753657, 101.116910; 1.5 km NE	1 min	9.0	1.1	0 0 1 0 0 1	10	Grass
		2 min			0 1 0 0 0 0		
		3 min			0 0 0 0 1 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	7.5	1.1	0 0 0 0 1 1	3	Passing vehicle
		6 min			1 0 1 0 0 0		
24/6/2019 & 3.10 pm	South, 1.7 MPS	7 min	8.0		0 0 0 0 0 0	3	Passing vehicle
		8 min			1 1 0 0 0 1		
		9 min			0 0 0 0 1 0		
		10 min			0 1 1 1 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy/Grassy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Sri Kanthan	4.747782, 101.117719; 1.5 km E	1 min	7.5	1.1	1 1 1 1 1 1	10	Grass
		2 min			1 1 0 0 1 1		
		3 min			1 1 1 1 1 1		
		4 min			1 0 1 1 1 1		
Date & time of analysis	Wind condition	5 min	9.0	1.1	1 1 1 1 1 1	8, 13	Waste/leachate
		6 min			1 1 1 1 1 1		
24/6/2019 & 3.30 pm	South, 1.7 MPS	7 min	8.0		0 1 0 0 1 0	10	Grass
		8 min			0 0 1 0 1 1		
		9 min			1 0 1 0 0 1		
		10 min			1 0 1 1 1 1		

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
Euroma Rubber Industry, Kulim,
Kedah

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.509887, 100.684838	1 min	7.5	1.2	0 0 0 0 0 1	8	Rubber processing
		2 min			0 0 0 1 1 1		
		3 min			1 1 0 0 1 1		
		4 min			1 1 1 0 1 1		
Date & time of analysis	Wind condition	5 min	9.0	1.0	1 1 1 1 0 1	8	Rubber processing
		6 min			1 0 0 0 0 0		
25/6/2019 & 1.32 pm	South, 5 MPS	7 min	9.1	1.0	0 0 0 0 1 0	8	Rubber processing
		8 min			0 1 0 0 0 0		
		9 min			0 1 1 1 0 1		
		10 min			1 1 1 0 0 1		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Masjid Labu Besar	5.504842, 100.683409;530 m SW	1 min	5.6	1.1	0 0 0 1 1 0	2	Pavement
		2 min			0 0 0 1 1 0		
		3 min			0 1 1 1 1 0		
		4 min			0 0 1 1 1 1		
Date & time of analysis	Wind condition	5 min	6.4	1.0	1 1 1 0 1 0	2	Pavement
		6 min			1 0 1 1 0 1		
25/6/2019 & 2.15 pm	South, 5 MPS *after rain	7 min	6.1	1.0	0 1 1 0 1 0	2	Pavement
		8 min			0 1 1 1 1 1		
		9 min			0 1 1 1 1 1		
		10 min			1 1 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Kg Bukit Cempedak	5.513744, 100.685592; 430 m NW	1 min	7.5	1.1	0 0 0 0 1 0	8	Rubber processing
		2 min			1 1 0 1 1 1		
		3 min			0 0 0 1 1 0		
		4 min			0 0 1 1 1 1		
Date & time of analysis	Wind condition	5 min	6.4	1.1	1 0 1 0 1 0	2	Pavement
		6 min			0 0 1 1 0 0		
25/6/2019 & 2.32 pm	South, 5 MPS *after rain	7 min	7.1	1.1	1 0 0 1 0 1	8	Rubber processing
		8 min			0 0 1 1 1 1		
		9 min			0 0 1 1 0 1		
		10 min			0 1 1 0 1 1		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 Tapak Pelupusan Ulu Maasop, Kuala Pilah, Negeri Sembilan

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	2.688167, 102.250666	1 min	0	0	0 1 1 1 0 0	8,13	Waste/leachate
		2 min			0 0 0 0 0 1		
		3 min			0 0 0 1 1 1		
		4 min			1 0 0 0 1 1		
Date & time of analysis	Wind condition	5 min	<3.5	-	1 1 0 0 1 1		
26/6/2019 & 2.56 pm	South, 1.7 MPS	6 min			0 0 0 0 1 1		
		7 min			1 1 0 1 0 0		
		8 min			0 0 1 0 1 1		
		9 min			0 0 0 0 0 0		
		10 min			1 0 0 0 0 1		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Kg. Maasop	2.694815, 102.253921; 900 m NE	1 min	<3.5	-	1 1 0 0 1 1	8,13	Waste/leachate
		2 min			0 0 1 1 1 1		
		3 min			0 0 1 1 1 1		
		4 min			0 0 0 1 1 1		
Date & time of analysis	Wind condition	5 min	<3.5	-	1 0 0 1 1 1		
26/6/2019 & 3.19 pm	South, 1.7 MPS	6 min			1 0 1 1 1 1		
		7 min			1 1 1 0 1 1		
		8 min			1 0 0 0 1 1		
		9 min			1 1 1 0 0 1		
		10 min			1 1 1 1 1 1		

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Kg Batang Pilah	2.703458, 102.247025; 1.8 km NW;	1 min	0	0	0 0 0 0 0 0	8,13	Waste/leachate
		2 min			0 0 0 0 0 0		
		3 min			1 0 0 0 0 0		
		4 min			0 0 1 1 0 1		
Date & time of analysis	Wind condition	5 min	<3.5	-	0 0 1 1 1 1		
26/6/2019 & 3.33 pm	South, 1.7 MPS	6 min			0 1 0 0 0 0		
		7 min			1 0 0 0 1 1		
		8 min			0 0 0 0 0 1		
		9 min			1 0 0 0 0 0		
		10 min			0 0 0 0 0 1		

Note: * predominant odour character
 MPS meter per second
 Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT		Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
PROJECT: <i>Kok Foh Palm Oil Mill, Rompin, Negeri Sembilan</i>	Boundary	2.786644, 102.503546	1 min	4.9	1.2	0 0 0 1 1 0	18	Fresh fruit bunch	
			2 min			0 1 1 0 1 0			
			3 min			1 0 0 1 1 0			
			4 min			0 0 1 0 1 0			
CLIENT:	Date & time of analysis	Wind condition	5 min	4.9	1.2	0 0 0 1 1 1	18	Fresh fruit bunch	
	1/7/2019 & 3.23 pm	South, 3.9 MPS	6 min			0 1 0 0 0 1			
7 min			0 1 0 0 1 1						
8 min			1 1 1 0 1 1						
9 min			0 1 1 1 1 1						
CHECKED BY:			10 min	5.6		1 1 0 0 1 1			

Odour Descriptors:	
1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:	
0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character

MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
Gold Coin Feedmills (M) Sdn Bhd,
Butterworth, Penang

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.415052, 100.392811	1 min	4.9	1.1	0 0 1 1 1 1	13	Drain
		2 min			0 0 1 0 0 1		
		3 min			0 0 1 0 0 1		
		4 min			0 1 0 1 0 1		
Date & time of analysis	Wind condition	5 min	3.9	1.2	0 0 0 1 0 0		
		6 min			1 1 0 0 0 0		
3/7/2019 & 2.21 pm	Northwest, 0.4 MPS	7 min	4.5		1 0 0 0 1 0		
		8 min			0 1 0 0 0 0		
		9 min			0 0 0 1 0 0		
		10 min			0 1 1 0 0 1		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Ampang Jajar	5.414804, 100.397629; 500 m E	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
3/7/2019 & 3.11 pm	Northwest, 0.9 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
MPS meter per second

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Lee Bin Café	5.413968, 100.388453; 500 m SW	1 min	4.9	1.1	0 0 0 0 0 0	9	Oil processing
		2 min			1 1 1 0 1 0		
		3 min			0 0 0 0 0 1		
		4 min			0 0 0 0 0 1		
Date & time of analysis	Wind condition	5 min	5.6	1.0	0 0 1 1 1 0		
		6 min			0 0 0 0 0 0		
3/7/2019 & 3.37 pm	0 MPS	7 min	5.4		0 0 0 1 0 0		
		8 min			1 1 0 1 0 1		
		9 min			1 1 1 1 1 1		
		10 min			1 1 1 1 0 0		

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
PW Nutrifeed Sdn Bhd, Juru, Penang

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.307947, 100.447973	1 min	3.9	1.1	0 0 0 0 1 0	13	Drain
		2 min			0 0 0 0 1 1		
		3 min			1 0 0 0 0 0		
		4 min			0 1 1 1 0 0		
Date & time of analysis	Wind condition	5 min	4.9	1.2	0 0 0 0 1 1		
		6 min			0 0 0 0 1 1		
4/7/2019 & 2.20 pm	0 MPS	7 min	4.2		0 1 1 0 0 0		
		8 min			1 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			1 1 1 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: 5-23, Lorong Seri Juru	5.312149, 100.446236; 500 m NW	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
4/7/2019 & 2.50 pm	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: JMTI	5.303814, 100.446503; 500 m SW	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
4/7/2019 & 3.25 pm	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
Kulim Anaerobic Digester, Kulim,
Kedah

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.371029, 100.528512	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
11/7/2019 & 2.38 pm	Northwest, 1.0 MPS *Rain	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Lorong Angsana 8/2	5.370853, 100.528237, 36 m N	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
11/7/2019 & 2.57 pm	0 MPS, *rain	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Jalan Angsana 2	5.370500, 100.528204, 46 m SW	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
11/7/2019 & 3.20 pm	0 MPS, *rain	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
Aik Cheong Coffee Roaster Sdn Bhd,
Melaka

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	2.253693, 102.228724	1 min	3.9	1.0	0 0 0 0 0 0	18 - coffee	Coffee processing
		2 min			0 0 0 0 0 0		
		3 min			1 1 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	<3.5	-	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
15/7/2019 & 3.05 pm	Northwest, 1 MPS	7 min	3.9	-	0 0 0 0 0 0	18 - coffee	Coffee processing
		8 min			0 0 0 0 0 1		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Cheng Baru	2.253790, 102.224207; 500 m W	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
15/7/2019 & 4.02 pm	Northwest, 1 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Teknologi Cheng	2.258251, 102.228392; 500 m N	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
15/7/2019 & 4.18 pm	0 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 IWK Pump Station With Odour
 Control: PJA381 Seksyen 8, Petaling
 Jaya, Selangor

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	3.101049, 101.641048	1 min	3.9	1.2	0 0 0 0 0 0	13	Drain
		2 min			0 1 1 0 0 0		
		3 min			0 0 0 0 1 1		
		4 min			0 0 0 1 0 0		
Date & time of analysis	Wind condition	5 min	5.6	1.2	1 1 1 0 1 1		
		6 min			0 1 1 0 0 1		
16/7/2019 & 2.20pm	0 MPS	7 min	4.7		0 1 1 1 0 0		
		8 min			0 0 0 0 0 1		
		9 min			1 0 0 0 1 1		
		10 min			0 0 0 1 1 1		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: 48, Jalan Termerlian 8/14	3.100071, 101.636641; 500 m SW	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
16/7/2019 & 3.31 pm	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Jalan 14	3.105072, 101.638644; 500 m NW	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
16/7/2019 & 3.45 pm	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 IWK Extended Aeration: SP1576
 Taman Sejati, Juru, Penang

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.346171, 100.433708	1 min	3.9	1.2	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 1		
Date & time of analysis	Wind condition	5 min	4.9	1.1	1 0 0 1 1 1	14	Sewerage Treatment Plant
17/7/19 & 2.05 pm	Northwest, 1 MPS	6 min			0 0 1 1 0 0		
		7 min			1 1 0 0 0 0		
		8 min			0 0 0 1 1 0		
		9 min	4.5		0 1 1 1 0 0		
		10 min			0 0 1 1 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: 48, Lorong Langsat 4 Kampung Bukit Tengah	5.346145, 100.432350; 150 m W	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
17/7/2019 & 3.38 pm	0 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	0		0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Sejati	5.344789, 100.433643; 150 m S	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
17/7/2019 & 4.17 pm	Northwest, 1 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	0		0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 QL Anson Poultry Farm Sdn Bhd.,
 Karangan, Kedah

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.520483, 100.603054	1 min	4.9	1.1	0 0 0 0 0 0	18 - chicken	Poultry farm
		2 min			0 0 1 1 0 0		
		3 min			1 0 1 1 0 1		
		4 min			0 1 1 1 1 1		
Date & time of analysis	Wind condition	5 min	6.4	1.1	1 1 0 0 0 1		
		6 min			1 1 1 1 0 1		
18/7/19 & 3.19 pm	0 MPS	7 min	5.6		0 1 0 0 0 1		
		8 min			0 0 0 0 0 1		
		9 min			1 0 1 1 1 1		
		10 min			1 1 1 1 1 1		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Jalan Kampung Paya Union	5.517022, 100.600248; 500 m SW	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
18/7/2019 & 3.41 pm	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Unnamed Road	5.520762, 100.607518; 500 m E	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
18/7/2019 & 3.56 pm	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 IWK Centralised Sludge Treatment Facility, MTH492 Sg Udang CSTF (JBIC), Sg Udang, Melaka

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
IWK CSTF Boundary	2.290888, 102.149494	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
22/7/19 & 2.23 pm	0 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Indah	2.292448, 102.144302; 1.5 km SW	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
22/7/2019 & 2.41 pm	Northwest, 1.0 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Bertam Impian	2.295988, 102.169506; 1.5 km SE	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
22/7/2019 & 3.03 pm	Northwest, 2.0 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT		Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity						Odour character*	Potential Odour source
PROJECT: <i>Sg Udang Sanitary Landfill, Sg Udang, Melaka</i>	Sg Udang Landfill Boundary	2.300479, 102.158215	1 min	88.0	2.5	2	2	0	1	2	3	8,13	Waste/leachate	
			2 min			3	2	2	3	2	3			
			3 min			1	2	3	2	2	3			
			4 min			2	3	3	0	0	1			
CLIENT:	Date & time of analysis	Wind condition	5 min	44.0	1.3	2	2	2	2	2	2	8,13	Waste/leachate	
			6 min			2	2	2	2	2	2			
			7 min			0	2	2	2	3	2			
			8 min			2	2	0	0	2	2			
CHECKED BY:	22/7/19 & 3.24 pm	0 MPS	9 min	34.9		2	2	0	0	0	2	8,13	Waste/leachate	
			10 min			2	2	2	2	0	0			

Odour Descriptors:	
1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:	
0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character

MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 IWK Centralised Sludge Treatment Facility, MTH492 Sg Udang CSTF (JBIC), Sg Udang, Melaka

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
IWK CSTF Boundary	2.290888, 102.149494	1 min	3.9	1.0	0 0 0 0 0 0	8,13	Waste/leachate
		2 min			0 0 0 0 0 0		
		3 min			0 1 1 1 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
23/7/19 & 9.00 am	Northwest, 1.0 MPS	7 min	3.9		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Indah	2.292448, 102.144302; 1.5 km SW	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
23/7/2019 & 8.46 am	Northwest, 1.0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Bertam Impian	2.295988, 102.169506; 1.5 km SE	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
23/7/2019 & 8.03 am	Northwest, 2 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT		Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
PROJECT: <i>Sg Udang Sanitary Landfill, Sg Udang, Melaka</i>	Sg Udang Landfill Boundary	2.300479, 102.158215	1 min	5.6	1.1	1 1 1 1 0 0	8,13	Waste/leachate	
			2 min			1 1 0 0 0 0			
			3 min			0 1 1 1 1 1			
			4 min			1 0 0 0 0 0			
CLIENT:	Date & time of analysis	Wind condition	5 min	7.5	1.3	1 1 0 1 1 0	8,13	Waste/leachate	
	23/7/19 & 8.25 am	0 MPS *rain	6 min			0 1 1 1 0 0			
7 min			0 1 0 0 1 1						
8 min			1 1 1 1 0 0						
9 min			0 1 1 0 0 1						
CHECKED BY:			10 min	5.9		0 0 0 0 0 0			

Odour Descriptors:	
1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:	
0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character

MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 IWK Centralised Sludge Treatment Facility, MTH492 Sg Udang CSTF (JBIC), Sg Udang, Melaka

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
IWK CSTF Boundary	2.290888, 102.149494	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
23/7/19 & 12.53 pm	Northwest, 1 MPS	7 min	0.0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Indah	2.292448, 102.144302; 1.5 km SW	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
23/7/2019 & 1.50 pm	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Bertam Impian	2.295988, 102.169506; 1.5 km SE	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
23/7/2019 & 1.14 pm	Northwest, 1.0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT		Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity						Odour character*	Potential Odour source
PROJECT: <i>Sg Udang Sanitary Landfill, Sg Udang, Melaka</i>	Sg Udang Landfill Boundary	2.300479, 102.158215	1 min	20.0	1.0	2	1	2	1	2	2	8,13	Waste/leachate	
			2 min			0	0	0	2	1	2			
			3 min			2	1	2	2	0	1			
			4 min			0	0	2	0	0	0			
CLIENT:	Date & time of analysis	Wind condition	5 min	9.0	2.2	1	2	2	0	0	1	8,13	Waste/leachate	
			6 min			1	0	2	1	0	2			
			7 min			1	2	2	2	0	1			
			8 min			1	2	1	0	0	0			
CHECKED BY:	23/7/19 & 2.07 pm	Northwest, 1 MPS	9 min	19.9		1	0	0	0	0	0	8,13	Waste/leachate	
			10 min			1	2	1	0	0	0			

Odour Descriptors:	
1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:	
0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character

MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT		Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
PROJECT: IWK Centralised Sludge Treatment Facility, MTH492 Sg Udang CSTF (JBIC), Sg Udang, Melaka	IWK CSTF Boundary	2.290888, 102.149494	1 min	7.5	1.1	0 0 1 1 2 2	8,13	Waste/leachate	
			2 min			2 2 2 2 2 2			
			3 min			2 2 2 2 2 2			
			4 min			2 2 2 2 2 2			
	CLIENT:	Date & time of analysis	Wind condition	5 min	3.9	1.8			2 2 2 2 2 2
				6 min					2 2 2 2 1 0
	CHECKED BY:	24/7/19 & 8.31 am	0 MPS	7 min	6.9				0 0 0 0 0 0
				8 min					0 0 0 0 0 0
				9 min					0 0 0 0 0 0
				10 min					0 0 0 0 0 0

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Indah	2.292448, 102.144302; 1.5 km SW	1 min	5.6	1.0	1 1 0 1 1 1	8,13	Waste/leachate
		2 min			1 1 0 0 0 0		
		3 min			1 1 1 0 0 0		
		4 min			0 0 0 0 1 1		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
24/7/2019 & 8.16 am	0 MPS	7 min	5.6		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Bertam Impian	2.295988, 102.169506; 1.5 km SE	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
24/7/2019 & 7.59 am	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

IN-SITU ODOR ASSESSMENT		Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source	
PROJECT: <i>Sg Udang Sanitary Landfill, Sg Udang, Melaka</i>	Sg Udang Landfill Boundary	2.300479, 102.158215	1 min	3.5	3.3	0 0 0 0 0 0	8,13	Waste/leachate		
			2 min			1 0 0 0 0 0				
			3 min			1 1 0 0 0 1				
			4 min			1 1 0 0 0 0				
CLIENT:	Date & time of analysis	Wind condition	5 min	15.0	1.3	1 1 1 1 0 0	8,13	Waste/leachate		
			6 min			0 0 0 0 0 0				
			7 min			0 0 0 0 0 0				
			8 min			1 2 2 0 2 2				
CHECKED BY:	24/7/19 & 8.49 am	0 MPS *rain	9 min	29.0	2.5	2 1 1 0 1 1	8,13	Waste/leachate		
			10 min			2 2 2 2 1 2				
						11.5				

Odour Descriptors:	
1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:	
0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character

MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 IWK Centralised Sludge Treatment Facility, MTH492 Sg Udang CSTF (JBIC), Sg Udang, Melaka

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
IWK CSTF Boundary	2.290888, 102.149494	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
24/7/19 & 12.22 pm	Northwest, 2 MPS	7 min	0.0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Indah	2.292448, 102.144302; 1.5 km SW	1 min	<3.5	-	0 1 1 1 1 1	8,13	Waste/leachate
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
24/7/2019 & 12.56 pm	0 MPS	7 min	<3.5		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Bertam Impian	2.295988, 102.169506; 1.5 km SE	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
24/7/2019 & 12.36 pm	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
Sg Udang Sanitary Landfill, Sg Udang, Melaka

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Sg Udang Landfill Boundary	2.300479, 102.158215	1 min	4.9	1.8	1 1 1 1 1 1	8,13	Waste/leachate
		2 min			0 0 1 1 0 1		
		3 min	1 1 1 1 1 1				
		4 min	1 1 1 1 0 1				
Date & time of analysis	Wind condition	5 min	15.0	1.7	1 1 1 1 1 1	8,13	Waste/leachate
		6 min			2 1 2 1 2 1		
24/7/19 & 1.15 pm	Northwest, 2 MPS	7 min	8.7		1 1 1 1 1 1		
		8 min			2 2 2 2 2 2		
		9 min			1 1 1 2 1 1		
		10 min			1 1 1 2 2 2		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character

MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
Materials Recovery Facility Sg Udang,
Melaka

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	2.300479, 102.158215	1 min	44.0	1.6	3 3 2 2 1 1	8,13	Waste/leachate
		2 min			3 3 3 2 2 3		
		3 min			0 2 3 3 3 3		
		4 min			2 2 2 2 2 2		
Date & time of analysis	Wind condition	5 min	88.0	1.3	1 2 1 2 1 2	8,13	Waste/leachate
25/7/19 & 1.57 pm	0 MPS	6 min			3 3 3 2 1 1		
		7 min			3 3 3 2 2 1		
		8 min			2 3 3 3 2 2		
		9 min	3 2 2 2 1 2				
		10 min	69.8		2 2 3 3 1 1		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Indah	2.292448, 102.144302; 1.5 km SW	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
25/7/19 & 1.43 pm	Northwest, 0.5 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	0 0 0 0 0 0				
		10 min	0		0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Bertam Impian	2.295988, 102.169506; 1.5 km SE	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
25/7/19 & 1.23 pm	Northwest, 0.1 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	0 0 0 0 0 0				
		10 min	0		0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 IWK Pump Station: SPI519 Taman Kelisa Emas, Seberang Perai, Penang

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.391614, 100.408851	1 min	4.9	1.0	1 1 1 1 1 1	14	Sewerage Treatment Plant
		2 min			1 1 1 1 1 1		
		3 min			1 1 1 1 1 1		
		4 min			1 1 1 1 1 1		
Date & time of analysis	Wind condition	5 min	3.9	1.3	1 1 1 1 1 1		
		6 min			1 1 1 1 1 1		
1/8/19 & 2.30 pm	0 MPS	7 min	5.0		1 1 1 1 1 1		
		8 min			1 1 1 1 1 1		
		9 min			1 1 1 1 1 1		
		10 min			1 1 1 1 1 1		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Kelisa Emas	5.392571, 100.409900; 150 m NE	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
1/8/19 & 3.13 pm	South-southwest, 0.1 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
 MPS meter per second

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Surau al-hidayah, Taman Kelisa Emas	5.391872, 100.407338; 170 m NW	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
1/8/19 & 3.28 pm	West-northwest, 0.3 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
Setiakawan Palm Oil Mill, Karangas, Kedah

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.446649, 100.628542	1 min	0.0	0.0	1 1 0 1 1 0	8	Palm oil mill effluent
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	4.9	1.2	1 1 1 1 1 1	8	Palm oil mill effluent
5/8/19 & 2.30 pm	East, 0.1 MPS	6 min			1 1 1 1 0 1		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	1 1 1 1 1 1				
		10 min	4.1		1 1 1 1 1 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Mutiara	5.442597, 100.641857, 1.5 km SE	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
5/8/19 & 2.52 pm	Northwest, 0.1 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	0 0 0 0 0 0				
		10 min	0		0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Unnamed road	5.457636, 100.637202, 1.5 km NE	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
5/8/19 & 3.15 pm	South-southeast, 0.6 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	0 0 0 0 0 0				
		10 min	0		0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
Jimat Jaya Sdn Bhd, Sg. Petani, Kedah

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.690387, 100.515100	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
6/8/19 & 12.22 pm	Southwest, 0.1 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	0 0 0 0 0 0				
		10 min	0		0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Unnamed Road, Sungai Lalang	5.690716, 100.519557, 500 m E	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
6/8/19 & 12.44 pm	West-northwest, 0.2 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	0 0 0 0 0 0				
		10 min	0		0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Permata Hill Park	5.689221, 100.509219, 660 m W	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
6/8/19 & 1.00 pm	Southwest, 1.0 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	0 0 0 0 0 0				
		10 min	0		0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 Rimba Mas Sanitary Landfill, Kangar,
 Perlis

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	6.598759, 100.272198	1 min	3.9	1.0	1 1 1 1 1 1	8,13	Waste/leachate
		2 min			1 1 1 1 1 1		
		3 min			1 1 1 1 1 1		
		4 min			1 1 1 1 1 1		
Date & time of analysis	Wind condition	5 min	3.5	1.2	1 1 1 1 1 1		
		6 min			1 1 1 1 1 0		
8/8/19 & 3.20 pm	North-northwest, 1.3 MPS	7 min	4.1	1.2	1 1 1 1 0 1		
		8 min			0 1 1 0 0 0		
		9 min			0 0 1 1 1 0		
		10 min			1 1 1 1 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Kg. Kubang Tiga	6.578641, 100.277427, 2.27 km S	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
8/8/19 & 3.34 pm	Southwest, 0.4 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Pos Pemeriksaan AKSEM	6.599183, 100.281185, 988 m	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
8/8/19 & 3.50 pm	0 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 Wilmar Edible Oil Sdn Bhd,
 Butterworth, Penang

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.416237, 100.386126	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
22/8/2019 & 3.40 pm	North-northwest, 1.7 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Villa Sri Bagan	5.411867, 100.385776; 500 m S	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
22/8/2019 & 4.02 pm	South-southwest, 2.9 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Masjid At-Taqwa	5.420570, 100.386905; 500 m N	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
22/8/2019 & 4.22 pm	West-southwest, 1.9 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy/Grassy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT		Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity						Odour character*	Potential Odour source
PROJECT: <i>Tong Heng Coffee Factory Sdn. Bhd., Batu Berendam, Melaka</i>	Boundary	2.275126, 102.242631	1 min	0	0	1	1	1	1	1	1	18 - coffee	Coffee Factory	
			2 min			1	1	0	0	0	0			
			3 min			0	0	0	0	0	0			
			4 min			0	0	0	0	0	0			
CLIENT:	Date & time of analysis	Wind condition	5 min	0	0	0	0	0	0	0	0			
			6 min			0	0	0	0	0	0			
			7 min			0	0	0	0	0	0			
			8 min			0	0	0	0	0	0			
CHECKED BY:	27/8/2019 & 2.56 pm	East, 0.1 MPS	9 min	0	0	0	0	0	0	0	0			
			10 min			0	0	0	0	0	0			

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity						Odour character*	Potential Odour source
O1: Taman Merdeka Jaya	2.274601, 102.247190; 480 m E	1 min	0	0	0	0	0	0	0	0		
		2 min			0	0	0	0	0	0		
		3 min			0	0	0	0	0	0		
		4 min			0	0	0	0	0	0		
Date & time of analysis	Wind condition	5 min	0	0	0	0	0	0	0	0	-	-
		6 min			0	0	0	0	0	0		
		7 min			0	0	0	0	0	0		
		8 min			0	0	0	0	0	0		
27/8/2019 & 3.15 pm	Northwest, 1.3 MPS	9 min	0	0	0	0	0	0	0	0		
		10 min			0	0	0	0	0	0		

Odour Descriptors:

1 Burnt rubber	10 Earthy/Grassy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity						Odour character*	Potential Odour source
O2: Taman Sri Krubong	2.273908, 102.238595; 490 m W	1 min	3.5	1.0	1	1	1	1	1	1	18 - coffee	Coffee Factory
		2 min			1	1	1	1	1	1		
		3 min			1	1	1	1	1	1		
		4 min			0	0	0	0	0	0		
Date & time of analysis	Wind condition	5 min	0	0	0	0	0	0	1	1		
		6 min			0	0	0	0	0	0		
		7 min			0	0	0	0	0	0		
		8 min			0	0	0	0	0	0		
27/8/2019 & 3.37 pm	South, 0.8 MPS	9 min	3.5	0	0	0	0	0	0	0		
		10 min			0	0	0	0	0	0		

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
Stesen Pemindahan Sisa Pepejal
Kuala Lumpur, Taman Beringin, Kuala Lumpur

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	3.230341, 101.659887	1 min	5.6	1.6	1 1 1 1 1 1	8,13	Waste/leachate, Passing rubbish truck
		2 min			1 1 1 1 1 1		
		3 min			1 1 1 1 1 1		
		4 min			1 1 1 1 1 1		
Date & time of analysis	Wind condition	5 min	11.0	1.3	1 1 1 1 1 1	8,13	Waste/leachate, Passing rubbish truck
		6 min			1 1 1 1 2 2		
28/8/2019 & 3.56 pm	0 MPS, *after rain	7 min	8.3		2 1 1 1 1 1		
		8 min			1 1 1 1 2 2		
		9 min			2 1 1 1 1 1		
		10 min			1 2 2 2 1 1		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Perumahan Awam Jinjang Utara	3.225987, 101.658208; 500 m SW	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
28/8/2019 & 4.34 pm	North-northeast, 0.1 MPS, *after rain	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
MPS meter per second

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Sri Murni	3.234630, 101.661606; 500 m NE	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
28/8/2019 & 4.53 pm	0 MPS, *after rain	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 IWK Pump Station: SPI504 Taman Cowin, Nibong Tebal, Penang

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.177784, 100.468157	1 min	3.5	1.0	0 0 0 0 0 0	14	Sewerage Treatment Plant
		2 min			0 0 0 0 0 0		
		3 min			1 0 0 1 1 1		
		4 min			1 0 1 1 0 0		
Date & time of analysis	Wind condition	5 min	<3.5	-	0 0 0 1 1 0		
		6 min			<3.5		
29/8/2019 & 3.15 pm	0 MPS	7 min	3.5	-	0 1 1 1 1 1		
		8 min			0 0 0 1 1 1		
		9 min			1 1 1 1 1 0		
		10 min			1 1 0 1 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Cowin	5.177954, 100.469543; 150 m E	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
29/8/2019 & 3.35 pm	Southeast, 0.3 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Nibong Tebal Indah	5.177634, 100.466761; 150 m W	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
29/8/2019 & 3.55 pm	Northeast, 1.5 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
PWF Farms Sdn Bhd., Pendang, Kedah

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.902412, 100.515281	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
3/9/2019 & 4.15 pm	0 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	0 0 0 0 0 0				
		10 min	0		0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Kampung Baloh	5.904463, 100.524914; 1.2 km E	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
3/9/2019 & 4.36 pm	0 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	0 0 0 0 0 0				
		10 min	0		0 0 0 0 0 0		

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
MPS meter per second

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Air Puteh	5.902478, 100.514559; 1.2 km SE	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
3/9/2019 & 5.13 pm	0 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min	0 0 0 0 0 0				
		10 min	0		0 0 0 0 0 0		

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 IWK Oxidation Ditch: IPH240 Taman Pakatan Jaya, Ipoh, Perak

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	5.307947, 100.447973	1 min	5.6	1.0	1 1 1 1 1 1	14	Sewerage Treatment Plant
		2 min			1 1 1 1 1 1		
		3 min			1 1 1 1 1 1		
		4 min			1 1 1 1 1 1		
Date & time of analysis	Wind condition	5 min	4.9	1.1	1 1 1 1 1 1		
		6 min			1 1 1 1 1 1		
4/9/2019 & 3.01 pm	0 MPS	7 min	5.4		1 1 1 1 1 1		
		8 min			1 1 1 1 1 1		
		9 min			1 1 1 1 1 1		
		10 min			1 1 1 1 1 1		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Bercham Raya	4.639103, 101.145400; 150 m NE	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
4/9/2019 & 3.20 pm	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Perpaduan Ria	4.638804, 101.141398, 150 m W	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
4/9/2019 & 3.40 pm	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
Dinding Poultry Processing Sdn Bhd.,
Sitiawan, Perak

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	4.245974, 100.669815	1 min	11.0	1.0	2 2 2 2 2 2	18 - Palm Oil	Palm Oil Processing Factory
		2 min			2 2 2 2 2 2		
		3 min			2 2 2 2 2 2		
		4 min			2 2 2 2 2 2		
Date & time of analysis	Wind condition	5 min	11.0	1.0	2 2 2 2 2 2		
		6 min			2 2 2 2 2 2		
5/9/2019 & 4.00 pm	0 MPS	7 min	11.0	1.0	2 2 2 2 2 2		
		8 min			2 2 2 2 2 2		
		9 min			2 2 2 2 2 2		
		10 min			2 2 2 2 2 2		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Taman Perindustrian Iks Kampung Acheh 2	4.242319, 100.673990; 500 m E	1 min	3.5	1.0	1 1 1 1 1 1	10	Ground
		2 min			1 1 1 1 1 1		
		3 min			1 1 1 1 1 1		
		4 min			<3.5		
Date & time of analysis	Wind condition	5 min	3.5	1.0	1 1 1 1 1 1		
		6 min			1 1 1 1 1 1		
5/9/2019 & 4.15 pm	0 MPS	7 min	3.5	1.0	1 1 1 1 1 1		
		8 min			1 1 1 1 1 1		
		9 min			1 1 1 1 1 1		
		10 min			1 1 1 1 1 1		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Perindustrian Iks Kampung Acheh 2	4.244631, 100.665333; 500 m NW	1 min	9.0	1.1	1 1 1 1 2 2	18 - Burnt wood	Furniture factory
		2 min			2 2 1 1 1 2		
		3 min			2 2 2 1 1 1		
		4 min			1 1 1 1 1 1		
Date & time of analysis	Wind condition	5 min	7.5	1.1	2 2 2 2 2 2		
		6 min			2 2 2 2 2 2		
5/9/2019 & 4.30 pm	1 MPS	7 min	8.0	1.1	2 2 1 1 1 1		
		8 min			1 1 2 2 2 2		
		9 min			2 2 2 1 1 1		
		10 min			1 1 1 2 2 2		

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 IWK Extended Aeration With Odour Control: PTG238- Batu 14 Puchong, Selangor

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	2.998748, 101.620570	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
11/9/2019 & 3.27 pm	0 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Casa Tropika	2.998428, 101.621868; 150 m E	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
11/9/2019 & 3.42 pm	0 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: 180-182, Jalan Bunga Melor	2.998905, 101.619270; 145 m W	1 min	0	0	0 0 0 0 0 0		
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0	-	-
		6 min			0 0 0 0 0 0		
11/9/2019 & 3.53 pm	0 MPS	7 min	0	0	0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT		Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity						Odour character*	Potential Odour source
PROJECT: IWK Oxidation Ditch: SPI411- Tmn Perindustrian Bukit Minyak, Penang	Boundary	5.300581, 100.457258	1 min	0	0	0	0	0	0	0	0			
			2 min			0	0	0	0	0				
			3 min			0	0	0	0	0				
			4 min			0	0	0	0	0				
CLIENT:	Date & time of analysis	Wind condition	5 min	0	0	0	0	0	0	0	0	-	-	
			6 min			0	0	0	0	0				
			7 min			0	0	0	0	0				
			8 min			0	0	0	0	0				
CHECKED BY:	12/9/2019 & 12.44 pm	0 MPS	9 min	0	0	0	0	0	0	0	0			
			10 min			0	0	0	0	0				

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity						Odour character*	Potential Odour source
O1: Kawasan Perindustrian Bukit Minyak	5.300297, 100.458593; 150 m E	1 min	0	0	0	0	0	0	0	0		
		2 min			0	0	0	0	0			
		3 min			0	0	0	0	0			
		4 min			0	0	0	0	0			
Date & time of analysis	Wind condition	5 min	0	0	0	0	0	0	0	0	-	-
		6 min			0	0	0	0	0			
		7 min			0	0	0	0	0			
		8 min			0	0	0	0	0			
12/9/2019 & 12.56 pm	0 MPS	9 min	0	0	0	0	0	0	0	0		
		10 min			0	0	0	0	0			

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity						Odour character*	Potential Odour source
O2: Kawasan Perindustrian	5.300728, 100.455944; 150 m W	1 min	0	0	0	0	0	0	0	0		
		2 min			0	0	0	0	0			
		3 min			0	0	0	0	0			
		4 min			0	0	0	0	0			
Date & time of analysis	Wind condition	5 min	0	0	0	0	0	0	0	0	-	-
		6 min			0	0	0	0	0			
		7 min			0	0	0	0	0			
		8 min			0	0	0	0	0			
12/9/2019 & 1.07 pm	0 MPS	9 min	0	0	0	0	0	0	0	0		
		10 min			0	0	0	0	0			

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
 Sykt. Cahaya Muda Perak (Oil Mill)
 Sdn. Bhd., Tapah, Perak

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	4.159430, 101.280497	1 min	3.9	1.0	1 1 1 1 1 1	8	Palm Oil Mill Effluent
		2 min			1 1 1 1 1 1		
		3 min			1 1 1 1 1 1		
		4 min			1 1 1 1 1 1		
Date & time of analysis	Wind condition	5 min	3.5	1.1	1 1 1 1 1 1	3	Lorry
		6 min			1 1 1 1 1 1		
19/9/19 & 4.35 pm	0 MPS	7 min	3.8		1 1 1 1 1 1		
		8 min			1 1 1 1 1 1		
		9 min			1 1 1 1 1 1		
		10 min			1 1 1 1 1 1		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Kg Tersusun Batu 2 Tambahan	4.157790, 101.270456; 1.1 km SW	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
19/9/2019 & 4.56 pm	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Unnamed Road	4.172396, 101.267763; 2 km NW	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
		6 min			0 0 0 0 0 0		
19/9/2019 & 5.22 pm	0 MPS	7 min	0		0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Note: * predominant odour character
 MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

IN-SITU ODOR ASSESSMENT

PROJECT:
QL Poultry Farms Sdn. Bhd., Pajam,
Negeri Sembilan

CLIENT:

CHECKED BY:

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
Boundary	2.832968, 101.850820	1 min	0	0	0 1 1 0 1 1	18 - chicken	Poultry Farm
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	<3.5	-	0 0 0 0 0 0		
26/9/19 & 2.55 pm	0 MPS	6 min			1 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 1 1		
		9 min			1 0 1 0 1 1		
		10 min			0 0 1 1 1 1		

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O1: Kg. Gebok	2.833140, 101.855740; 500 W	1 min	0	0	0 0 0 0 0 0	16	Goats
		2 min			0 0 0 0 0 0		
		3 min			1 0 1 0 1 1		
		4 min			1 0 1 0 1 0		
Date & time of analysis	Wind condition	5 min	<3.5	-	0 0 0 0 0 0		
26/9/2019 & 3.09 pm	East, 1 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 1 1		
		8 min			0 0 1 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Odour Descriptors:

1 Burnt rubber	10 Earthy
2 Tar/asphalt	11 Pungent, urine
3 Exhaust	12 Rotten egg
4 Smokey	13 Putrid, decay
5 Solvent	14 Sewer
6 Sweet	15 Rotten cabbage
7 Bleach	16 Fecal/Manure
8 Sour vinegar	17 Fishy
9 Oil/Gasoline	18 Other

Odour Intensity:

0	No odour
1	Very weak
2	Weak
3	Distinct
4	Strong
5	Very strong
6	Extremely strong

Sample ID	Sample description	10 min interval	OU/m ³	ΔZ	Odour intensity	Odour character*	Potential Odour source
O2: Taman Mulia	2.838173,101.845299; 0.8 km NW	1 min	0	0	0 0 0 0 0 0	-	-
		2 min			0 0 0 0 0 0		
		3 min			0 0 0 0 0 0		
		4 min			0 0 0 0 0 0		
Date & time of analysis	Wind condition	5 min	0	0	0 0 0 0 0 0		
26/9/2019 & 3.30 pm	Southwest, 1 MPS	6 min			0 0 0 0 0 0		
		7 min			0 0 0 0 0 0		
		8 min			0 0 0 0 0 0		
		9 min			0 0 0 0 0 0		
		10 min			0 0 0 0 0 0		

Note: * predominant odour character
MPS meter per second

Wind direction is reported by the direction from which it originates. For example, a northerly wind blows from the north to the south.

CHAPTER 4:

OUTPUT 2: SUITABLE LIMIT VALUES FOR SOURCE ODOUR EMISSION FROM IDENTIFIED INDUSTRY AND ACTIVITY

4.1 INTRODUCTION

In enforcing the Environmental Quality Act 1974 aimed at controlling environmental pollution, in which some are caused by industries and facilities, the Department of Environment often received odour related complaints that affects the public's comfort. The odour complaints include emissions from the rubber industries, sewerage treatment plants, landfills, fishmeal, husbandries, and slaughterhouses. In many cases there is a need to determine the extent of the nuisance, and requires methods and techniques to characterize, quantify and define limits for specific odour emissions. The limits imposed must balance the need for protecting the public from odour exposure on one hand, while at the same not imposing over-stringent controls on site operators. This chapter aims to identify limit values that best meets both of this requirement in order to improve the management of odour pollution. Issues associated with the development of limit values are also presented here.

4.2 PRESENTATION OF DATA SPREAD USING BOXPLOT

The odour concentration data gathered in Chapter 3, was analysed and herein presented in a box and whisker plot. A box and whisker plot helps to show the shape of the distribution, its central value, and its variability (refer Figure 4.1). In this type of graph: the ends of the box are the upper and lower quartiles, so the box spans the interquartile range. The median is marked by a vertical line inside the box (Berthouex and Brown, 2002). Plotting median instead of the average is advantageous in that the median is not affected by the extreme values. The odour threshold limit value for each of the seven industry or activity categories was obtained from the median number. The spacings between the different parts of the box indicate the degree of dispersion (spread) and skewness in the data, and show outliers.

An outlier is an observation that is numerically distant from the rest of the data. When reviewing a boxplot, an outlier is defined as a data point that is located outside the fences ("whiskers") of the boxplot. Extreme outliers are data points that are more extreme than $Q1 - 3 * IQR$ or $Q3 + 3 * IQR$. Extreme outliers are marked with an asterisk (*) on the boxplot. Mild outliers are data points that are more extreme than $Q1 - 1.5 * IQR$ or $Q3 + 1.5 * IQR$, but are not extreme outliers. Mild outliers are marked with a circle (O) on the boxplot.

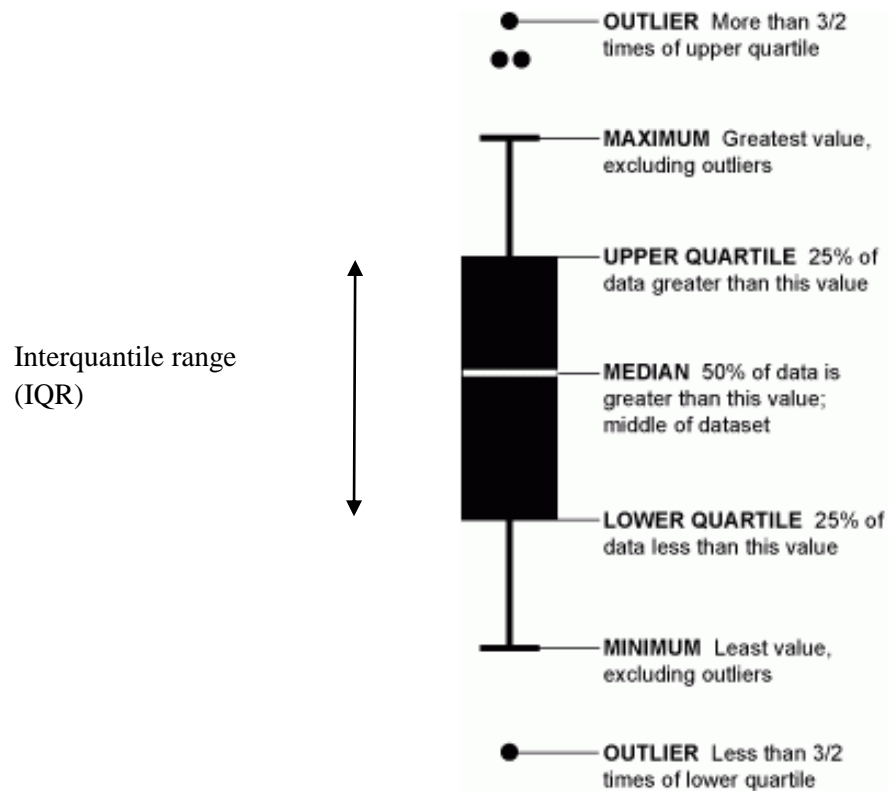


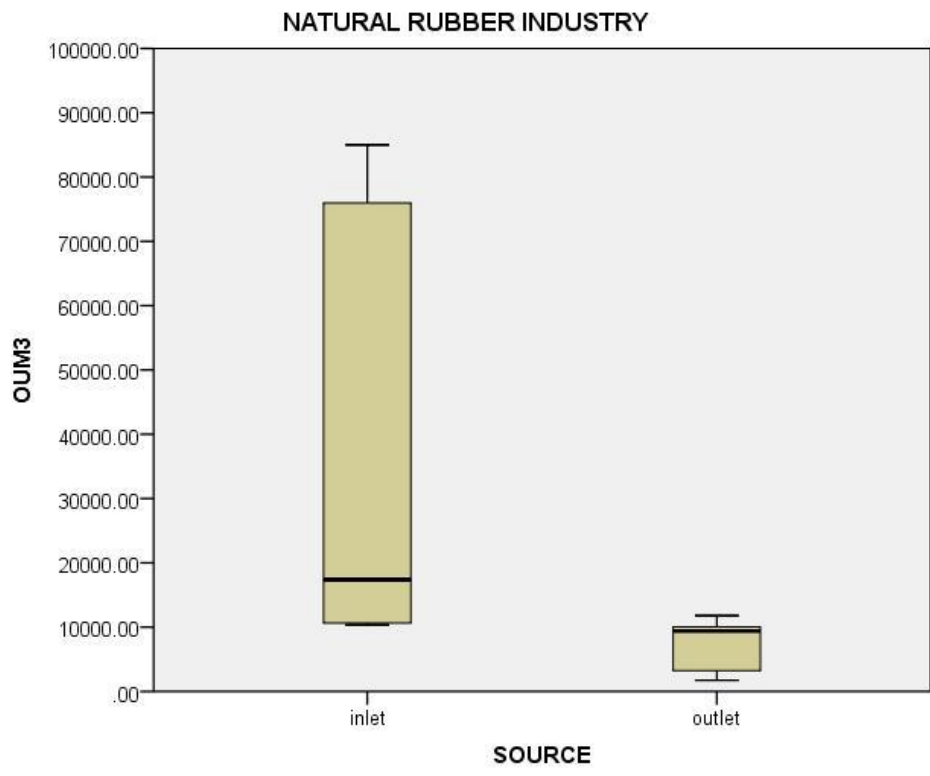
Figure 4.1 Description of a box and whisker plot for the determination of the odour limit value

4.3 POINT OF EMISSION ODOUR DATA

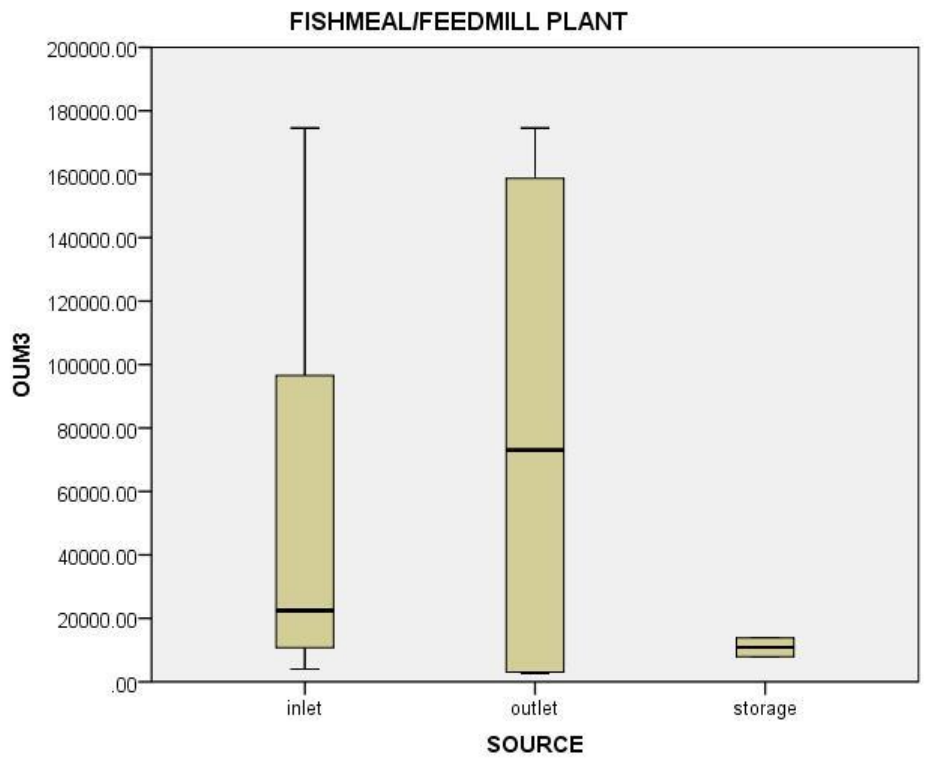
4.3.1 Odour of Each Industrial/Activity Category According to Their Source of Emissions

Figure 4.2 – Figure 4.5 shows the odour concentration at various the point of emissions of all seven categories of industries/activities that was involved in the data collection. Only the most odourous source was sampled and analyzed in each location. This single odour source was usually identified after consultation with the premise operators regarding the production process, the facility’s storage condition, as well as any waste/wastewater treatment and stack emissions. In addition, this discussion was often accompanied by a walkabout within the premise to experience first-hand the odour emission of the identified sources and at the same time comprehend the potentiality of odour dispersion to the surroundings based on the scale and condition of the source. For example, incoming raw sewage into a pumping station might be most odourous, however, given the incoming’s underground and covered location, sampling was not conducted over this source. Instead, the biofilter system installed on site was analysed, due to its uncovered surface being the only potential source of emission that could be detected in the open air.

The odour emission from the rubber industries was measured from the installed wet scrubbers, both at the inlet and outlet after passing the scrubber system as shown in Figure 4.2. The wet scrubber’s median outlet value was much lower (9393 OU/m³) compared to the inlet at 17376



(a)



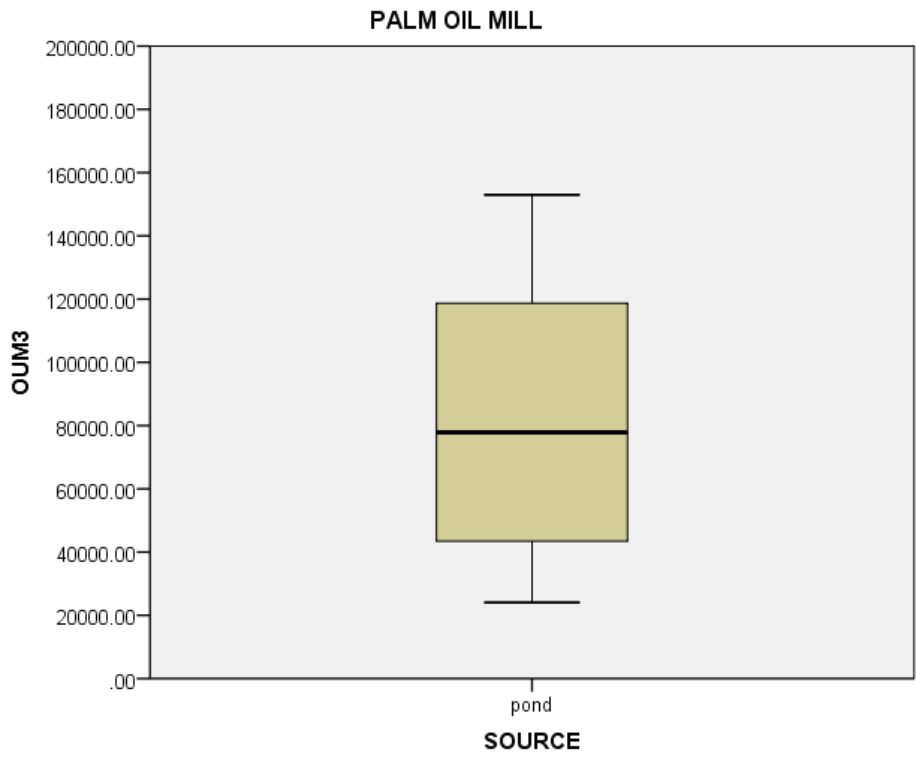
(b)

Figure 4.2 Odour concentration of emission from (a) natural rubber industry and (b) fishmeal/feedmill plants assessed at the point of emission

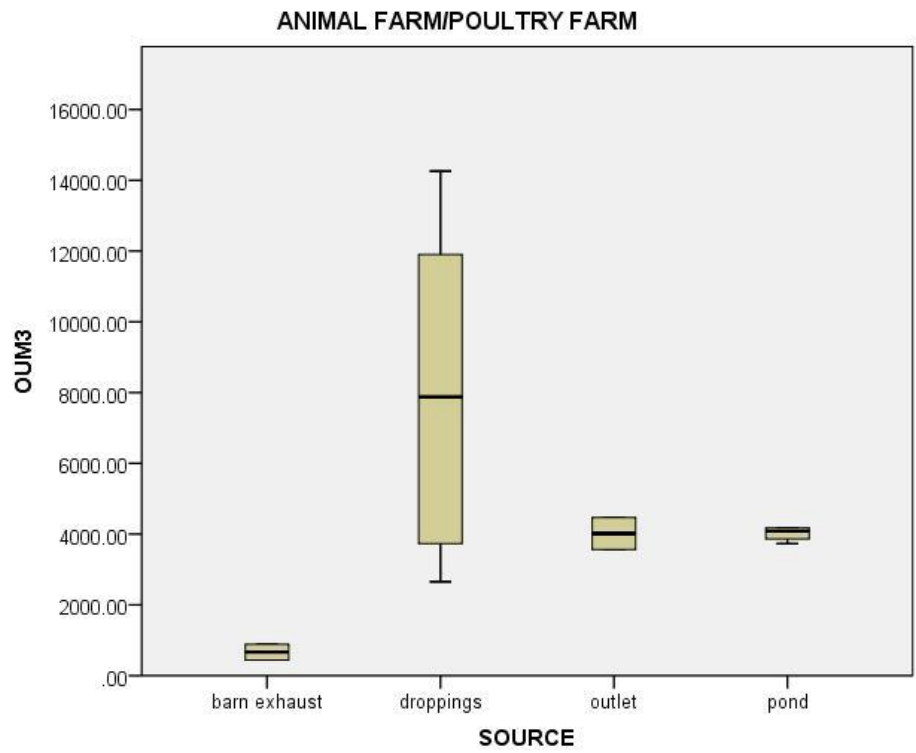
OU/m³. Wet scrubbers were also installed at fishmeal plants, which coincidentally again was the main source of odour at the facility (refer Figure 4.2b). This time, the wet scrubbers were not as effective whereby the median outlet values 73055 OU/m³ was higher than the median inlet value (22,452 OU/m³). There were also other odourous sources in feedmills, including stacks and the product storage area. For palm oil mills, open ponding system is unavoidable, despite the installation of modern covered lagoons and tank digesters. Figure 4.3a shows the odour concentration from the effluent pond consisting of cooling or acidification pond was around 77,851 OU/m³ (median). Sources for odour at animal/poultry are aplenty and varies depending on the animal rearing system that was in place, as well as the management of its chicken droppings. The highest odour contributor seemed to be from the droppings at 7875 OU/m³ (median) as shown in Figure 4.3b, while the least came from the barn exhaust at 663 (OU/m³)

Solid waste management facilities in this study comprised of landfills, an anaerobic digester, a transfer station and a material recovery facility. Various odour sources were analysed, whereby odour was highest from the leachate treatment plant (26000 OU/m³, median value) as shown in Figure 4.4a, followed by the waste pile (5780 OU/m³, median value). Only one measurement of digestate was available, which was collected from a single food waste anaerobic digester. Figure 4.4b demonstrates the odour emission from sewerage systems, which was mostly measured from the sewerage treatment ponds. Measurement was also performed on odour biofiltration systems installed at selected facility to control malodour. On average, the pump station emitted the highest odour at 2604 OU/m³, followed from the incoming sump (1178 OU/m³) and the least odour coming from the biofilter bed (182 OU/m³). The treatment pond had a median value of 669 OU/m³, but has quite a large data spread. A mild outlier (O) was recorded at 7652 OU/m³, and extreme outliers (*) at 14764 and 14924 OU/m³. These outlier data originated from one treatment plant where odour sample was collected from the grit and grease pond that was suspected to be affected from illegal dumping of industrial effluents.

The results of odour monitoring from other premises are presented in Figure 4.5, which revolved around manufacturing or processing of coffee, edible oil and poultry. Odour from these industries were mostly detected to be high from the processing part, e.g. from the coffee roaster (51230 OU/m³) compared to its waste/wastewater treatment system (3709 OU/m³).



(a)



(b)

Figure 4.3 Odour concentration of emission from (a) palm oil mill and (b) animal farm/poultry farm assessed at the point of emission

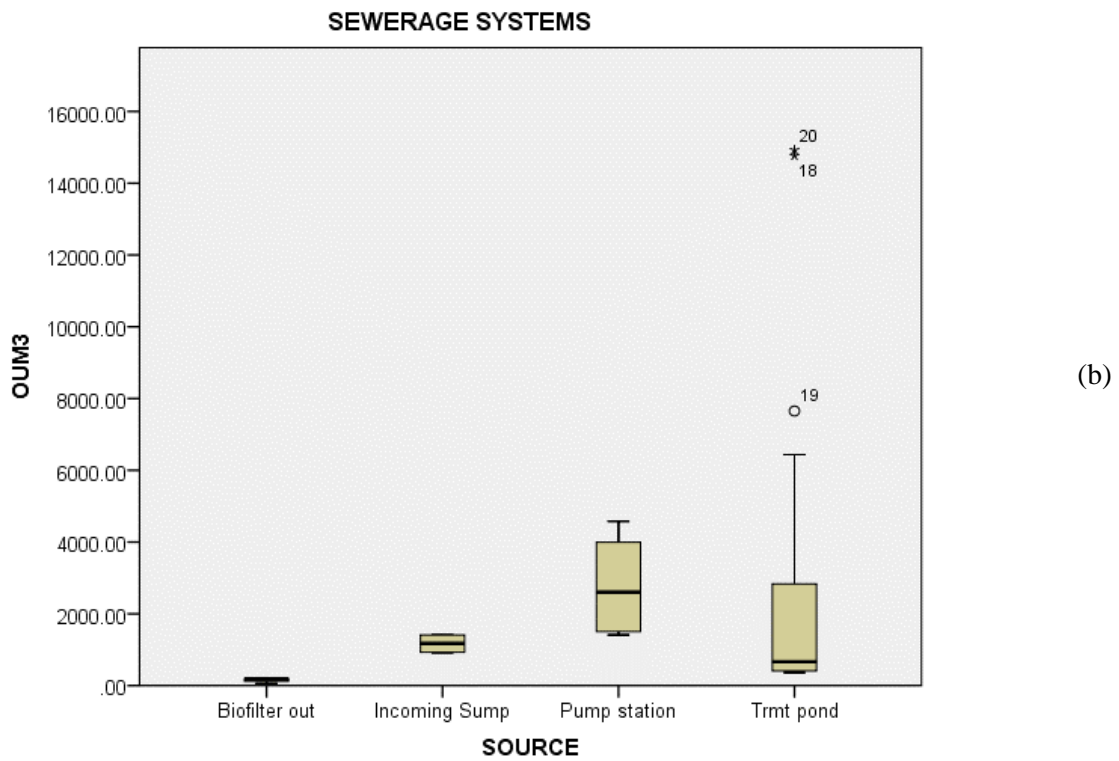


Figure 4.4 Odour concentration of emission from (a) solid waste management facility and (b) sewerage systems assessed at the point of emission

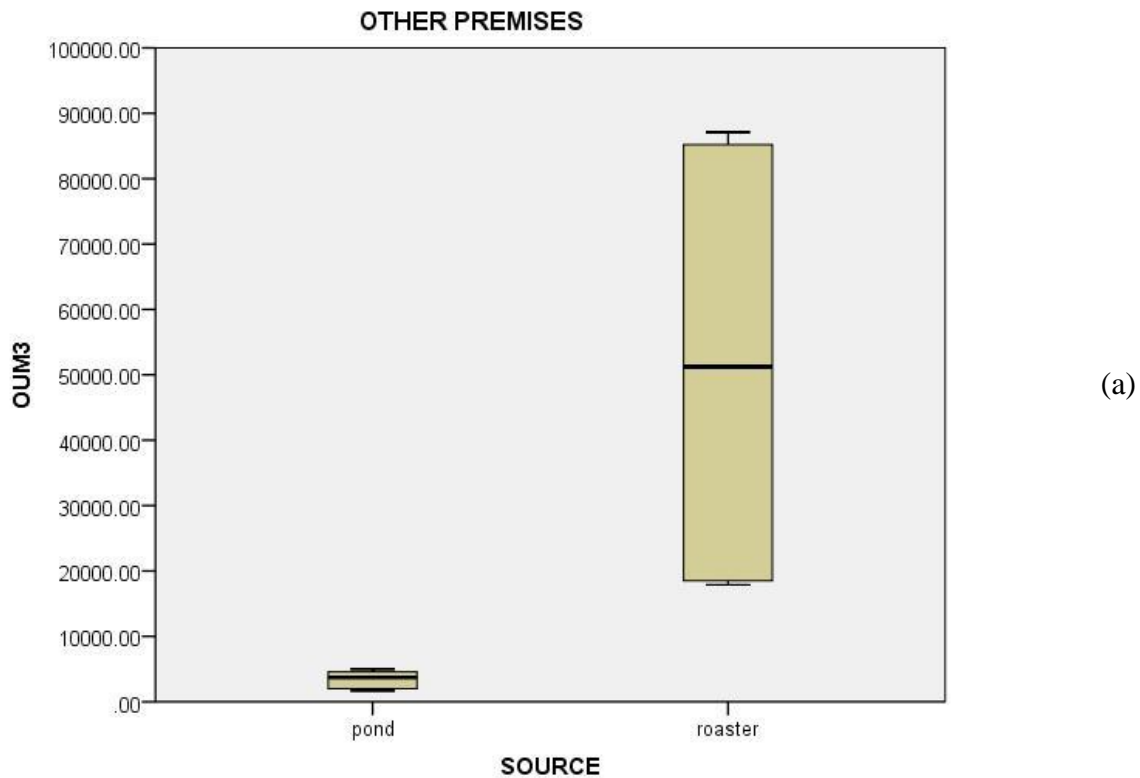


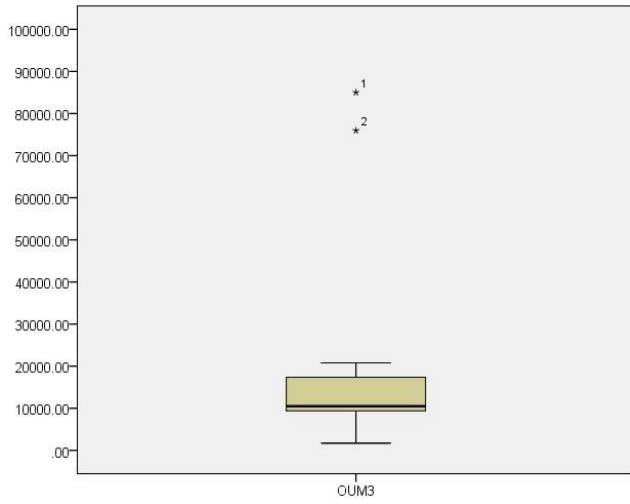
Figure 4.5 Odour concentration of emission from any other premises that emits or capable of emitting objectionable odour into atmosphere, assessed at the point of emission

4.3.2 Representative Odour Range of Each Industrial/Activity Category (Combined data)

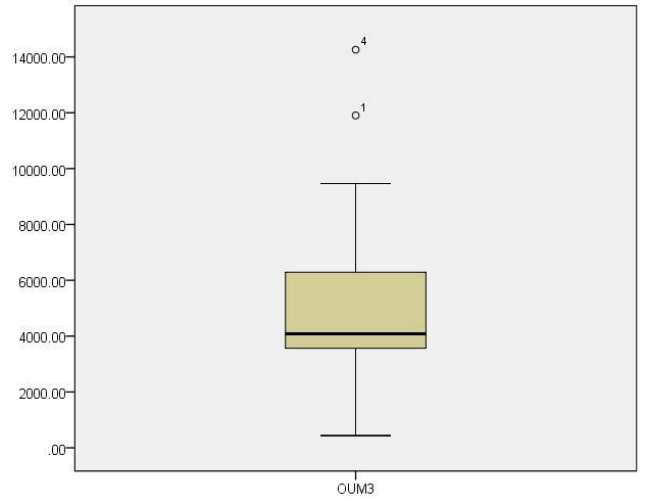
In general, the odour data for the seven industries/activities in Figure 4.2 – Figure 4.5, shows the tendency for the concentration to be widespread. The variability in odour measurement has been widely regarded by many environmental practitioners and researchers noting that “*emission rates varied considerably between points on individual ponds, between different ponds and between sample days for individual ponds in the same week, or between seasons. Variation in odour emission rates was evident for each pond during each sampling day, during each sampling week and during each season.*” (Hudson et al., 2007). Although many factors have been suggested to affect variability such as the physical design and shape of the source of emission e.g pond, timing of sample collection etc., no exact and proven factor can be scientifically tied to cause inconsistencies in the odour result.

To help us gauge the suitable odour limit value for each of the categories regardless of the different source of emission, all 134 odour data was compiled in their respective categories and presented in Figure 4.6 and gathered in Table 4.1.

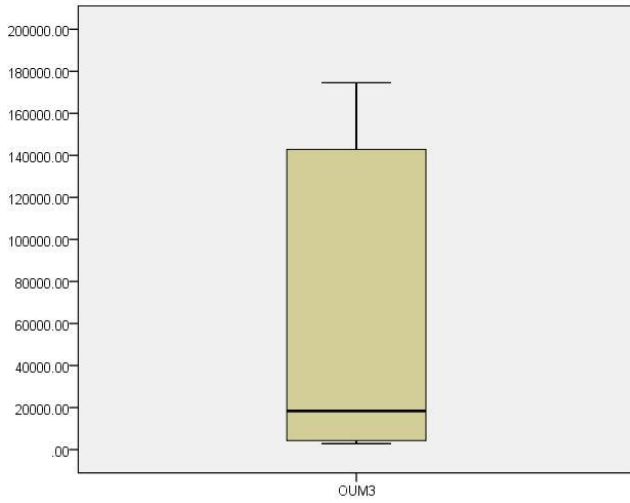
RUBBER INDUSTRY



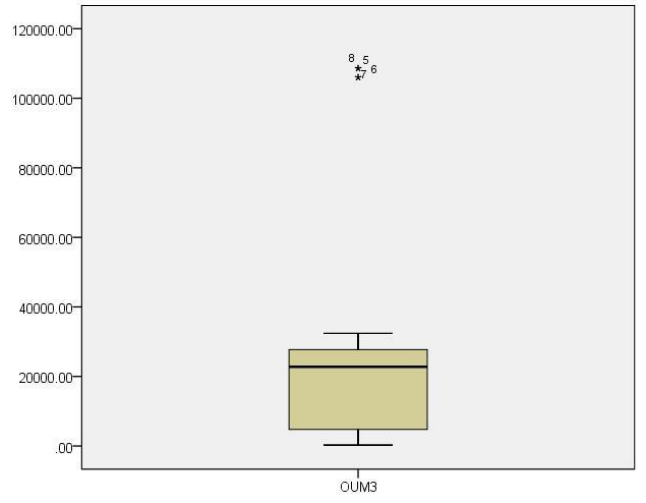
ANIMAL FARM/POULTRY FARM



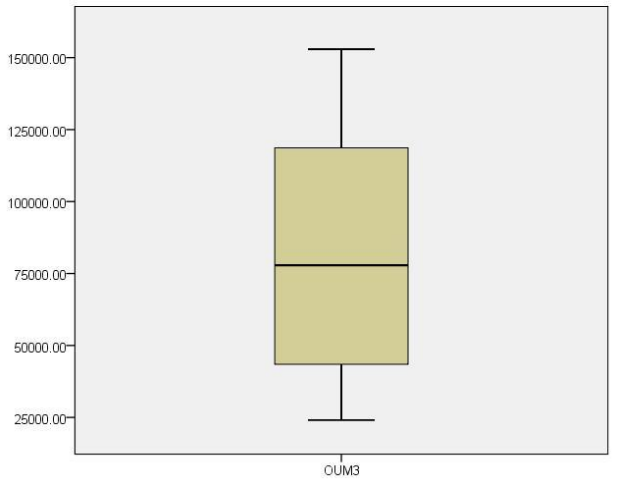
FISHMEAL/FEEDMILL PLANTS



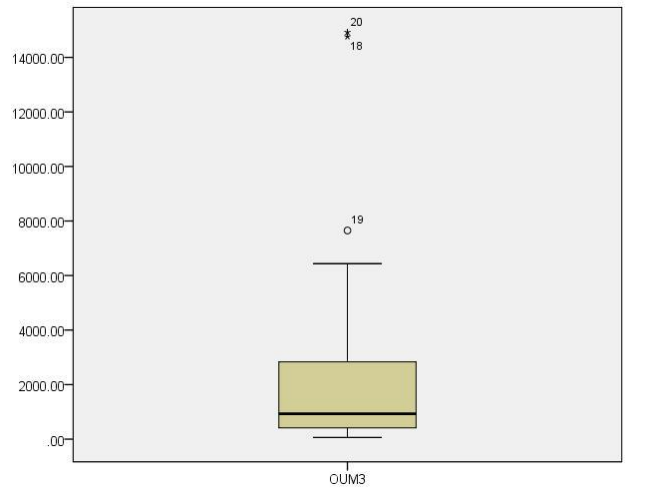
SOLID WASTE MANAGEMENT FACILITY



PALM OIL MILL



SEWERAGE SYSTEM



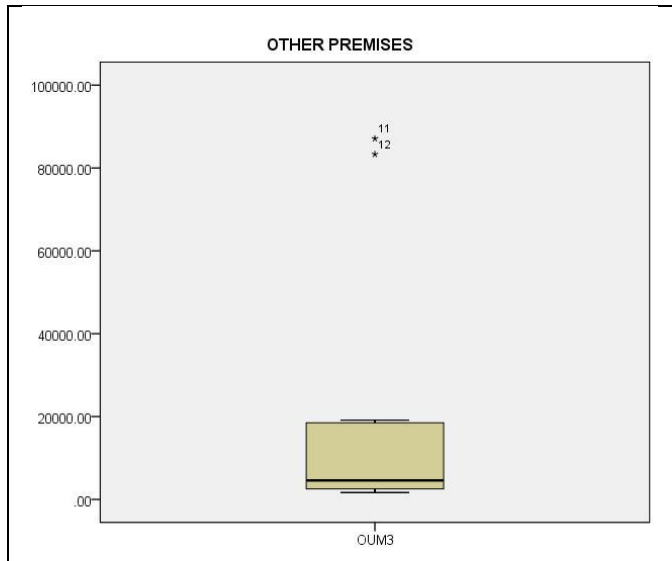


Figure 4.6 The odour concentration of all sources combined into one representation of odour emission for each industry/facility.

As can be seen in Table 4.1, the descriptive statistics of the box-and-whisker plot of Figure 4.6 is directly obtainable. In general, the mean values were always higher across all seven categories compared to the median values. This is because *mean* represents the average value of the data, whereas *median* is the “middle” value in a list of data when it is organized in an ascending or descending order. In the case of odour data, where variability is often the case, thus data is more skewed, median values would be more suitable as it takes into consideration frequent data and are not affected by outliers.

Table 4.1 Descriptive statistics and interquartile percentiles of all data for each seven categories

Industry/Activity	n	MIN	MAX	MEAN	PERCENTILES		
					25	50 (MEDIAN)	75
OU/M3							
Raw natural rubber industry	12	1726	85012	21860	9343	10494	19073
Fishmeal/Feedmill Plant	14	2840	174580	55950	4206	18394	148904
Palm Oil Mill	12	24070	152936	81385	41774	77851	120414
Animal Farm/Poultry Farm	14	438	14258	5266	3336	4084	7081
Solid Waste Management Facility	30	257	108581	28372	4627	22789	28202
Sewerage System	40	60	14924	2278	410	931	2937
Other Premises	12	1669	87087	19557	2409	4578	18824

Note: n = no. of data

4.4 BOUNDARY AND NEARBY RESIDENCES ODOUR DATA

Investigations of odour problems should be made at a place where the adverse effect is being felt, which in some cases will be some distance beyond the boundary of the offending activity and not necessarily at the boundary. Odour is a sensation that is caused by breathing in odourous contaminants. Typically, most odourous air contaminants carry low levels of odourants, thus are more of a nuisance than a health hazard. In some cases, the high odour concentration generated at the sources, are rarely detected at the boundary or nearby residences due to the dispersion and dilution mechanism that reduces odour as it travels away from the source of emission. The data shown in Table 4.2 demonstrates the odour concentration measured at the boundary of the industry/activity and nearby residences.

Table 4.2 Odour at the industries’/facilities’ boundary and nearby residential area summarized from data in Section 3.5.

INDUSTRY	BOUNDARY		RESIDENTIAL			OVERALL RANGE
	Odour (OU/M ³)	Detection Frequency	Odour (OU/M ³)	Detection Frequency	Distance Residential to Industry	Odour (OU/M ³)
Raw natural rubber industry	80	1 of 12 (8%)	8.5	1 of 12 (8%)	500 m, W	7.1 – 80.0
	14	1 of 12 (8%)	16.5	1 of 12 (8%)	500 m	
	9.1	1 of 12 (8%)	7.1	1 of 12 (8%)	430 m, NW	
Fishmeal/feedmill plant			0	3 of 12 (25%)	500 m, E 500 m, NW 500 m SW	0
Palm oil mill	5.6	1 of 7 (14%)	0	4 of 7 (57%)	1500 m, SE	0 - 5.6
	4.1	1 of 7 (14%)			1500 m, NE	
	3.8	1 of 7 (14%)			1100 m, SW 2000 m, NW	
Animal farm/poultry farm	0	2 of 12 (17%)	0	5 of 12 (42%)	500 m, SW	0 - <3.5
	<3.5	1 of 12 (8%)			500 m, E 1200 m, E 1200 m, SE 800 m, NW 500 m, W	
Solid waste management facility	<3.5	1 of 27 (4%)	<3.5	3 of 27 (11%)	900 m, NE	0 – 69.8
	0	1 of 27 (4%)	0	19 of 27 (70%)	1800 m, NW	
	34.9	1 of 27 (4%)			1500 m, SW	
	5.9	1 of 27 (4%)	36 m, N			
	19.9	1 of 27 (4%)	46 m, SW			
	11.5	1 of 27 (4%)	1100 m, SW			
	8.7	1 of 27 (4%)	1500 m, SW			
	69.8	1 of 27 (4%)				

	4.1 8.8	1 of 27 (4%) 1 of 27 (4%)			1500 m, SE 2270 m, S 988 m 500 m, SW 500 m, NE 1100 m, SW 1100 m, SW 1500 m, SW	
			3.9 6.9 5.6			
				1 of 27 (4%) 1 of 27 (4%) 1 of 27 (4%)		
Sewerage system	0 4.5 5.0 3.5 5.4	4 of 30 (13%) 1 of 30 (3%) 1 of 30 (3%) 1 of 30 (3%) 1 of 30 (3%)	0	22 of 30 (73%)	500 m, SW 500 m, NW 150 m, W 150 m, S 1500 m, SW 1500 m, SE 150 m, NE 170 m, NW 150 m, E 145 m, W	0 – 5.4
Other premises						
- Coffee manufacturing	3.9 0	1 of 12 (8%) 1 of 12 (8%)	0	3 of 12 (25%)	500 m, W 500 m, N 480 m, E 490 m, W	0 – 3.9
- Poultry processing			3.5	1 of 12 (8%)		
- Poultry processing			0	3 of 12 (25%)	500 m, E 660 m, W	
- Edible oil processing	0	1 of 12 (8%)	0	2 of 12 (17%)	500 m, S 500 m, N	

4.5 PROPOSED ODOUR LIMIT VALUE FOR POINT OF EMISSION AND BOUNDARY

The identification of limit value that is representative of each category proved to be challenging as each industry/activity comprised of numerous emission sources that emits varying degrees of malodour. For example, referring to Section 4.3.1, solid waste management facility emitted a reasonable odour from the digestate (4489 OU/m³) and waste piles (5780 OU/m³) and at the same time, emitted a strong odour of 26,000 OU/m³ from the leachate treatment pond. Thus, careful consideration must be given in selecting a limit value that is representative across the board for the different waste treatment facilities as well as their varying emission sources.

Table 4.3 presents the proposed odour limit as a result of the sampling activities. Over 243 data comprising of 134 samples at the point of emission and 109 boundary readings, were gathered in this study for the purpose of establishing limit values. The limit value was established based on the following considerations:

- (i) the median values of odour without treatment based on data presented in Section 4.3.1 and 4.3.2;
- (ii) values if odour treatment is in place (about 50% removal efficiency of values identified in step (i)); and
- (iii) to retain the values in the draft regulation (Section 1.3) for limits having lesser values; and
- (iv) the ability of the current data (Section 3.2.1 and Section 3.5) to meet the proposed value.

All in all, the spirit of the proposed limit is to encourage the management of odour, whereby the values suggested are limits imposed after the implementation of odour control measures. The limits should also not be a burden, rather of more a realistic approach that is achievable by the affected industries, either through proper housekeeping or with the addition of suitable technologies.

Table 4.3 Proposed odour limit value at point of emission and boundary as a result of data collection in this study

Industry/Activity Category	POINT OF EMISSION (OU/m³)	BOUNDARY (OU/m³)
Raw natural rubber industry	35,000	15
*Fishmeal/Feedmill Plant	12,000	15
Palm Oil Mill	35,000	15
Animal Farm/Poultry Farm	7,000	15
Solid Waste Management Facility	13,000	15
*Sewerage System	1200	15
Other Premises	2500	15

Note: *the values proposed are status quo as per previous draft odour regulation

When the proposed point of emission limits in Table 4.3 are compared to odour data compiled in Chapter 2 as well as the secondary data in Appendices, the following compliance is achievable by the respective industries/activities:

- Raw natural rubber industry : 10 of 12 data, 83%
167 of 448 data, 37% (secondary data, refer Appendix 2)
- Fishmeal/Feedmill Plant : 5 of 14 data, 36%
- Palm Oil Mill : 2 of 14 data, 14%
30 of 100 data, 30% (secondary data, refer Appendix 3)
- Animal Farm/Poultry Farm : 11 of 14 data, 79%
14 of 14 data, 100% (secondary data, refer Appendix 4)
- Solid Waste Management Facility : 10 of 30 data, 33%
- Sewerage System : 22 of 40 data, 55%
- Other Premises : 3 of 12 data, 25%

It can be seen that generally, the point of emission values proposed in this study can be reasonably achieved by the respective industries. For some, further efforts need to be put in place to better manage their odourous emissions.

In terms of the boundary values, 15 OU/m³ is proposed as the limit that is applicable across all types of industrial/activity categories. A fence line/residential limit ranging from 1 – 20 OU has been regulated in certain localities, mostly in the US including San Francisco, Colorado, Connecticut, North Dakota, Oregon and Philadelphia (refer Section 6.3). Considering our higher tolerance to environmental odour probably owing to our Asian culture, food and lifestyle, a higher limit of 15 OU/m³ is thus proposed. This same limit is also being regulated in Thailand (15) and Korea (15 D/T) for fence area located outside of industrial zones (refer Section 6.3). It is defined that 10 OU/M³ is a distinct odour and that normal background odours e.g. traffic, vegetation, grass mowings etc, can provide background odour concentrations from 5 to 60 OU/M³ or more (DEFRA, 2010). At 10 OU/m³, complaints are highly likely and odour exposure at these levels represents an actionable nuisance (CIWEM, 2012).

As can be seen by the boundary data presented in Table 4.2, a majority of the boundary and residential locations nearby the industries/activities were able to meet the required 15 OU/m³ limit, except for a few instances of non-compliance. The exceedance of the proposed boundary limit of 15 OU/m³ is mostly a concern with the raw natural rubber industry recording a range of 7.1 - 80.0 OU/m³ odour range as well as the solid waste management facility with 0 – 69.8 OU/m³ odour range, although not all the time.

There is a wide ranging concept of odour regulations currently practiced worldwide as described in Section 6.3. However, a vast majority of international regulatory framework relies on odour impact criteria (maximum impact standard) based on time series of ambient air odour concentration calculated by dispersion models. As shown in Table 4.4, only China and South Korea regulates odour at the source of emission, based on stack height or the location of the odour source, respectively.

Table 4.4 shows the comparison of the proposed limit value at point of emission against limits already enforced elsewhere as odour legislation

Industry/Activity Category	POINT OF EMISSION	POINT OF EMISSION	METHOD OF ASSESSMENT	REFERENCE
	(OU/m ³) Proposed	(OU/m ³) Literature		
Raw natural rubber industry	35,000	China: Source height > 15 m: The stack height and maximum emission rate, respectively:	Dimensionless. Triangular odour bag method	Brancher et al., 2017
Fishmeal/Feedmill Plant	12,000	15 m: 2000;		
Palm Oil Mill	35,000	25 m: 6000;		
Animal Farm/Poultry Farm	7,000	35 m: 15,000; 40 m: 20,000; 50 m: 40,000;		
		>60 m: 60,000		
Solid Waste Management Facility	13,000	South Korea: Outlets including stack:	Triangular odour bag method	Brancher et al., 2017
Sewerage System	1200	Facilities in industrial areas: 1000 D/T;		
Other Premises	2500	Facilities in other areas: 500 D/T.		

On the other hand, the assessment of odour at the boundary is more accepted in countries such as the US, Panama, China, South Korea and Taiwan as shown in Table 4.5. Odour at the boundary was measured using an infield olfactometer such as Scentometer as well as the Triangular Odour Bag method. As can be seen, the values proposed by this study is well in agreement with the odour limits regulated in these countries.

Table 4.5 shows the comparison of the proposed limit value at boundary against limits already enforced elsewhere as odour legislation

Industry/Activity Category	BOUNDARY (OU/m³) Proposed	BOUNDARY (OU/m³) Literature	METHOD OF ASSESSMENT	REFERENCE
Raw natural rubber industry	15	Colorado: 7 D/T in urban areas/ 15 D/T in rural areas For Swine Operations: 7 D/T at property line 2 D/T at receptor location (residence or location of complainant)	Scentometer*	SRF Consulting Group, Inc., 2004
Fishmeal/Feedmill Plant	15	Missouri: 7 D/T Wyoming: 7 D/T		
Palm Oil Mill	15	San Francisco: 5 D/T at fence line	Applied after at least 10 complaints within a 90-day period	Brancher et al., 2017

Animal Farm/Poultry Farm	15	<p>Panama: Residential or commercial: 15 D/T at the fence line and 7 D/T at the receptor; Industrial or rural: 30 D/T at the fence line and 15 D/T at the receptor</p>	Field olfactometry. The measurement times at each point should not be less than 5 min.	Brancher et al., 2017
Solid Waste Management Facility	15	<p>China: Source height < 15 m: Class 1: 10; Class 2: 20 for new, extension/rebuilt and 30 for existing facilities; Class 3: 60 for new, extension/rebuilt and 70 for existing facilities.</p>	Triangular odour bag method	Brancher et al., 2017
Sewerage System	15	<p>South Korea: Facilities in industrial areas: 20 D/T; Facilities in other areas: 15 D/T.</p>	Triangular odour bag method	Brancher et al., 2017
Other Premises	15	<p>Taiwan: 50 D/T in industrial and agricultural regions; 10 D/T in residential areas.</p>	Triangular odour bag method	Brancher et al., 2017

Note: *Scentometer is a field olfactometer which creates a series of dilutions (dilution factors) by mixing odourous ambient air with odour-free (carbon-filtered) air; the practice known as the Dilution-to-Threshold (D/T) standard field olfactometer method.

CHAPTER 5:

OUTPUT 3: ACTION PLAN FOR REDUCING ODOUR POLLUTION, IMPLEMENTATION MEASURES FOR IMPROVING THE AIR QUALITY ESPECIALLY IN AREAS OFTEN AFFECTED BY THIS ISSUE, INCLUDING THE FEASIBILITY OF DEVELOPING LEGISLATION REGARDING ODOUR POLLUTION AND GUIDELINE FOR ODOUR POLLUTION CONTROL

5.1 INTRODUCTION

To prevent or minimize odourous effects, a systematic approach towards an extensive odour management is required. Such aspiration can be achieved through the adoption of an odour action plan that is to be undertaken to manage odour and its nuisance impact which may arise from processing and other site activities. This action plan defines a clear pathway for the resolution of odour nuisance outlining a series of steps starting with odour and source assessment and ending with the measures to prevent, contain and minimise odourous emissions. This plan of action (refer Figure 5.1) should allow all stakeholders to appreciate that the choice of control measures proposed for a specific site has been arrived in a way that is both technically and economically justifiable. The target is that by 2022, we should be able through the establishment of legislation and guidelines, reduce odour pollution as well as improve air quality of areas affected by odour issues.

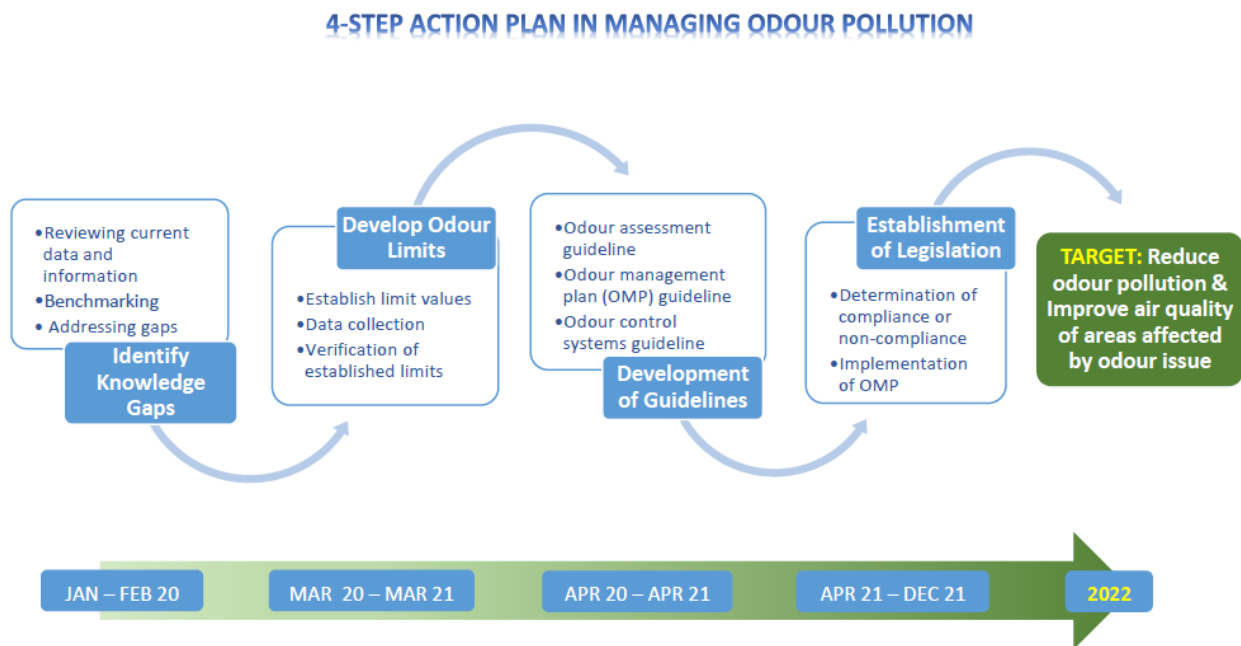


Figure 5.1 Proposed action plan for a systematic approach in reducing environmental odour and its impact

5.2 ACTION 1: IDENTIFY KNOWLEDGE GAPS

For Action 1, the following activities are to be undertaken; (i) reviewing of current data and information, (ii) benchmarking, and (iii) addressing gaps. The proposed duration to achieve Action 1 is two months, between early January 2020 until end February 2020.

The following are some of the questions and issues that may affect the limit values and thus should be addressed in a continuing study:

Limit Values

- 1- Should chemical substances be included as a limit value (less prone to subjectivity of odour measurement)?
- 2- Should the determination of odour annoyance (e.g. using Odour Rating (OR) = $\frac{((\text{Frequency} \times \text{Complaints}) \times \text{Sensitivity})}{\text{Radius}} \times \frac{(\text{Intensity})}{\text{Radius}}$ (SEPA, 2010)) whereby boundary or nearby residences be taken into account?
- 3- Should limit values take into consideration the air flow rate of point sources and area sizes of areas sources?

Odour treatment systems

- 1- What are the options and how effective are they in reducing odour?

Odour assessment

- 1- No. of samples, its frequency and timing of sample collection
- 2- Sampling location, what is the basis of its selection? Is a preliminary assessment required to first evaluate all emission sources, before arriving at the specific emission for regular monitoring?

In order to address the gaps in knowledge highlighted above and gain further information, the following means of data collection can be implemented:

- 1- Desktop study
- 2- Survey to various stakeholders
- 3- Site visits
- 4- Field and/or experimental data collection.

5.3 ACTION 2: DEVELOP ODOUR LIMITS

For Action 2, the suggested activities include; (i) establish limit values, (ii) data collection, and (iii) verification of established limits. The proposed timeline to realize Action 1 is twelve months, between early March 2020 until end March 2021.

Setting emission limit value that defines specific quantitative limit for odourous industries and activities is a move towards minimizing emission of pollutants and to ensure that pollution or nuisance through odour cannot occur. The inclusion of specific emission limit value can either

restricts the release of specific substances and/or mixtures of odour, verified either at the point of emission or at the receptors/boundary as well.

It has to be remembered that the measurement of odour can be difficult. Most odours are mixtures of compounds and a knowledge of the chemical species present rarely gives any indication of the human response to a mixture. The biggest advantage of olfactometry techniques is that they provide a direct link between the odour and human perception. The disadvantages are that it is necessarily labour intensive and not continuous. Whether the development of limit values are based solely on sensory analysis or with the supplementation of chemical compounds, the key is to set a criteria that is able to profile the extent of the odour emission and nuisance to the nearby community.

As emission limit values defines maximum allowed values for emissions to air, and constitute guiding or legally binding values for industries, a robust justification of the limit's derivation becomes important. There lies a need for a large compilation of odour datasets being the strong foundation underpinning the establishment of the odour exposure limit values. More importantly, the proposed limit values should also undergo sufficient verification stages looking at many aspects of its implementation including its practicality and effectiveness before finally legalizing its execution.

5.4 ACTION 3: DEVELOPMENT OF GUIDELINES

The development of guidelines is planned for Action 3 pertaining to documentation on (i) odour assessment, (ii) odour management plan, and (iii) odour control systems. It is predicted that the development of these guidelines will take twelve months to complete, beginning early April 2020 until end April 2021.

5.4.1 Guideline on odour assessment

This guideline would provide advice on the different methodologies for qualitative and quantitative assessment of odour and indicate the appropriate use of each in order to bring about consistency of approach.

5.4.2 Odour Management Plan

OMPs are described in a number of guidance documents from the United Kingdom “*Guidance on the assessment of odour for planning*” (Bull, 2018) and New Zealand “*Good Practice Guide for Assessing and Managing Odour*” (Ministry for the Environment, 2016) among others.

Developing the odour management plan involves a process of describing the site and its general management, identifying the sources of odour at site by including the description of the whole process and its waste activities, as well as its surrounding areas such as the odour pathway and receptors characterisation. Consideration must be given to the distance between the site under investigation and the neighbours, prevailing wind directions, and the mostly affected community. The obtained information would provide sufficient data for the selection of the most suitable odour

control solution for the facility's needs. Because all odour issues and control are thought through beforehand in a holistic and systematic manner, odour incidences and possible crisis management are diverted, instead, is a well-planned execution. A guideline on a standard odour management plan is proposed to provide guidance on the content and style of odour management plans for controlling odour emissions from industrial sites.

5.4.3 Guideline on Odour Control Systems

In general, each of the industrial sources of odours differs both in terms of emitted odourant types and their amount. The amount of odours emission from production operations depends on a number of factors and remedies used to prevent odour nuisance. Industrial facilities are often located in the immediate vicinity of residential areas; therefore, it is necessary to use appropriate techniques to prevent odour emissions into the atmosphere. Among the techniques allowing for the elimination of odourous pollution, the following techniques can be distinguished: combustion, adsorption, absorption, biological methods or deodourization. The use of an appropriate deodourization system allows for effective reduction of the odour emissions of the facility, as well as to improve the quality of life of the local residents.

Figure 5.2 shows some the odour control systems that was observed at several industries/activities which was visited during the odour sampling activities. These includes wet scrubbers, biofilters and self-made solutions using filters etc. The results in Chapter 3, indicated a varying odour removal efficiency for these technologies, which may be influenced by the age of the technology themselves, its maintenance and operation parameters.



Figure 5.2 (a) The biofilter at a sewerage pump station was emitting an average 158 OU/m³ from its treatment system.



(b) A self-made odour scrubbing and filtering system using a combination of chemicals (e.g. sulfuric acid) and rice husks, for treating odour from the chicken droppings storage. The system was inefficient as the odour actually increased by 25% resulting in an average 4017 OU/m³.



(c) The wet scrubber at a feedmill had a poor odour removal efficiency of 26%, which still emitted 3048 OU/m³ after undergoing treatment. This scrubber was feed with water extracted from the nearby river as part of the system operation.

Consideration of “end-of-pipe” odour control options was to include standard options as well as low cost options and innovative solutions to odour problems. The fundamental aim of odour control is to ensure that, where odourous substances are used or generated (ie where they cannot be avoided), they are controlled using a high level of containment, leading to well designed, maintained and operated abatement systems.

5.5 ACTION 4: ESTABLISHMENT OF LEGISLATION

The establishment of legislation on odour pollution is planned for Action 4, which includes activities on the (i) determination of compliance or non-compliance, and (ii) implementation of Odour Management Plan. The establishment of legislation builds from the outcomes gained from the previous actions (Action 1 – 3), and is predicted to progress within ten months, starting early April 2021 until end December 2021.

The general aim of an odour legislation is to ensure the activity is operated in such a manner that pollution is prevented or, if that is impossible, minimised. For activities with the potential to release odourous substances routine inspections and compliance assessment should be undertaken on a regular basis. Particular attention should be given during inspections to the techniques used to prevent or minimise the release of odourous substances, such as abatement equipment. The effectiveness of these odour control measures is to be checked for compliance against the set limit values and according to the proposed assessment guidelines.

When it is verified that the industry is non-compliant with the potential to generate odours, the provision for an odour management plan should be made compulsory. Odour management plan, essentially details all of the potential odour sources, any actions required to reduce or prevent these potential odour releases and, if there is an ongoing odour issue, the expected date of completion and the person responsible for rectifying the problem.

5.6 TARGET OF THE ACTION PLAN

The *4-Step Action Plan in Managing Odour Pollution* as shown in Figure 5.1 is built on the underlying spirit of achieving its set target on a systemic approach in managing environmental odour. The goal is that when the actions and activities are executed as plan, odour pollution can be reduced whilst also improving air quality of areas affected by odour issue.

CHAPTER 6:

OUTPUT 4: LITERATURE REVIEW COMPARING SAMPLING METHODS AND ODOUR POLLUTION LEGISLATION IN OTHER COUNTRIES

6.1 INTRODUCTION

There are several industrial, agricultural and domestic activities that can give rise to odours. A careful investigation of the odour issue requires odourous air measurement by applying standardized scientific methods. In general, the available techniques can be broken down into two different approaches: sensory and chemical techniques.

Instrumental approaches to the characterization of odourants are based on the evaluation of the odourous air chemical composition. Figure 6.1 shows data for single, pure compounds. The detection and recognition thresholds can change markedly from these levels if several odourants are present in a mixture and act synergistically to produce either a greater or lesser-perceived odour strength than their individual components.

For the analysis of odourous compounds, the air samples need to be collected for subsequent analysis using adsorbent tubes, metal canister or polymer bags. Proper sampling containers and procedure should be maintained to ensure the sample integrity, preserve the odour originally associated to the sample, minimize losses and chemical-physical interaction between odourants and the sampler medium. Gas Chromatography coupled with Mass Spectrometry (GC/MS) has been widely used to analyse air samples, in order to produce a list of substances involved and their concentration. However, the main limit of this technique relies on the complexity of the odour: the perceived odour results from many volatile chemicals, often at concentration lower than the instrumental detection limit, that may interact synergistically or additively. Furthermore, GC/MS instrumentation is expensive and does not give information about human perception, thus not allowing a linear correlation between a quantified substance and an olfactory stimulus.

For many years, the sensory evaluation of smells by means of panels of sensory trained evaluators has been the main odour assessment and quantification tool: the so-called dynamic olfactometry is the standardized method used for determining the concentration of odours and evaluating odour complaints. This methodology is based on the use of a dilution instrument, called olfactometer, which presents the odour sample diluted with odour-free air at precise ratios, to a panel of human

Compound name	Detection threshold, ppm (v/v)	Recognition threshold, ppm (v/v)	Odour description	Recognition : detection ratio
Acetaldehyde	0.067	0.21	Pungent, fruity	3.1
Allyl mercaptan	0.0001	0.0015	Disagreeable, garlic	15
Ammonia	17	37	Pungent, irritating	2.2
Benzyl mercaptan	0.0002	0.0026	Unpleasant, strong	13
<i>n</i> -Butyl amine	0.080	1.8	Sour, ammonia	22.5
Chlorine	0.080	0.31	Pungent, suffocating	3.9
Di-isopropyl amine	0.13	0.38	Fishy	2.9
Dimethyl sulfide	0.001	0.001	Decayed cabbage	1
Diphenyl sulfide	0.0001	0.0021	Unpleasant	21
Ethyl amine	0.27	1.7	Ammonia-like	6.3
Ethyl mercaptan	0.0003	0.001	Decayed cabbage	3.3
Hydrogen sulfide	0.0005	0.0047	Rotten eggs	9.4
Methyl mercaptan	0.0005	0.0010	Rotten cabbage	2
Phenyl mercaptan	0.0003	0.0015	Putrid, garlic	5
Propyl mercaptan	0.0005	0.020	Unpleasant	40
Pyridine	0.66	0.74	Pungent, irritating	1.1
Skatole	0.001	0.050	Faecal, nauseating	50
Sulphur dioxide	2.7	4.4	Pungent, irritating	1.6

Figure 6.1 Detection and recognition thresholds for some odourous compounds

assessors. The examiners are selected in compliance with a standardized procedure performed using reference gases; only assessors who meet predetermined repeatability and accuracy criteria are selected as panelists. The odour concentration, usually expressed in odour units (ou/m^3) is numerically equal to the dilution factor necessary to reach the odour threshold, that is the minimum concentration perceived by 50% of population. According to European standardization, $1 \text{ ou}/\text{m}^3$ is defined as the amount of odourant that, when evaporated into 1 m^3 of gas air at standard conditions, causes a physiological response from a panel (detection threshold) equivalent to that of *n*-butanol (reference gas) evaporated into 1 m^3 of neutral gas.

6.2 THE CONCEPT OF OLFACTOMETRY ASSESSMENT

Presently, international standards are in place, which dictate the scientific methods and practices of odour measurement. These international standard methods for quantifying odour are: objective, quantitative, dependable, and reproducible.

From ASTM International:

- ASTM E679-04: *Standard Practice for Determination of Odour and Taste Threshold by a Forced-Choice Ascending Concentration Series Method of Limits*
- ASTM E544-99(2004): *Standard Practice for Referencing Suprathreshold Odour intensity*

From the Comité Européen de Normalisation (CEN):

- EN13725:2003: *Air Quality – Determination of Odour Concentration by Dynamic Olfactometry*

In Malaysia, the Malaysian Standard MS 1963:2007 *Air quality – determination of odour concentration by dynamic olfactometry* applies and was developed by the Working Group on Odour Control and Treatment Systems under the authority of the Environmental Management Industry Standards Committee. This Malaysian Standard corresponds to EN 13725:2003 Air quality - Determination of odour concentration by dynamic olfactometry.

6.2.1 Delayed Olfactometry

Delayed olfactometry is the measurement of an odour with a time-lag between sampling and measurement (Belgiorno et al., 2012). Odourous air samples are collected from emission sources, stored in an appropriate container and sent to an odour laboratory for analysis using a dynamic olfactometer. Samples with high concentrations of potentially hazardous components may not be analysed where safety of the laboratory operator or panelist are potentially at risk.

Odour emission sources can be classified as (Capelli et al., 2013):

- a) Point Sources: Odour emission is generally in a controlled manner from a single point for example through a stack, vent or exhaust where sampling involves the extraction of a fraction of the conveyed air flow.
- b) Surface Sources: Surface source emissions typically come from extended solid or liquid surfaces and often classified into an active or passive sources. An active surface source have an outward air flow (e.g., biofilters or aerated heaps); while those without outward air flow are passive surface sources. With the latter, the mass flow from the solid or liquid surface to the air (volatilization) is due to phenomena such as equilibrium or convection (natural or forced) with examples include landfill surfaces and wastewater treatment tanks.

- c) **Volume Sources:** Volume sources are typically buildings from which odours emerge either intentionally through naturally ventilated ducts, or unintentionally through doors, windows or other openings.

Odour samples are collected from the point, area and volume sources using the ‘lung’ technique, whereby the sampling bag is placed inside a rigid container and the container evacuated using a vacuum pump in accordance to the MS 1963:2007. This technique prevents any contamination that may occur from the direct use of pumps in the sampling line.

6.2.2 *Field Olfactometry*

The assessment of odourous environments also includes the use of field olfactometer, which allow for in-situ determination of odour concentration. This technique incorporates a dilution device within a portable device, allowing direct measurements of odour concentration to be carried out in real time in the field, without the need for separate sampling and laboratory dilution stages.

Sensory field odour assessments using the in-field olfactometer are useful for the following conditions:

- a) **Area Inspection/Investigation** – possibly, to a planned schedule to assess environmental impact of odour. A single survey can only provide a subjective snapshot assessment of the impact of an odour at the test locations at a particular time and date. Therefore, for a representative assessment of the odour impact of an installation on the surrounding environment, repeat surveys must be carried out over a suitably representative period of time.
- b) **Reactive** - In response to a complaint. Regulators and site operators are making increasing use of Odour Complaint Hotlines together with a Complaints Response Procedure. The latter usually requires some form of follow-up of the complaint. Sensory field odour assessment by in-field olfactometer is suitable as a tool for following up odour complaints and tracking odour sources.
- c) In the US, state regulations often require boundary odour concentrations to be measured using portable field olfactometer.

Field olfactometer are designed for assessing the odour impact by recording some or all of the FIDOL factors, including odour strength (as concentration), the type of odour/hedonic tone, the hourly, daily and seasonal distribution of nuisance, and consideration of odour in the affected area. DEFRA UK states in its “Odour guidance for local authorities” that the most useful tool for Environmental Health Personnel assessing odours will be the on-site “olfactometry” test type assessment (ideally by two or more officers) at the complainants/receptors locations. In practice this is likely to be the main tool used by EHPs to corroborate, odour impact.

6.3 ODOUR REGULATIONS

Industries and facility owners have a responsibility to minimise the impact of their operations on the environment, and to avoid disturbing the quality of life and nuisance occurring in the vicinity of their production site. To assist regulatory agencies in managing odour issues, a number of countries have issued guidelines, regulations or even legislation in their efforts to apply a regulatory mechanism to odours from industries, facilities and activities that are prone to odour emissions. There are generally a number of different approaches commonly used in the different parts of the world to regulate odours, which can be basically categorized into 5 principles as follows:

- (i) The *use of concentration guidelines for specific chemicals*, expressed in typical mass/volume units, where the limits have been established based on odour thresholds rather than toxicological impacts. Typically, such odour limits are associated with compounds that are commonly associated with odorous impacts (e.g., ammonia, hydrogen sulphide, methyl mercaptans). The Japanese Offensive Odour Control Law (Law No. 91 of 1971 - Latest Amendment by Law No. 71 of 1995) for example specifies limits for 22 compounds including 0.02 – 0.2 ppm of hydrogen sulfide, 1 – 5 ppm ammonia etc. in addition to the 10 to 21 odour index limit (Higuchi et al., 2007).
- (ii) Offsite limits or guidelines *based on odour concentrations*, primarily in OU or equivalent units. As shown in Table 1, the magnitude of the specific odour concentration limit is highly variable between jurisdictions, with concentration ranging from as low as 0.5 to as high as 50 odour units and with averaging times that range from 1 s to 1 h. The values in Table 1 are obtained using two means; a dispersion model and also an in-field olfactometer device (e.g. Scentometer). Dispersion modelling input includes odour emission rates, given by the odour concentration multiplied by the volume flow rate of the source, and simulation of the topographic and meteorological data of the site to estimate the odour dilution in the surrounding environment. In-field olfactometer on the other hand involves the use of a portable olfactometer device that allows an “on-the-spot” measurement thus provides a near-instantaneous measure of odour pollution.
- (iii) *Best available control technology (BACT)* or similar approaches that specify required levels of odour treatment controls for new or upgraded large facilities.
- (iv) Fixed and variable *separation distances*. The American Society of Agricultural Engineering (ASAE) document Engineering Practice 379.1 “Control of Manure Odours” for example recommends setbacks from livestock facilities of 0.4 to 0.8 km for neighboring residences and 1.6 km to residential development (Mahin, 2003).
- (v) Jurisdictions which did not promulgate regulations with standardized odour methodologies and limit values commonly use the principles of *Nuisance Law* to fundament the management of odour episodes.

Looking specifically at regulations based on offsite limits, the Netherlands Emission Guidelines (Nederlandse Emissie Richtlijn), the so-called NeR (Van Harreveld, 2003) which was withdrawn in 2016, is one of few which imposed limits as source-specific according to industrial activities such as grass dryers, livestock feed industry, bakeries and pastry, slaughterhouses, meat processing, cocoa beans processing industry, coffee roasters, breweries, asphalt mixing plants, composting of green waste and composting of organic waste. The odour concentration threshold varied from $0.5 \text{ ou}_E \text{ m}^{-3}$ to $25 \text{ ou}_E \text{ m}^{-3}$ and the percentiles from 98th to 99.99th. Other jurisdictions which regulates odour as source specific includes Colombia under the Resolution 1541:2013, and Flanders, Belgium which specifies limits of 0.5 se m^{-3} – 5 se m^{-3} for facilities such as asphalt mixing plants, slaughterhouse, biscuit factory, cocoa bean processing plants etc. (Brancher et al., 2017).

Table 6.1 Examples of odour concentration (OU) limits or guidelines used in various jurisdictions throughout the world (Nicell, 2009).

Location	Odour limit (OU or equivalent)	Averaging time @ compliance frequency ^a
Bay Area Air Quality District (San Francisco, USA)	5 (fence line)	Applied after at least 10 complaints within a 90 day period
Colorado (USA)	7 (residential or commercial)	Scentometer ^b
Connecticut (USA)	7	Scentometer ^b
Denmark	0.6–1.2	1 h @ 99%
	5–10	1 min @ 99%
Hong Kong	5	5 s
Massachusetts (USA)	5	1 h
Netherlands	0.5 (sensitive receptors)	1 h @ 99.5%—for new facilities 1 h @ 98.0%—for existing facilities
Newbiggin-by-the-Sea and Derby WWTP (UK)	5	Not specified @ 98% compliance
New Jersey (USA)	5	5 min or less
New South Wales (AU)	2 (urban)	1 s @ 99.5%
	7 (rural)	1 s @ 99.5%
	15 (area source)	1 s @ 99.5%
New Zealand	2	1 h @ 99.5%
North Dakota (USA)	2	Scentometer ^b
Oregon (USA)	1–2	15 min
Philadelphia (USA)	20 (residential)	<100 h/yr non-compliance)—wastewater treatment plant

There also jurisdictions that sets maximum emission limits, some applied at the source of emission, and others at the boundary and receptors. Manitoba Conservation under its Environment Act (Loi Sur L'environnement, c. E125 de la C.P.L.M.), restricts 2 ou for residential areas and 7 ou for industrial zones. The Draft Standard for Control of Nuisance Odours in Panama, requires that for area sources, measurements at the fence boundary of the installation to be 15 D/T for residential or commercial and 30 D/T for Industrial or rural, whereas for point sources, odour-emitting facilities must comply both limits set at the fence boundary of the facility, as well as the limit at the receptor (Brancher et al., 2017). China and South Korea seems to be the only jurisdictions that imposes maximum emission limits at the source of emission. For emission limits in China, odour criteria are set according to the stack height and maximum emission rate, respectively: 15 m: 2000; 25 m: 6000; 35 m: 15,000; 40 m: 20,000; 50 m: 40,000; 60 m: 60,000. South Korea imposes a maximum emission standard (outlets including stack) for facilities in industrial areas as 1000 D/T and facilities in other areas as 500 D/T (Brancher et al., 2017).

Unlike noise which is also a nuisance concern, there are no “simple” instruments which can be used to accurately measure odours in the field. Currently, successful legislations use a combination of approaches with different tools and methods to address odour issues. The utilization of several tools are necessary to give a reliable portrayal of an odour impact from an industry given that each tools have different strengths and limitations. Therefore, this project intends to explore the applicability of using multiple methods and integrated tools strategy for odour assessment and regulation. Portrayal of an odour impact from an industry are certainly stronger when multiple lines of convergent evidence support each other. For instance, field inspection data supports complaints data which are inside calculated separation distances, and poor levels of technology are present at the industry. This example demonstrates that an integrated strategy consisting of multi-tools is much stronger than any individual tool by itself.

6.4 PERMISSIBLE ODOUR LIMITS IN ASIA

In Japan, the Offensive Odour Control Law (Law No. 91 of 1971 - Latest Amendment by Law No. 71 of 1995) (MOE, 2003) regulates odour based on the concentration of offensive odour substances or odour index. Odourous emissions of all kinds of industries and facilities are monitored at the fence line, the stack emissions as well as the liquid effluent outlets. Odour Index associated with an odour intensity scale ranging from 2.5 to 3.5 (equivalent to 10-21 Odour Index) is deemed acceptable at the site boundary, while a range of maximum concentrations permitted at ground-level on the fence line of a facility is provided for 22 specified offensive odour substances. The odour concentration is measured using the Japanese triangular odour bag method, where odour panelists measures odour which is diluted until odour can no longer be detected. A 5-point intensity scale from from 0 (no odour) to 5 (very strong) is used.

China also regulates its odour emissions based on two measurements, the odourous pollutants and odour. The Emission standards for odour pollutants (National standard GB 14554-93) was enforced on 15 January 1994 (MEP, 2016) to manage odour events in China. The Standard specifies the maximum allowable limits at one-time emission of 8 odour pollutants, the odour concentration limit complex odour substances, and the factory concentration limit at boundary of fugitive emission sources. Here, odour is considered dimensionless and is measured using the Japanese triangular odour bag method. The emission limits for 8 odourous pollutants (ammonia, trimethylamine, hydrogen sulfide, methyl mercaptan, dimethyl sulfide, dimethyl disulfide, carbon disulfide and styrene) are imposed according to stack height including odour. For example, the following odour limits are applied according to the stack heights including:

- 15 m: 2000;
- 25 m: 6000;
- 35 m: 15,000;
- 40 m: 20,000;
- 50 m: 40,000; and
- 60 m: 60,000.

South Korea is also another Asian country that adopts the Japanese's Triangle Bag Method in the determination of environmental odour, although being renamed as air dilution sensory (ADS) test (KMOE, 2008). Similar to Japan and China, South Korea too regulates both odour concentration and the chemical analysis of 22 odourous compounds. These chemical compounds and odour should be measured at critical off-site and emission points. Under the Malodour Prevention Law (KMOE, 2008) odour at the sources (emission limits) or other surrounding areas (immission limits), are controlled as follows:

Maximum emission standard (outlets including stack):

- Facilities in industrial areas: 1000 D/T;
- Facilities in other areas: 500 D/T.

Maximum impact standard (boundaries of facilities including enclosures):

- Facilities in industrial areas: 20 D/T;
- Facilities in other areas: 15 D/T.

Thailand under the Ministerial Regulation Standard and Measurement Method of Odour Emission from factory B.E. 2548 (2005) covers 23 types of factory emissions such as Item No. 1- Factories engaged in business related to curing tea and tobacco and Item No. 14 - Distilleries of liquor blending houses. The Standard specifies that odour concentration is to be determined at the fence area/within premise and at the factory air vent. Methods of testing should follow the American Society for Testing and Materials (ASTM), Japanese Industrial Standard (JIS) or others prescribed by the Government. An industrial odour emission should not have a concentration exceeding the prescribed value as:

- 30 for fence area/within premise & 1,000 for factory air vent for factories location in industrial zone; and
- 15 for fence area/within premise & 300 for factory air vent for factories location off the industrial zone.

Other Asian countries including Singapore, Brunei and Vietnam is not known to have an odour policy in place, nor any odour emission limits criteria.

CHAPTER 7: CONCLUSIONS

7.1 SUMMARY OF CONCLUSIONS

The growing concern for human and environmental wellbeing, along with the increasing air pollution complaints submitted to regulators and government bodies, has promoted the necessity for effective odour impact assessment and consequent odour emission regulation. On the basis of the issues explored in this report the following conclusions are drawn:

OUTPUT 1: SET OF SAMPLING DATA CONDUCTED AT SEVERAL SELECTED LOCATIONS

A total of 32 locations were visited for the seven categories of industries or activities stated in the project's Term of References. These locations were:

- Raw natural rubber industry, 3 sites
- Fishmeal/feedmill plant, 4 sites
- Pam oil mill, 3 sites
- Animal farm/poultry farm, 4 sites
- Solid waste management facility, 6 sites
- Sewerage system, 8 sites
- Any other premises, 4 sites

Overall, 243 odour data was obtained with 134 data covering the at-source emission and another 109 data for boundary data.

OUTPUT 2: SUITABLE LIMIT VALUES FOR SOURCE ODOUR EMISSION FROM IDENTIFIED IN INDUSTRY AND ACTIVITY

- A box and whisker plot useful in presenting the data as it helps to show the shape of the distribution, its central value, and its variability.
- The variability in odour measurement is well known among odour consultants, although the exact factor is yet to be determined.
- The proposed limit values obtained in this study is based on a limited number of samples for each industrial/activities category. Further data collection is highly recommended before these proposed values can be reviewed and considered for possible implementation.

OUTPUT 2: SUITABLE LIMIT VALUES FOR SOURCE ODOUR EMISSION IDENTIFIED IN INDUSTRY AND ACTIVITY

Proposed odour limit value at point of emission and boundary as a result of data collection in this study

Industry/Activity Category	POINT OF EMISSION (OU/m³)	BOUNDARY (OU/m³)
Raw natural rubber industry	35,000	15
*Fishmeal/Feedmill Plant	12,000	15
Palm Oil Mill	35,000	15
Animal Farm/Poultry Farm	7,000	15
Solid Waste Management Facility	13,000	15
*Sewerage System	1200	15
Other Premises	2500	15

Note: *the values proposed are status quo as per previous draft odour regulation

OUTPUT 3: ACTION PLAN FOR REDUCING ODOUR POLLUTION, IMPLEMENTATION MEASURES FOR IMPROVING THE AIR QUALITY ESPECIALLY IN AREAS OFTEN AFFECTED BY THIS ISSUE, INCLUDING THE FEASIBILITY OF DEVELOPING LEGISLATION REGARDING ODOUR POLLUTION AND GUIDELINE FOR ODOUR POLLUTION CONTROL

- The *4-Step Action Plan in Odour Management* is a plan of action that starts with developing the options to minimise odour impacts and ends with the resolution of the problem.
- Guidelines are required to promote consistent practice among site operators, environmental management consultants, and regulators in Malaysia. Industries have expressed concerns about the uncertainty surrounding current odour assessment practices and their ability to plan for the future. Guidelines attempts to address these concerns by providing clear direction in the use of odour assessment tools and odour control systems. The resulting evaluation and the information gained will be translated in clear reporting through odour management plans.

OUTPUT 4: LITERATURE REVIEW COMPARING SAMPLING METHODS AND ODOUR POLLUTION LEGISLATION IN OTHER COUNTRIES

- Odour, being a subjective parameter, must be monitored and assessed with reference to an established standard such as the MS1963 2007. Odour emission measurements including methods used for odour sampling and sample testing should be undertaken in accordance to the standard.
- This project recommends the utilization of multiple tools and methods for odour assessment and regulation to give a reliable portrayal of an odour impact from an industry given that each tools have different strengths and limitations. Portrayal of an odour impact from an industry are certainly stronger when multiple lines of convergent evidence support each other. For instance, field inspection data supports complaints data which are substantiated by odour data at the point of emission, and poor levels of technology present at the industry.

7.2 RECOMMENDATIONS FOR FURTHER STUDY

The initially stated overarching aim of this research was to establish suitable odour limit values from selected industries/activities and propose the required legislative and guideline requirements for control of odour pollution. In terms of the two objectives, we have come up with a suggestion of the odour limits encompassing point of emission and boundary values of seven categories of industries/activities (Objective 1). As intended, an action plan is also proposed as documented plan to progress the development of guidelines and subsequent odour regulation as a step towards reducing odour pollution (Objective 2).

This study also acknowledges a dire limitation in sample size for each category which would have otherwise improved the outcome of the objectives. It would have been ideal that at least 5-10% of the total number of each industry/activity were assessed, in order to obtain a more representative value. For example, at least 300 sewerage treatment plants (STPs) from over 6000 STPs in Malaysia, or a minimum of 20 palm oil mills from over 400 mills here. Unfortunately, a large number of sampling locations, would require more funding as well as a longer project duration, one which we have no such liberty.

We have also recognized there remains many unanswered questions such as the validity of the proposed odour limits, the standard method for odour assessment, as well as the odour control systems to manage odour to acceptable levels. There also remains the fundamental question of the basic framework of the odour regulation itself, should it be a mainly a sensorial analysis, or perhaps a combination with analytical analysis of odourous compounds and the applicability of dispersion modeling. In view of these shortcomings, further study is thus recommended with focus on the following aspects:

- 1) **More data collection:** Involvement from the industry themselves are required to conduct their own odour monitoring (e.g. akin to self-regulation) and reporting to the Department of Environment for compilation of the odour data. The sampling locations should also focus on facilities that practiced or installed effective odour treatment systems to help gauge a more realistic limit value that promotes odour control.
- 2) **Guideline on odour control:** To treat odourous emissions from industries several technologies are available and can be grouped as a physical, biological and oxidation treatment system. A physical system includes adsorption and absorption whereas thermal, catalytic and non-thermal plasma are examples of oxidation system. A biological process on the other hand relies on microorganism for the degradation of odourous components. Guideline is needed as a reference material to premise owners and operators in making the proper technology selection pertaining to the respective source of emission. The guideline should be prepared in consultation with technology providers in order to provide the best advice on the operational and maintenance requirement of the respective technologies.
- 3) **Community survey regarding odour impact:** To better understand the health and nuisance impact of odour exposure to the public. The findings from the community survey regarding implications of odour to the health of nearby residences can further justify the necessity of an odour regulation.
- 4) **Inclusion of odorous chemical substances as a limit value:** In light of the recent events regarding toxic odorous emissions from non-organic based industries/activities, the possibility of adding another spectrum to quantify odour need to be explored. Japan and South Korea for instance regulates 22 odourous substances in addition to the odour limit values. The quantification of chemical substances allows the regulation of odorous emissions from the industries which would have otherwise been left of the hook due its unsuitability for olfactometry assessment.
- 5) **Guideline on odour assessment methods and in-field odour monitoring:** Odour assessments are conducted for a variety of reasons, and the tools used to conduct the assessment will depend on its purpose. There are a wide variety of odour assessment tools and approaches available source such as source odour measurements, dispersion modelling, ambient air testing and monitoring. An odour assessment may include a combination of these elements. Thus, a guideline is important to provide an objective and consistent framework to assess and manage odour primarily for regulatory officers and environmental consultants. The purpose of the

guideline is to provide guidance on methodology acceptable to the Department of Environment for odour sampling and analysis using dynamic olfactometry, in-field olfactometry for assessing boundary odour and the reporting format required by the DOE.

6) Guideline on odour management plan: To abide by the odour limits, certain affected industries/facilities must employ the appropriate measures necessary to prevent odour pollution or minimise it when prevention is not practicable. There needs to be a systematic approach to odour control: creating a plan that addresses each area of concern in a proactive and effective way. Odour management plans help through the thought process on odour issues of a premise in a holistic and systematic way. This guidance should cover regulatory requirements with regard to odour, advice on the management of odour and the aspects that should be dealt with in an odour management plan (OMP). Developing the plan should involve a process of identifying the sources of odour as well as its surrounding areas, the distance between the industry and the neighbours, prevailing wind directions, identification of the most severe issues and the implementation of the best odour control solutions. OMP is advised to be reviewed and evaluated periodically where odour performance is to be compared to the original targets.

7) Framework for odour regulation: Considerations in managing odour include a number of factors such as the nature and complexity of the odorous air contaminants being emitted from a source, additional potential sources of odorous air contaminants in the vicinity, the feasibility of applying technology to reduce emissions, and the regulatory mechanism being used to control emissions. An integrated multi-tool strategy that addressed the many complexities of odour emission as highlighted above to be used within regulatory frameworks is recommended. The integrated multi-tool strategy regulatory framework will encompass the following elements:

Step 1: Impact assessment of facilities includes observational and quantitative analysis to determine the extent of odour issue at the community through monitoring of odour in ambient air using field olfactometry. The odour limit at the boundary would be applicable at this stage.

Step 2: To further investigate possible emission sources of odour contributing industries which caused odour nuisance to the community. The odour limit at the point of emission assessed using laboratory dynamic olfactometer would be applicable at this stage.

Step 3: Mitigation and control plans must be in place to assist industry to minimize and manage odour impact risks of the non-compliant facilities. A robust and proactive odour management plan are required at this stage.

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Appendix 1: Chronology for the Development of the Draft Environmental Quality (Odour) Regulations

Bil	Aktiviti	Tarikh	Catatan
1	Kajian pencemaran bau JAS dengan kerjasama Lembaga Getah Malaysia (LGM)	2002-2003	110 persampelan telah dijalankan
2	Mesyuarat Jawatankuasa Teknikal Projek Kajian Pencemaran Bau	27 Disember 2004	Mesyuarat untuk penyediaan deraf Peraturan Bau.
3	Kajian LGM terhadap industri getah	2004-2006	Persampelan dijalankan ke atas 39 premis
4	Mesyuarat Jawatankuasa Teknikal Penyediaan Peraturan Bau	25 Julai 2006 21 November 2006 24 Januari 2008 11 Mac 2008 23 Mei 2008	Dianggotai oleh wakil: i) JAS ii) LGM iii) Jabatan Kimia iv) SIRIM v) AECCOM
5	Mesyuarat Jawatankuasa "Tripartite" bagi Industri Pemprosesan Getah	10 April 2007 23 Mei 2007	Dihadiri oleh wakil industri getah dan industri berasaskan getah
6	Taklimat deraf penyediaan Peraturan Bau bagi agensi-agensi dan wakil-wakil industri	10 Julai 2007	Dihadiri oleh wakil dari: i) MPOB ii) Palm Oil Miller Association iii) Indah water Konsortium iv) Persatuan Penapis Minyak Kelapa Sawit (PORAM) v) Federation of Livestock Farmers Association of Malaysia (FLFAM) vi) Persatuan Pekilang-Pekilang Malaysia (FMM)
7	Taklimat deraf penyediaan Peraturan Bau bersama Industri Asas Getah	24 Julai 2007	Mesyuarat telah dihadiri oleh wakil : i) JAS ii) LGM iii) MRPMA iv) FMM v) MARGMA

Bil	Aktiviti	Tarikh	Catatan
8	Taklimat deraf penyediaan Peraturan Bau bersama Wakil Penternak Ayam dan Babi (FLFAM)	10 Ogos 2007	Dihadiri oleh wakil penternak ayam dan khinzir
9	Maklumbalas draf penyediaan Peraturan Bau daripada industri		8 laporan maklumbalas telah diterima daripada pihak industri.
10	Persampelan tambahan (Kilang Pemprosesan Getah dan Asas Getah)	September 2007- November 2007	Persampelan dijalankan ke atas 27 premis
11	Sesi dialog/taklimat deraf penyediaan Peraturan Bau bersama MPOB	7 Mac 2008	Dihadiri oleh wakil industri kelapa sawit.
12	Mesyuarat Majlis Kualiti Alam Sekeliling (EQC)	3 Mac 2009 15 Oktober 2009	Deraf Peraturan Bau telah dimuktamadkan
13	Deraf final Peraturan Bau dikemukakan kepada Jabatan Peguam Negara	6 Ogos 2009	Deraf yang dikemaskini berdasarkan komen dan cadangan telah dimuktamadkan dan dimajukan kepada JPN
14	Perbincangan dengan pihak LGM bagi menentukan semula had pelepasan bau menggunakan olfactometer dan juga kromatografi gas.	10 Jun 2011	Cadangan oleh pihak LGM bagi mengkaji semula had pelepasan yang telah ditetapkan
15	Persampelan Bau tambahan di beberapa kawasan yang telah dikenalpasti	14 Mac 2012- 24 Mei 2012	Kajian tambahan telah dijalankan di beberapa lokasi/kategori yang telah dikenalpasti seperti lading ternakan, tapak pelupusan sampah dan kilang berasaskan getah
16	Mesyuarat Jawatankuasa Teknikal Kajian Semula Peraturan Bau Bil 1/2013 – Memuktamadkan had bau yang ditetapkan.	9 April 2013	Berdasarkan keputusan persampelan tambahan yang telah dilaksanakan
18	Deraf Peraturan (Bau) 201X dimajukan kepada JPN oleh PUU NRE	5 Feb 2014	

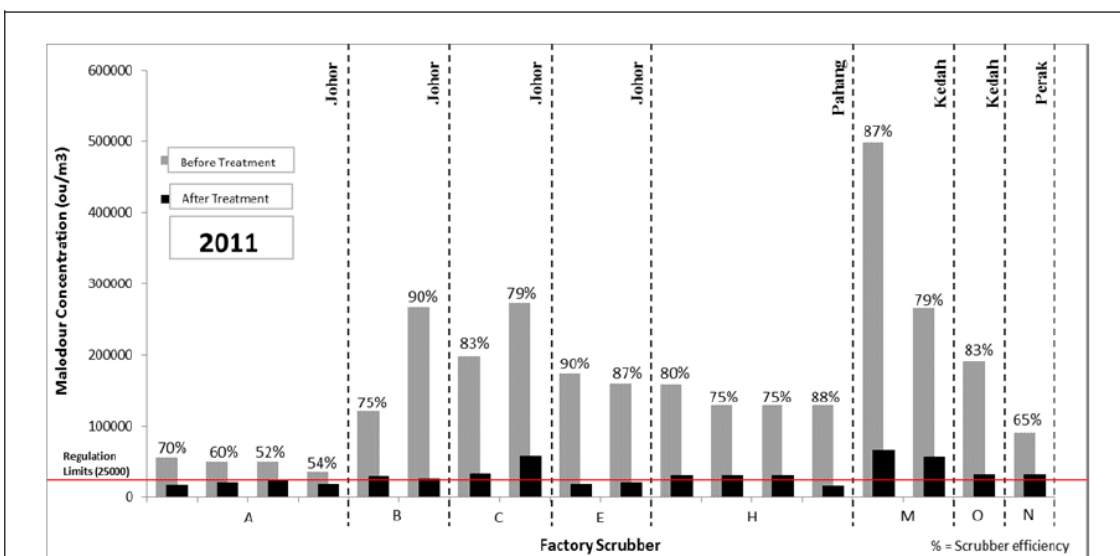
Bil	Aktiviti	Tarikh	Catatan
19	Memaklumkan kepada JPN mengenai penangguhan Peraturan Kualiti Alam Sekeliling (Bau)	23 Mac 2015	
20	Mesyuarat Pelaksanaan Peraturan Kualiti Alam Sekeliling (Bau) Bersama Dengan Lembaga Getah Malaysia	14 April 2015	Untuk membincangkan dengan lebih lanjut mengenai pelaksanaan Peraturan Bau

Hebahan melalui Serata Awam di laman web Jabatan Alam Sekitar

Bil	Aktiviti	Tarikh	Catatan
1	Hebahan Seranta Awam kali pertama	17 Okt – 1 Nov 2012	Tiada komen/ cadangan yang diterima daripada pihak industri
2	Hebahan Seranta Awam kali kedua	15-30 April 2013	Hanya menerima ulasan dan komen berkaitan had bau dari bahan kimia sahaja.

Appendix 2: Secondary Odour Data of Raw Natural Rubber Industry (source: Malaysian Rubber Board)

**Compilation of odour concentrations emitted from scrubbers (before and after) at various SMR
(Standard Malaysian Rubber) factories in 2011**

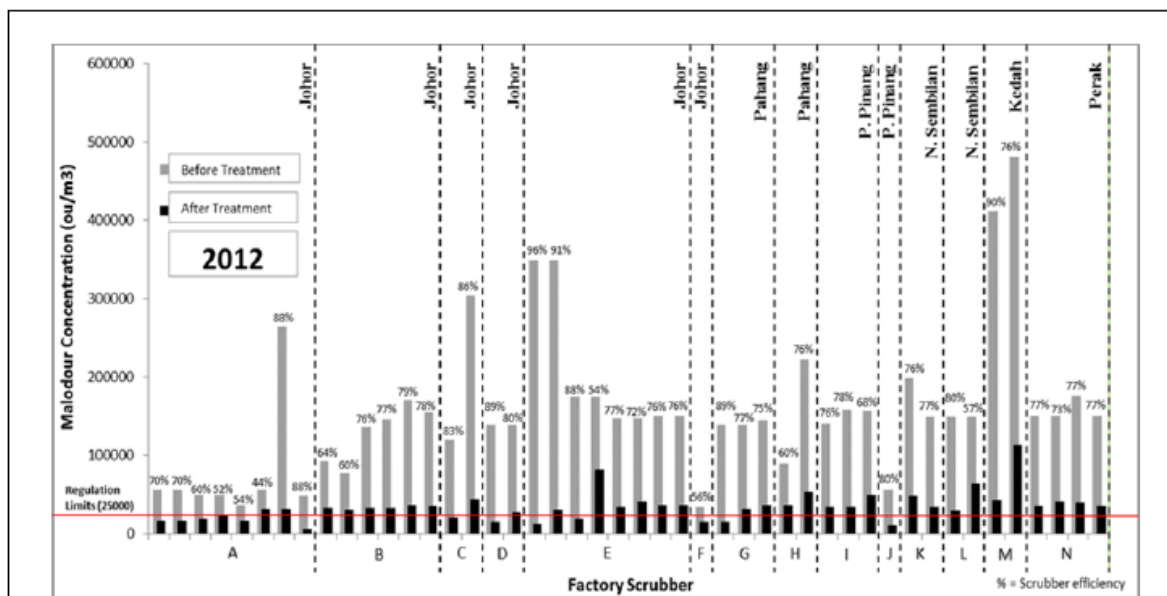


% = scrubber odour removal efficiency

A = Lee Rubber Co. (Pte.) Ltd., Labis	H = Mardec Processing Sdn. Bhd., Mentakab
B = Lee Rubber Co. (Pte.) Ltd., Muar	M = Mardec Processing Sdn. Bhd., Baling
C = Hock Hin (Muar) Sdn. Bhd., Muar	O = A1 Rubber, Sungai Petani, Kedah
E = Kota Trading Co. Sdn. Bhd., Batu Pahat	N = Lee Rubber Co. (Pte.) Ltd., K. Kangsar

Factory (2011)	Before (ou/m ³)	After (ou/m ³)
A = Lee Rubber Co. (Pte.) Ltd., Labis	56396	16990
	50544	20337
	50544	24350
	36778	17249
B = Lee Rubber Co. (Pte.) Ltd., Muar	120847	29815
	268339	26427
C = Hock Hin (Muar) Sdn. Bhd., Muar	198899	34014
	273418	57715
E = Kota Trading Co. Sdn. Bhd., Batu Pahat	173390	17067
	160237	20430
H = Mardec Processing Sdn. Bhd., Mentakab	158697	31784
	128834	31784
	128834	31784
	128834	15667
M = Mardec Processing Sdn. Bhd., Baling	499365	66036
	266264	56227
O = A1 Rubber, Sungai Petani, Kedah	192235	32261
N = Lee Rubber Co. (Pte.) Ltd., K. Kangsar	91939	32194
PURATA	165799.67	31229.5

Compilation of odour concentrations emitted from scrubbers (before and after) at various SMR (Standard Malaysian Rubber) factories in 2012



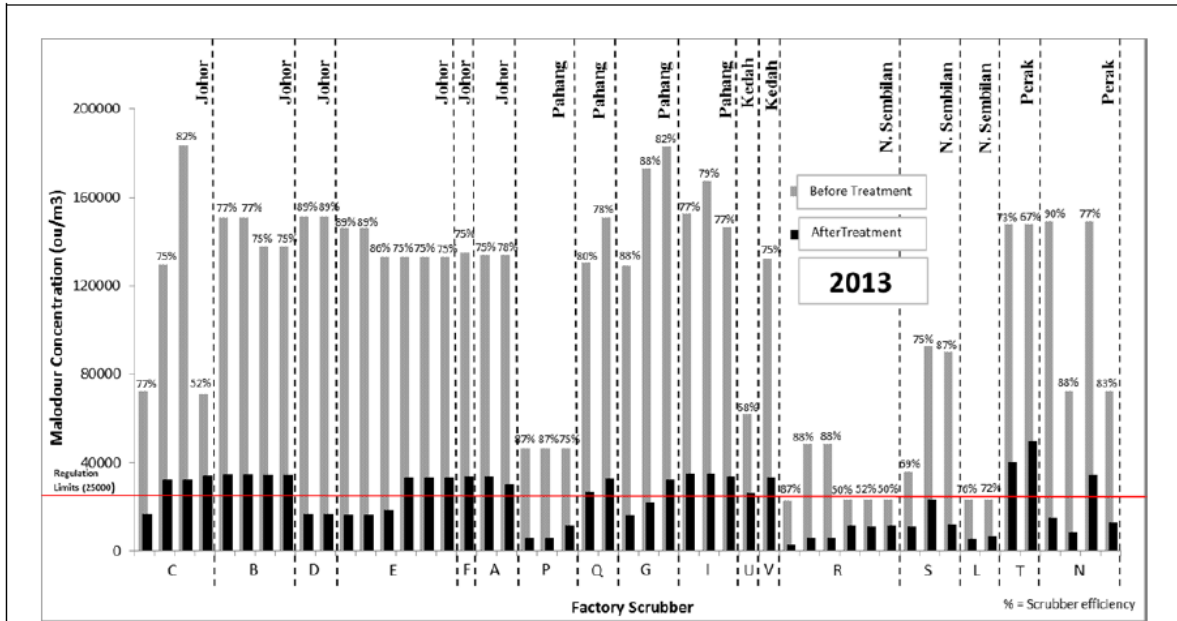
% = scrubber odour removal efficiency

A = Lee Rubber Co. (Pte.) Ltd., Labis	H = Mardec Processing Sdn. Bhd., Mentakab
B = Lee Rubber Co. (Pte.) Ltd., Muar	I = Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam
C = Hock Hin (Muar) Sdn. Bhd., Muar	J = Alma Rubber Estates Sdn. Bhd., Bukit Mertajam
D = Felda Rubber Industries Sdn. Bhd., Pasak, Kota Tinggi	K = Syarikat Tenaga (Gemas) Sdn. Bhd., Gemas
E = Kota Trading Co. Sdn. Bhd., Batu Pahat	L = Kota Trading Co. Sdn. Bhd., Tampin
F = Tangkah Rubber Factory, Tangkah	M = Mardec Processing Sdn. Bhd., Baling
G = Lee Rubber Co. (Pte.) Ltd., Bentong	N = Lee Rubber Co. (Pte.) Ltd., K. Kangsar

Factory (2012)	Before (ou/m3)	After(ou/m3)
A = Lee Rubber Co. (Pte.) Ltd., Labis	56396	16990
	56396	16990
	50544	20337
	50544	24350
	36778	16990
	57225	32292
	264815	32292
	48581	5924
B = Lee Rubber Co. (Pte.) Ltd., Muar	93652	33498
	77898	31006
	136920	32662
	146366	33185
	170773	35959
	155550	34915
C = Hock Hin (Muar) Sdn. Bhd., Muar	120242	20493
	304459	43735
D = Felda Rubber Industries Sdn. Bhd., Pasak, Kota Tinggi	139662	15712
	139662	27800

E = Kota Trading Co. Sdn. Bhd., Batu Pahat	349971	13593
	349971	30572
	175939	20266
	175939	81537
	147375	34069
	147375	40993
	151412	36806
	151412	36806
F = Tangkah Rubber Factory, Tangkah	34306	14987
G = Lee Rubber Co. (Pte.) Ltd., Bentong	140174	15770
	140174	32404
	146011	36102
H = Mardec Processing Sdn. Bhd., Mentakab	89621	35968
	223372	53270
I = Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam	141020	34179
	159416	34572
	157963	50055
J = Alma Rubber Estates Sdn. Bhd., Bukit Mertajam	57266	11342
K = Syarikat Tenaga (Gemas) Sdn. Bhd., Gemas	198543	48263
	150202	34398
L = Kota Trading Co. Sdn. Bhd., Tampin	150604	29550
	150604	64136
M = Mardec Processing Sdn. Bhd., Baling	412743	43297
	481606	113372
N = Lee Rubber Co. (Pte.) Ltd., K. Kangsar	150963	34898
	150963	40736
	177136	40135
	150963	34898
PURATA	156945.80	34176.17

Compilation of odour concentrations emitted from scrubbers (before and after) at various SMR (Standard Malaysian Rubber) factories in 2013



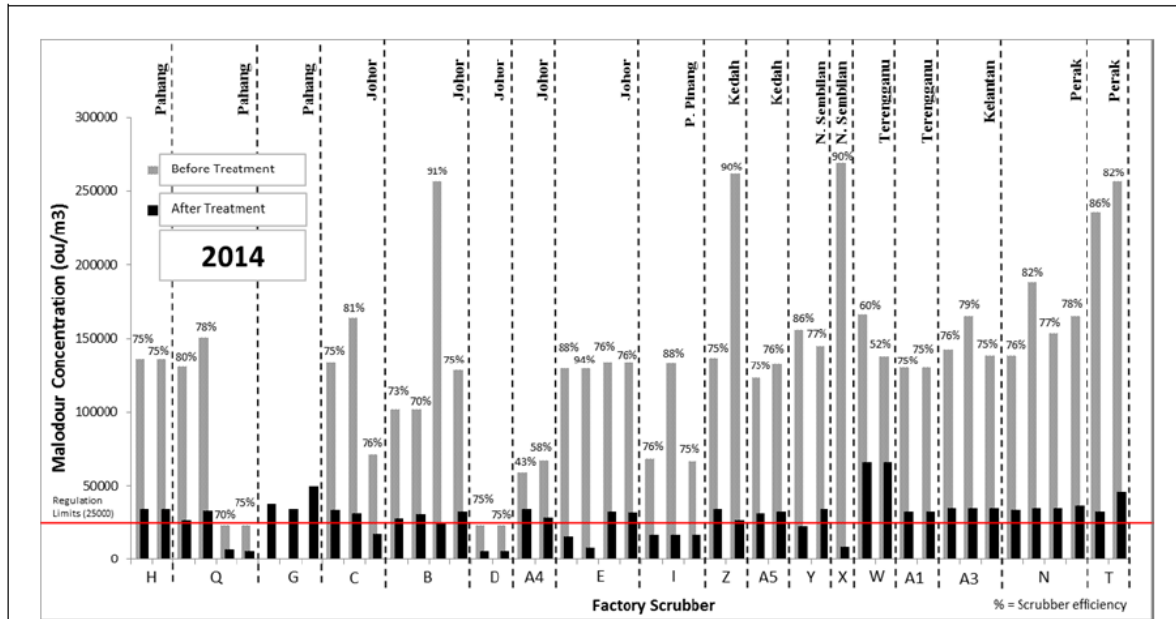
% = scrubber odour removal efficiency

C = Hock Hin (Muar) Sdn. Bhd., Muar	I = Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam
B = Lee Rubber Co. (Pte.) Ltd., Muar	U = Lam Eng Rubber Factory Sdn. Bhd., Sg. Petani
D = Felda Rubber Industries Sdn. Bhd., Pasak, Kota Tinggi	V = Tiong Huat Rubber Factory Sdn. Bhd., Sg. Petani
E = Kota Trading Co. Sdn. Bhd., Batu Pahat	R = Tatt Win Industries Sdn. Bhd., Jelebu
F = Tangkah Rubber Factory, Tangkah	S = Felda Rubber Industries Sdn. Bhd., Pasir Besar, Gemas
A = Lee Rubber Co. (Pte.) Ltd., Labis	L = Kota Trading Co. Sdn. Bhd., Tampin
P = Felda Rubber Industries Sdn. Bhd., Kg. Awah, Temerloh	T = Mardec Processing Sdn. Bhd., Bota
Q = Chuan Lee Rubber Sdn. Bhd., Jerantut	N = Lee Rubber Co. (Pte.) Ltd., K. Kangsar
G = Lee Rubber Co. (Pte.) Ltd., Bentong	

Factory (2013)	Before (ou/m ³)	After(ou/m ³)
C = Hock Hin (Muar) Sdn. Bhd., Muar	72236	16770
	129798	32452
	183566	32452
	70894	33820
B = Lee Rubber Co. (Pte.) Ltd., Muar	150886	34881
	150886	34881
	137537	34387
	137537	34387
D = Felda Rubber Industries Sdn. Bhd., Pasak, Kota Tinggi	151296	17021
	151296	17021
E = Kota Trading Co. Sdn. Bhd., Batu Pahat	145940	16419
	145940	16419
	133158	18218
	133158	33292

	133158	33292
	133158	33292
F = Tangkah Rubber Factory, Tangkah	134942	33738
A = Lee Rubber Co. (Pte.) Ltd., Labis	133899	33478
	133899	30028
P = Felda Rubber Industries Sdn. Bhd., Kg. Awah, Temerloh	46341	5793
	46341	5793
	46341	11585
Q = Chuan Lee Rubber Sdn. Bhd., Jerantut	130540	26677
	150884	32638
G = Lee Rubber Co. (Pte.) Ltd., Bentong	129312	16163
	172899	21610
	182878	32331
I = Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam	152475	35248
	167397	35248
	146288	33414
U = Lam Eng Rubber Factory Sdn. Bhd., Sg. Petani	61961	26182
V = Tiong Huat Rubber Factory Sdn. Bhd., Sg. Petani	132208	33055
R = Tatt Win Industries Sdn. Bhd., Jelebu	22877	2883
	48581	5924
	48581	5924
	23170	11585
	23170	11055
	23170	11585
S = Felda Rubber Industries Sdn. Bhd., Pasir Besar, Gemas	35868	11260
	92682	23170
	90081	11930
L = Kota Trading Co. Sdn. Bhd., Tampin	23170	5477
	23170	6546
T = Mardec Processing Sdn. Bhd., Bota	147862	39900
	147862	49489
N = Lee Rubber Co. (Pte.) Ltd., K. Kangsar	149118	15060
	72260	8432
	149118	34472
	72260	12604
PURATA	108613.25	22842.47

Compilation of odour concentrations emitted from scrubbers (before and after) at various SMR (Standard Malaysian Rubber) factories in 2014



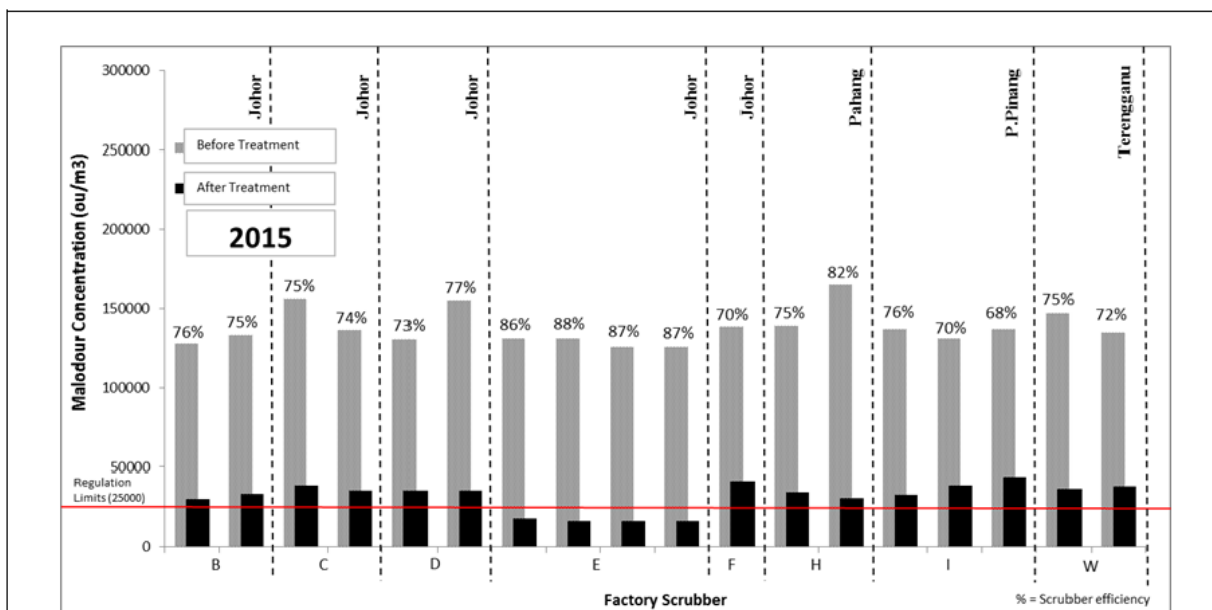
% = scrubber odour removal efficiency

H = Mardec Processing Sdn. Bhd., Mentakab	Z = Felda Rubber Industries Sdn. Bhd., Kuala Ketil
Q = Chuan Lee Rubber Sdn. Bhd., Jerantut	A5 = Teh Ah Yau Rubber Factory Sdn. Bhd., Semilang, Bedong
G = Lee Rubber Co. (Pte.) Ltd., Bentong	Y = Felda Rubber Industries Sdn. Bhd., Palong 8, Gemas
C = Hock Hin (Muar) Sdn. Bhd., Muar	X = Kilang Getah Jeram Padang, KLK Berhad, Bahau
B = Lee Rubber Co. (Pte.) Ltd., Muar	W = Mardec Processing Sdn. Bhd., Kuala Berang
D = Felda Rubber Industries Sdn. Bhd., Pasak	A1 = Felda Rubber Industries Sdn. Bhd., Chalok Barat, Setiu
A4 = Kian Lee SMR Factory Sdn. Bhd., Segamat	A3 = Seng Hin Rubber (M) Sdn. Bhd., Kuala Krai
E = Kota Trading Co. Sdn. Bhd., Batu Pahat	N = Lee Rubber Co. (Pte.) Ltd., K. Kangsar
I = Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam	T = Mardec Processing Sdn. Bhd., Bota

Factory (2014)	Before (ou/m3)	After(ou/m3)
H = Mardec Processing Sdn. Bhd., Mentakab	136031	34011
	136031	34011
Q = Chuan Lee Rubber Sdn. Bhd., Jerantut	130540	26677
	150884	32638
	23170	6889
	23170	5793
G = Lee Rubber Co. (Pte.) Ltd., Bentong	-	37557
	-	33772
	-	49897
C = Hock Hin (Muar) Sdn. Bhd., Muar	133598	33402
	163604	30744
	70781	17182

B = Lee Rubber Co. (Pte.) Ltd., Muar	102122	27555
	102122	30489
	256729	24202
	128362	32093
D = Felda Rubber Industries Sdn. Bhd., Pasak	23170	5793
	23170	5793
A4 = Kian Lee SMR Factory Sdn. Bhd., Segamat	58958	33709
	66948	28344
E = Kota Trading Co. Sdn. Bhd., Batu Pahat	129312	15711
	129312	8081
	133157	32331
	133157	31427
I = Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam	68440	16614
	132926	16614
	66463	16614
Z = Felda Rubber Industries Sdn. Bhd., Kuala Ketil	136717	33672
	261595	26182
A5 = Teh Ah Yau Rubber Factory Sdn. Bhd., Semilang, Bedong	123033	30761
	132341	32152
Y = Felda Rubber Industries Sdn. Bhd., Palong 8, Gemas	155571	22498
	144691	33652
X = Kilang Getah Jeram Padang, KLK Berhad, Bahau	269705	8427
W = Mardec Processing Sdn. Bhd., Kuala Berang	166254	65977
	137927	65977
A1 = Felda Rubber Industries Sdn. Bhd., Chalok Barat, Setiu	129752	32441
	129752	32441
A3 = Seng Hin Rubber (M) Sdn. Bhd., Kuala Krai	142796	34671
	164917	34671
	138672	34671
N = Lee Rubber Co. (Pte.) Ltd., K. Kangsar	138812	33265
	188165	34706
	153597	34706
	165082	36276
T = Mardec Processing Sdn. Bhd., Bota	235967	32047
	256358	45318
PURATA	133951.39	29201.15

Compilation of odour concentrations emitted from scrubbers (before and after) at various SMR (Standard Malaysian Rubber) factories in 2015

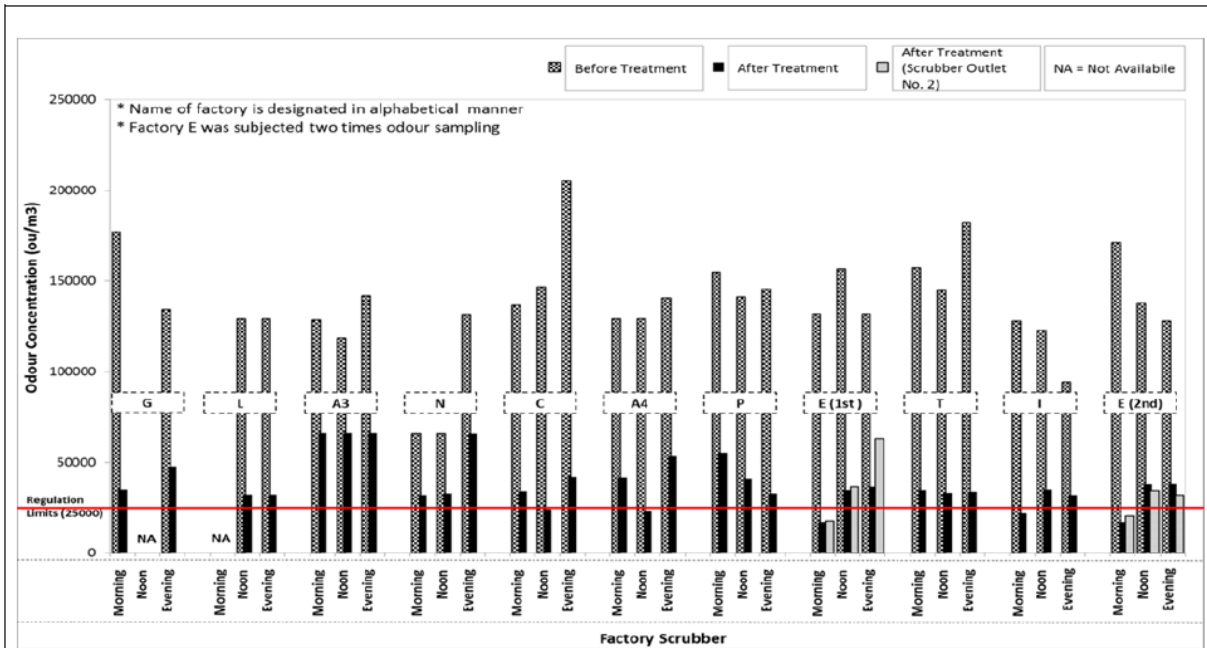


% = scrubber odour removal efficiency

B = Lee Rubber Co. (Pte.) Ltd., Muar	F = Tangkah Rubber Factory, Tangkah
C = Hock Hin (Muar) Sdn. Bhd., Muar	H = Mardec Processing Sdn. Bhd., Mentakab
D = Felda Rubber Industries Sdn. Bhd., Pasak	I = Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam
E = Kota Trading Co. Sdn. Bhd., Batu Pahat	W = Mardec Processing Sdn. Bhd., Kuala Berang

Factory (2015)	Before (ou/m3)	After(ou/m3)
B = Lee Rubber Co. (Pte.) Ltd., Muar	127477	30491
	132996	33252
C = Hock Hin (Muar) Sdn. Bhd., Muar	156063	39017
	136192	35779
D = Felda Rubber Industries Sdn. Bhd., Pasak	130180	35494
	154817	35494
E = Kota Trading Co. Sdn. Bhd., Batu Pahat	130976	17852
	130976	16370
	125303	16370
	125303	16370
F = Tangkah Rubber Factory, Tangkah	138580	41203
H = Mardec Processing Sdn. Bhd., Mentakab	138951	34741
	165241	30534
I = Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam	136725	32764
	131049	38962
	136725	44327
W = Mardec Processing Sdn. Bhd., Kuala Berang	146832	36848
	134641	38370
	PURATA	137723.72

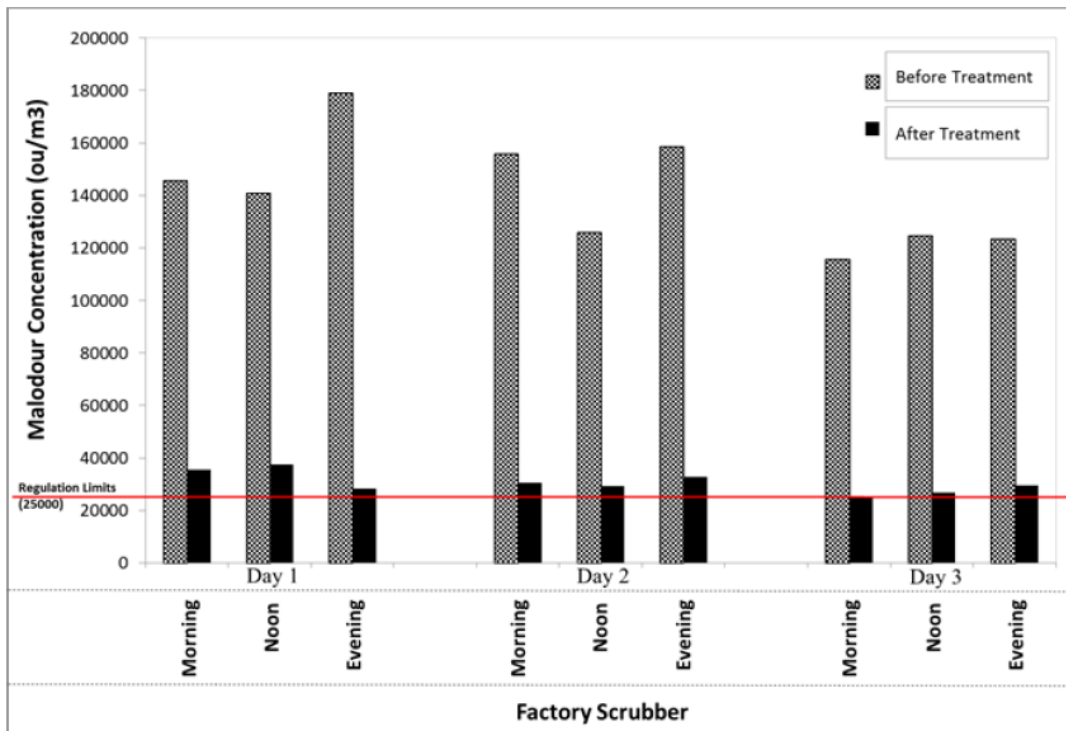
Monitoring of the odour concentrations emitted from scrubbers (before and after) at various SMR (Standard Malaysian Rubber) factories in 2014-2015



Factory	Time	Before (ou/m ³)	After(ou/m ³)
G = Lee Rubber Co. (Pte.) Ltd., Bentong	Morning	177258	34836
	Noon	-	-
	Evening	134283	47829
L = Kota Trading Co. Sdn. Bhd., Tampin	Morning	-	-
	Noon	129196	32302
	Evening	129196	32302
A3 = Seng Hin Rubber (M) Sdn. Bhd., Kuala Krai	Morning	128409	66058
	Noon	118488	66058
	Evening	142026	66058
N = Lee Rubber Co. (Pte.) Ltd., K. Kangsar	Morning	65895	32027
	Noon	65895	32951
	Evening	131791	65895
C = Hock Hin (Muar) Sdn. Bhd., Muar	Morning	136587	34150
	Noon	146833	24146
	Evening	204999	41819
A4 = Kian Lee SMR Factory Sdn. Bhd., Segamat	Morning	129202	41561
	Noon	129202	23170
	Evening	140895	53562
P = Felda Rubber Industries Sdn. Bhd., Kg. Awah, Temerloh	Morning	154971	55305
	Noon	141403	40878
	Evening	145547	32887
E = Kota Trading Co. Sdn. Bhd., Batu Pahat (1st)	Morning	131907	16980 (outlet 1) 17725 (outlet 2)
	Noon	156868	34472 (outlet 1) 36490 (outlet 2)

	Evening	131907	36490 (outlet 1) 63218 (outlet 2)
T = Mardec Processing Sdn. Bhd., Bota	Morning	157333	34574
	Noon	144817	33078
	Evening	182241	33673
I = Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam	Morning	127991	21687
	Noon	122680	35028
	Evening	94601	32001
E = Kota Trading Co. Sdn. Bhd., Batu Pahat (2nd)	Morning	171222	17217 (outlet 1) 20475 (outlet 2)
	Noon	137746	37697 (outlet 1) 34439 (outlet 2)
	Evening	127945	38041 (outlet 1) 31989 (outlet 2)
PURATA		136752.71	37812.65

Monitoring of the odour concentrations emitted from scrubbers (before and after) at Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam conducted on 25.8.2015 – 27.8.2015



Factory	Time	Before (ou/m3)	After(ou/m3)
Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam (DAY 1)	Morning	145528	35666
	Noon	140955	37517
	Evening	179049	28214
Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam (DAY 2)	Morning	155871	30488
	Noon	126022	29195
	Evening	158699	32871
Lee Rubber Co. (Pte.) Ltd., Bukit Mertajam (DAY 3)	Morning	115631	25347
	Noon	124594	26752
	Evening	123337	29575
PURATA		141076.22	30625

Appendix 3: Secondary Odour Data of Palm Oil Mill
(source: Malaysian Palm Oil Board)

**RESULT OF ODOUR CONCENTRATION (OU M⁻³) FROM ANAEROBIC POND OF
TACLICO OIL PALM MILL (KEDAH)**

Sample ID	Sampling date	Sampling time (24-hr)	Analysis date	Analysis time (24-hr)	OU/m³
sample 1D1	28/1/19	1200	29/1/19	0928	53435
sample 2D1	28/1/19	1300	29/1/19	1058	51142
sample 3D1	28/1/19	1400	29/1/19	1119	58604
sample 4D1	28/1/19	1500	29/1/19	1159	79407
sample 1D2	29/1/19	1200	30/1/19	0927	44135
sample 2D2	29/1/19	1300	30/1/19	0931	51142
sample 3D2	29/1/19	1400	30/1/19	1007	54746
sample 4D2	29/1/19	1500	30/1/19	1030	67904
sample 1D3	30/1/19	1200	31/1/19	0910	62754
sample 2D3	30/1/19	1300	31/1/19	0933	63427
sample 3D3	30/1/19	1400	31/1/19	1047	79407
sample 4D3	30/1/19	1500	31/1/19	1113	85012
sample 1D1	19/8/19	1200	20/8/19	0921	23369
sample 2D1	19/8/19	1300	20/8/19	0948	20384
sample 3D1	19/8/19	1400	20/8/19	1005	26881
sample 4D1	19/8/19	1500	20/8/19	1021	22859
sample 1D2	20/8/19	1200	21/8/19	1001	15324
sample 2D2	20/8/19	1300	21/8/19	1018	18164
sample 3D2	20/8/19	1400	21/8/19	1033	15379
sample 4D2	20/8/19	1500	21/8/19	1104	19237
sample 1D3	21/8/19	1200	22/8/19	0958	25280
sample 2D3	21/8/19	1300	22/8/19	1013	22131
sample 3D3	21/8/19	1400	22/8/19	1045	19074
sample 4D3	21/8/19	1500	22/8/19	1101	32523

**RESULT OF ODOUR CONCENTRATION (OU M⁻³) FROM ACIDIFICATION POND OF
TACLICO OIL PALM MILL (KEDAH)**

Sample ID	Sampling time and date	Analysis time and date	Odour concentration (OU/m³)
ACID POND/150816/S1	15 August 2016, 1010	16 August 2016, 0938	33,150
ACID POND /150816/S2	15 August 2016, 1205	16August 2016, 1027	50,558
ACID POND /150816/S3	15 August 2016, 1510	16 August 2016, 1147	70,210
ACID POND /150816/S4	15 August 2016, 1715	16 August 2016, 1214	70,448
ACID POND /160816/S1	16 August 2016, 1025	17 August 2016, 1108	65,943
ACID POND /160816/S2	16August 2016, 1215	17 August 2016, 1118	58,480
ACID POND /160816/S3	16 August 2016, 1445	17 August 2016, 1128	71,621
ACID POND /160816/S4	16 August 2016, 1700	17 August 2016, 1308	73,612
ACID POND /170816/S1	17 August 2016, 1045	18 August 2016, 0923	88,480
ACID POND /170816/S2	17 August 2016, 1225	18 August 2016, 0933	84,756
ACID POND /170816/S3	17 August 2016, 1530	18 August 2016, 1007	161,896
ACID POND /170816/S4	17 August 2016, 1725	18 August 2016, 1029	100,996
ACID POND/280317/S1	28 March 2017, 1115	28 March 2017, 2146	54309
ACID POND /280317/S2	28 March 2017, 1245	28 March 2017, 2211	42734
ACID POND /280317/S3	28 March 2017, 1400	28 March 2017, 2232	72381
ACID POND /280317/S4	28 March 2017, 1530	28 March 2017, 2249	53763
ACID POND /290317/S1	29 March 2017, 1110	29 March 2017, 2212	35890
ACID POND /290317/S2	29 March 2017, 1140	29 March 2017, 2235	29247
ACID POND /290317/S3	29 March 2017, 1210	29 March 2017, 2300	58731
ACID POND /290317/S4	29 March 2017, 1240	29 March 2017, 2319	36345
ACID POND /300317/S1	30 March 2017, 1120	30 March 2017, 2256	48940
ACID POND /300317/S2	30 March 2017, 1200	30 March 2017, 2233	45627
ACID POND /300317/S3	30 March 2017, 1240	30 March 2017, 2221	42734
ACID POND 300317/S4	30 March 2017, 1310	30 March 2017, 2241	58440

**RESULT OF ODOUR CONCENTRATION (OU M⁻³) FROM COOLING POND OF TIAN SIANG
(AIR KUNING), KEDAH**

Sample ID	Sampling time and date	Analysis time and date	Odour concentration (OU/m³)
COOLING POND/241016/S1	24 October 2016, 1300	25 October 2016, 1124	17,663
COOLING POND /241016/S2	24 October 2016, 1320	25 October 2016, 1145	16,333
COOLING POND /241016/S3	24 October 2016, 1345	25 October 2016, 1209	18,611
COOLING POND /241016/S4	24 October 2016, 1405	25 October 2016, 1230	22,276
COOLING POND /251016/S1	25 October 2016, 1240	25 October 2016, 2014	13,187
COOLING POND /251016/S2	25 October 2016, 1300	25 October 2016, 2039	21,206
COOLING POND /251016/S3	25 October 2016, 1320	25 October 2016, 2101	15,910
COOLING POND /251016/S4	25 October 2016, 1400	25 October 2016, 2127	17,663
COOLING POND /261016/S1	26 October 2016, 1315	26 October 2016, 2036	50,086
COOLING POND /261016/S2	26 October 2016, 1335	26 October 2016, 2058	52,925
COOLING POND /261016/S3	26 October 2016, 1350	26 October 2016, 2120	76,276
COOLING POND /261016/S4	26 October 2016, 1414	26 October 2016, 2138	52,925
COOLING POND/210217/S1	21/02/2017 & 1205	21/02/2017 & 2151	33,433
COOLING POND /210217/S2	21/02/2017 & 1250	21/02/2017 & 2112	36,837
COOLING POND /210217/S3	21/02/2017 & 1440	21/02/2017 & 2138	42,952
COOLING POND /210217/S4	21/02/2017 & 1525	21/02/2017 & 2209	42,734
COOLING POND /220217/S1	22/02/2017 & 1210	22/02/2017 & 2051	22,966
COOLING POND /220217/S2	22/02/2017 & 1250	22/02/2017 & 2109	24,829
COOLING POND /220217/S3	22/02/2017 & 1450	22/02/2017 & 2127	40,135
COOLING POND /220217/S4	22/02/2017 & 1520	22/02/2017 & 2142	22,966
COOLING POND /230217/S1	23/02/2017 & 1215	23/02/2017 & 2115	27,002
COOLING POND /230217/S2	23/02/2017 & 1300	23/02/2017 & 2142	29,348
COOLING POND /230217/S3	23/02/2017 & 1425	23/02/2017 & 2159	31,740
COOLING POND /230217/S4	23/02/2017 & 1550	23/02/2017 & 2222	29,348

RESULT OF ODOUR CONCENTRATION (OU M⁻³) FROM COOLING POND OF MALPOM INDUSTRIES SDN. BHD. (PULAU PINANG)

Sample ID	Sampling time and date	Analysis time and date	Odor concentration (OU/m ³)
COOLING POND/260916/S1	26 September 2016, 1010	26 September 2016, 1657	60,788
COOLING POND /260916/S2	26 September 2016, 1130	26 September 2016, 1721	44,800
COOLING POND /260916/S3	26 September 2016, 1230	26 September 2016, 1740	51,688
COOLING POND /260916/S4	26 September 2016, 1345	26 September 2016, 1758	76,860
COOLING POND /270916/S1	27 September 2016, 1050	28 September 2016, 0922	76,276
COOLING POND /270916/S2	27 September 2016, 1130	28 September 2016, 0939	91,582
COOLING POND /270916/S3	27 September 2016, 1205	28 September 2016, 1009	96,496
COOLING POND /270916/S4	27 September 2016, 1250	28 September 2016, 1030	109,619
COOLING POND /280916/S1	28 September 2016, 1100	29 September 2016, 0900	91,582
COOLING POND /280916/S2	28 September 2016, 1140	29 September 2016, 0918	96,496
COOLING POND /280916/S3	28 September 2016, 1215	29 September 2016, 0940	96,496
COOLING POND /280916/S4	28 September 2016, 1250	29 September 2016, 1000	80,371
ACID POND /280916/S1	28 September 2016, 1315	29 September 2016, 1020	96,496
ACID POND /280916/S2	28 September 2016, 1350	29 September 2016, 1040	109,619
ACID POND /280916/S3	28 September 2016, 1440	29 September 2016, 1100	96,496
ACID POND /280916/S4	28 September 2016, 1530	29 September 2016, 1118	101,665

Sample ID	Sampling time & date	Analysis time & date	Odor concentration (OU/m ³)
COOLING POND/070217/S1	07/02/2017 & 1115	08/02/2017 & 0939	82,482
COOLING POND /070217/S2	07/02/2017 & 1215	08/02/2017 & 1001	107,125
COOLING POND /070217/S3	07/02/2017 & 1545	08/02/2017 & 1303	89,216
COOLING POND /070217/S4	07/02/2017 & 1615	08/02/2017 & 1316	101,665
COOLING POND /080217/S1	08/02/2017 & 1028	09/02/2017 & 0940	68,705
COOLING POND /080217/S2	08/02/2017 & 1115	09/02/2017 & 0955	82,482
COOLING POND /080217/S3	08/02/2017 & 1500	09/02/2017 & 1024	91,582
COOLING POND /080217/S4	08/02/2017 & 1545	09/02/2017 & 1037	89,216
COOLING POND /090217/S1	09/02/2017 & 1120	09/02/2017 & 2110	101,665
COOLING POND /090217/S2	09/02/2017 & 1215	09/02/2017 & 2130	101,665
COOLING POND /090217/S3	09/02/2017 & 1445	09/02/2017 & 2146	101,665
COOLING POND /090217/S4	09/02/2017 & 1530	09/02/2017 & 2201	96,496

Appendix 4: Secondary Odour Data of Animal Farm/Poultry Farm
(source: *Jabatan Perkhidmatan Veterinar Negeri Johor*)

RESULT OF ODOUR CONCENTRATION (OU M⁻³) FROM POULTRY FARMS IN MACHAP, JOHOR

Sample ID	Sampling time and date	Analysis time and date	Odor concentration (OU/m ³)
JKG AD 002/UNDER1	14 JUNE 2017, 1555	15 JUNE 2017, 1525	3678
JKG AD 002/UNDER2	14 JUNE 2017, 1605	15 JUNE 2017, 1550	3227

Sample ID	Sampling time and date	Analysis time and date	Odor concentration (OU/m ³)
JKG AD 043/INDOOR	13 JUNE 2017, 1545	14 JUNE 2017, 1359	8299
JKG AD 043/EXHAUST	13 JUNE 2017, 1605	14 JUNE 2017, 1451	407

Sample ID	Sampling time and date	Analysis time and date	Odor concentration (OU/m ³)
JKG AD 065/UNDER1	15 JUNE 2017, 1415	16 JUNE 2017, 1130	530
JKG AD 065/UNDER2	15 JUNE 2017, 1425	16 JUNE 2017, 1046	539

Sample ID	Sampling time and date	Analysis time and date	Odor concentration (OU/m ³)
JKG AD 081/INDOOR	13 JUNE 2017, 14:54	14 JUNE 2017, 1254	195
JKG AD 081/EXHAUST	13 JUNE 2017, 15:15	14 JUNE 2017, 1342	631

Sample ID	Sampling time and date	Analysis time and date	Odor concentration (OU/m ³)
JKG AD 095/INDOOR1	14 JUNE 2017, 1530	15 JUNE 2017, 1456	4902
JKG AT 095/INDOOR2	14 JUNE 2017, 1540	15 JUNE 2017, 1510	4902

Sample ID	Sampling time and date	Analysis time and date	Odor concentration (OU/m ³)
JKG AT 016/INDOOR	13 JUNE 2017, 1411	14 JUNE 2017, 1138	224
JKG AT 016/EXHAUST	13 JUNE 2017, 1430	14 JUNE 2017, 1231	663

Sample ID	Sampling time and date	Analysis time and date	Odor concentration (OU/m ³)
JKG AT 017/INDOOR	14 JUNE 2017, 1410	15 JUNE 2017, 1130	887
JKG AT 017/EXHAUST	14 JUNE 2017, 1420	15 JUNE 2017, 1147	565

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