

GUIDELINE

ON POLLUTION CONTROL FOR PIG FARMING ACTIVITIES IN SABAH

EPD



ENVIRONMENT PROTECTION DEPARTMENT
SABAH

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FOREWORD

As part of the Environment Protection Department's continuous efforts to enhance environmental management in Sabah, this guideline is published to provide a clear, practical and comprehensive guidance on how to minimise impacts from pig farming activities. It outlines significant environmental issues from pig farming activities, recommended Siting and Buffer Zone, Best Management Practices (BMPs) and Best Available Techniques (BATs) which can be adopted by operators to minimise environmental impacts from their farms.

Best Management Practices (BMPs) are methods that have been determined to be the most effective and practical means of preventing or reducing pollution. This is in line with the Sabah State Policy on the Environment that states "while acknowledging the need for increases in agricultural production, Sabah will work to decrease dependency on artificial substances (e.g. fertilisers, pesticides, growth regulators) and encourage best management practices including organic farming and similar sustainable practices".

Best Available Techniques (BATs) means techniques which have been developed on a scale which allows implementation under economically and technically viable conditions, taking into consideration the cost and advantages, and found to be most effective in achieving a high general level of environmental protection.

I greatly acknowledge all government agencies, organisations and individuals who provided valuable comments, feedback and input into the development and publication of this guideline. I sincerely hope this guideline is utilised meaningfully by relevant stakeholders including pig farm operators for a more sustainable environment in Sabah.

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1 Introduction

1.1 Aim

The aims of this Guideline are:

- i. to produce specific guidance to pig operators in order to minimise environmental issues resulting from the uncontrolled pig farming activities in Sabah; and
- ii. to evaluate the present pig farming applications criteria and recommend effective and practical measures to improve monitoring of pig farming activities in Sabah.

1.2 Regional and Sabah Context

- i. Pig farming represents one of the significant sub-sectors in the livestock industry in Malaysia for the output value. The country is also reportedly at 90% self-sufficient in pork supply. According to the Department of Veterinary Services (DVS) Malaysia (as per 2020 records), Perak accounted for the highest number of pig productions in Malaysia, and Sabah ranked 6th.
- ii. Pig production in Sabah is vital to the State due to its self-sufficiency in pork for the domestic market, and it represents the second most crucial sector. As of the Year 2020, there are forty-five (45) registered pig farms of various sizes operating in Sabah with a Standing Pig Population (SPP) of approximately 90,660 (refer to **Table 1-1**).

Table 1-1: Distribution of Pig Farms in Sabah in 2020

District	Number of Farm	Current Standing Pig Population (SPP)
Keningau	2	200
Kota Kinabalu	4	7,100
Kudat	3	440
Papar	6	7,600
Penampang	3	3300
Sandakan	9	8,800
Tawau	6	26,000
Tenom	2	220
Tuaran	10	37,000
Total	45	90,660

Source: Department of Veterinary Services (DVS) Sabah, 2020

2 Legislations, Guidelines and Certifications

- i. The existing legislations, guidelines and certifications available and relevant to pig farming activities throughout Malaysia is listed in **Appendix 4**.
- ii. In Sabah, the relevant legislations gazetted by the State Government associated with pig farming activity are as follows:
 - a. Animals Ordinance 1962 (No.16 of 1962) Control of Livestock Activities (Pig) Rules 2008; and
 - b. Environment Protection (Control of Pig Farming Pollution) Rules 2008.

3 Existing Pig Farming Methods in Sabah

The methods of pig farming currently practiced in Sabah are summarised in **Table 3-1**.

Table 3-1: Pig Farming Methods in Sabah

No	Item	Pig Farming Method		
		Traditional	Conventional	Modern
1.	Farm scale category	Family-sized farm	Small to large-scale farm	Small to large-scale farm
2.	Type of farming	Subsistence farming	Commercial farming	Commercial farming
3.	Typical design of pigsty	Open-shed with concrete flooring and partition.	Open or closed-shed with concrete flooring and galvanised steel fencing.	Closed-shed with concrete flooring and aluminium-zinc sheet wall.
4.	Farm specialisation	Not available	Available	Available
5.	Feeding of pig	Unregulated nutrients	Regulated nutrients	Regulated nutrients
6.	Handling of pig manure	Discharge into an open pond	Manure pit/ponding system	Biogas system
7.	Handling of carcasses	Deep pit burial	Deep pit burial or open-pile burning	Deep pit burial or open-pile burning
8.	Handling of wastewater	Direct discharge to ground/ open pond.	Treated in series of treatment ponds prior to discharge to nearby streams.	Treated in series of treatment ponds with zero-discharge.

No	Item	Pig Farming Method		
		Traditional	Conventional	Modern
9.	Drainage system	No proper drainage system.	Combined wastewater and stormwater drainage system.	Separate wastewater and stormwater drainage system.
10.	Final discharge point	No established final discharge point.	Discharge to nearby watercourse.	No discharge to public waterways. Treated wastewater is recycled or reused for farm application or land techniques.

3.1 Traditional Pig Farming Method

- i. The traditional pig farming method is referred to as free-range and backyard pig rearing, mainly for home consumption purposes.
- ii. This subsistence farming method does not require a large land area as the pigs can be accommodated in an open-shed pigsty designed of a wooden structure supporting the roof, concrete flooring and concrete partition to separate individual pig pens (**Plate 3-1**).
- iii. Most pigs are raised from birth to maturity, with no specialised farms designed to care for the pigs at each life cycle stage.
- iv. Feeding of the pigs is also of unregulated nutrients such that the pigs are fed with cultivated vegetables, grass and even table scraps.



(a) Family-sized open-shed pig farm.



(b) Pig pen separation.



(c) Pig breeding in a traditional pig farm.

Plate 3-1: Example of a Traditional Pig Farm in Sabah

- v. The common method of waste handling in a traditional pig farm is illustrated in **Figure 3-1**.

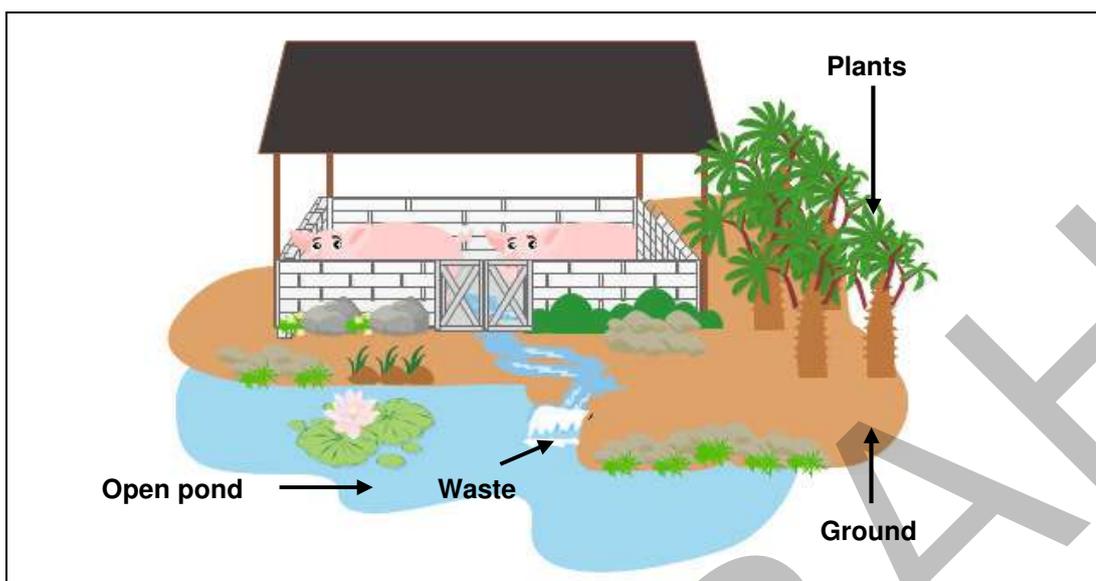


Figure 3-1: Common Method of Waste Handling in a Traditional Pig Farm

3.2 Conventional Pig Farming Method

- i. The conventional pig farming method is rearing a larger scale of pigs in an open or closed-shed farming system for commercial purposes (**Plate 3-2**).
- ii. Conventional pig farms have specialised pig pens to separate the pigs according to their different production requirements.
- iii. In terms of feeding, the pigs are fed according to their body weight and classification, as described in **Table 3-2**.

Table 3-2: Feeding Rates by Pig Classification

Pig Classification	Feed Intake (kg/day)
Weaners	0.7
Growers	1.5
Finishers	2.5
Gestating sows	1.8
Lactating sows	2.5

Source: *Pig Waste Management and Recycling*, E. Paul Taiganides, 1992.

- iv. This farming method adopts the most convenient way to handle the pig manure, i.e., to wash it down the drain enclosing the area of the pens whereby the discharge is thereafter channelled into a series of treatment pond for further retention, prior to discharge into the nearby stream (refer to **Plate 3-3**). Wastewater from this farming system generally results from the bathing of pigs and cleaning the pig sties, which are conducted routinely at an average frequency of twice a day. The typical wastewater flow in a conventional pig farm is illustrated in **Figure 3-2**.



(a) Open-shed pig farm. (b) Pig pen separation of a conventional pig farm. (c) Combined wastewater and stormwater drainage system.

Plate 3-2: Example of Conventional Pig Farm (Open-Shed) in Sabah



Plate 3-3: Aerial View of a Conventional Pig Farm in Sabah

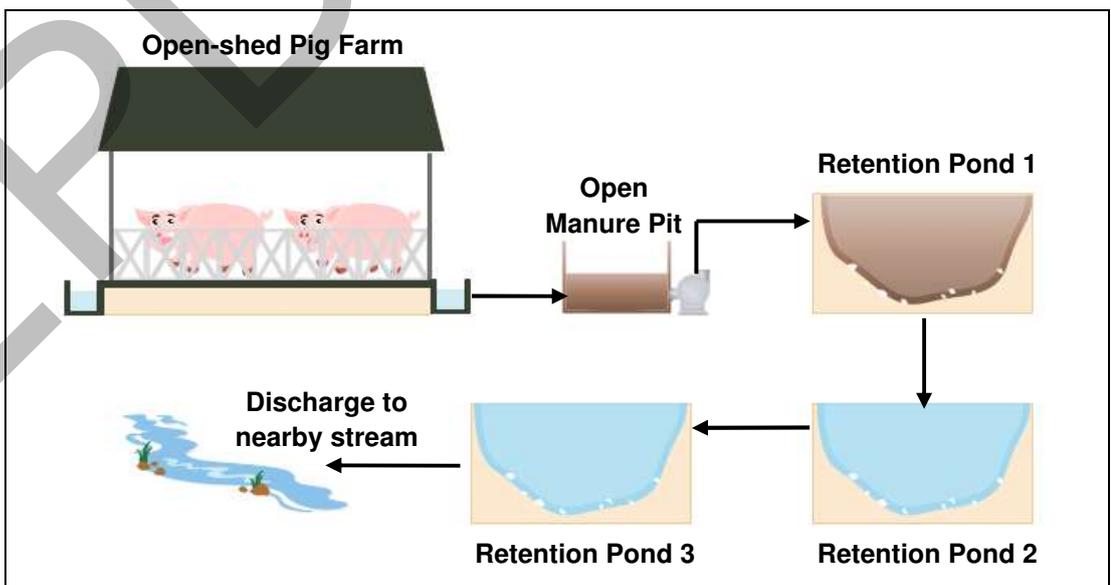


Figure 3-2: Typical Wastewater Treatment Flow at a Conventional Pig Farm

3.3 Modern Pig Farming Method

- i. The modern pig farming generally applies similar practices to that of conventional pig farming, particularly in terms of the farm specialisation, feeding, bathing, routine cleaning of pig sties, and handling or carcasses, except that this farming method is operated in a fully enclosed facility designed with adequate ventilation and employs a more sophisticated system in managing its pig manure and wastewater.
- ii. The various components comprise the following (**Plate 3-4**):
 - a. Underground-internal drainage facility to capture the wastewater containing pig manure;
 - b. Biogas capturing pond for methane gas production to generate electricity for the worker's house and to cook and heat up pigs' food (see **Plate 3-5**); and
 - c. Series of retention pond with no wastewater discharge into the public waterways (see **Plate 3-6**).
- iii. The typical wastewater treatment flow in a modern pig farm is illustrated in **Figure 3-3**.

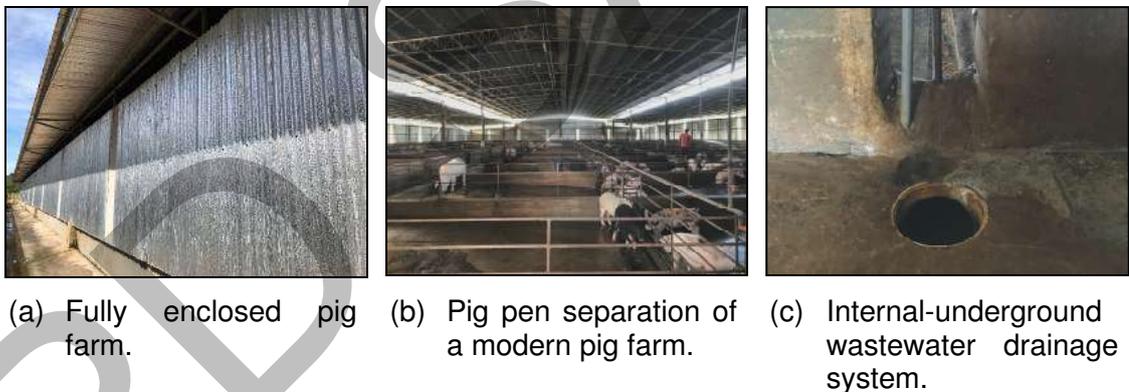


Plate 3-4: Example of a Modern Pig Farming in Sabah



Plate 3-5: Biogas Capturing Tank for Supply of Fuel

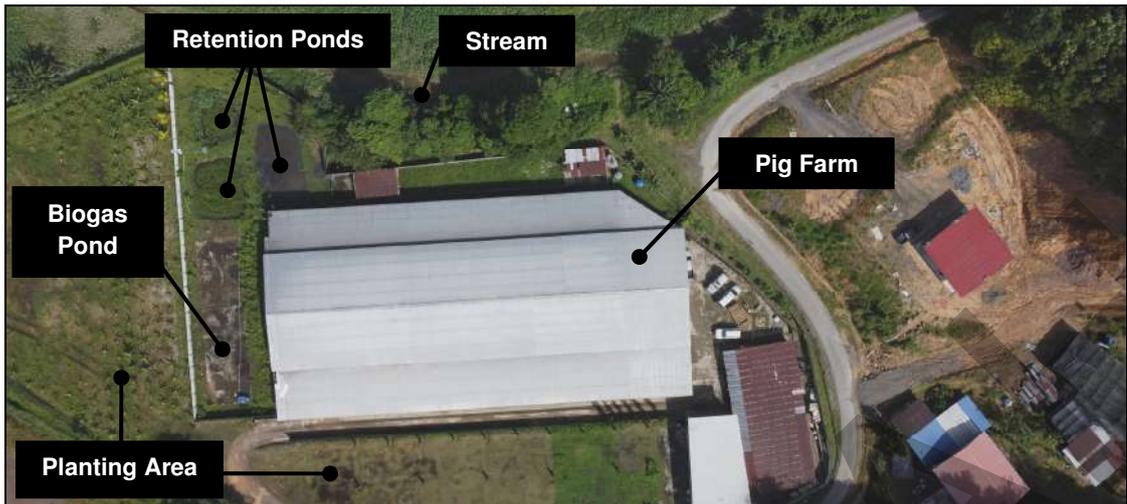


Plate 3-6: Aerial View of a Modern Pig Farm in Sabah

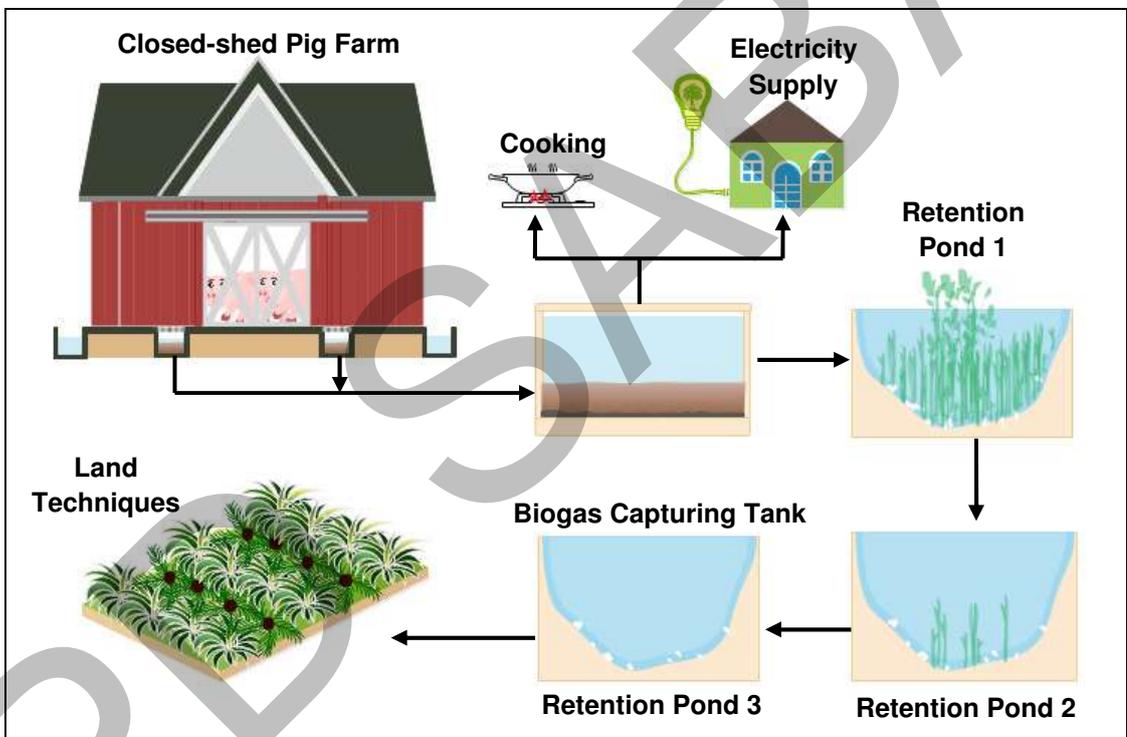


Figure 3-3: Typical Wastewater Treatment Flow at a Modern Pig Farm

4 Key Environmental Issues

The identified environmental issues associated with the pig farming activities in Sabah can be categorised into odour nuisance, water pollution, solid waste management and logistic issue. The root causes of these issues are as follows:

4.1 Odour Nuisance

i. Inappropriate Handling of Pig Manure.

Flushing of pig manure directly into the ponds as commonly practiced in most conventional pig farms causes the generation of various metabolic compounds, including hydrogen sulphide (H_2S) and ammonia (NH_3), arising from the anaerobic decomposition of the manure, thus leading to a continuous source of the persistent and unreasonably offensive odour (Wanninger T. B., 2011). This polluting fume is then dispersed by airborne dust to the downwind residential areas, which can reach to an average distance of about 700 m.



(a) Direct flushing of manure into the open pond.

- ### ii. Improper Disposal of Pig Carcasses.
- Pig carcasses that are not immediately or properly disposed contributes to the generation of foul odour caused by the bacterial activity during the biodegradation process.



(b) Carcass is left lying at the disposal site.

iii. Poor Management of Pig Farm.

Generation of odour that originates from the pig farm is often associated with overly dusty or dry farm, poorly managed farm, and improper field application of manure. The odour dispersion may not be as significant as the odour emitted from the improper handling of the manure and pig carcasses; however, the level of odour detected is enough to cause nuisance to the residents living within the vicinity of the farms.



(c) Unhygienic pigs due to poor management of pig farm.

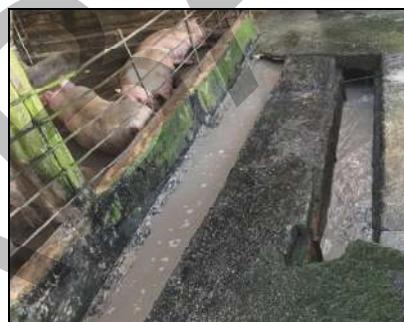
4.2 Water Pollution

- i. **Overstocking of Pig Population.** The overstocking of livestock resulting from the expanding pig population has led to an excessive generation of waste and wastewater; thus, the under-designed capacity of the treatment system will translate into inefficient performance of the ponding system, and occasional uncontrolled overflows of wastewater into the nearby watercourse.



(a) Overstocking of pig population.

- ii. **Improper Design of Drainage System.** The improper design of drainage systems to cater for the stormwater and wastewater separately is also one of the significant causes of pond overflowing, particularly during a heavy downpour and incessant rain due to the overloading quantity of water that is introduced into the ponds.



(b) Combined stormwater and wastewater drainage system.

- iii. **Unsuitable Design of Treatment Pond and Lack of Available Land.** Most ponding systems are of simple earth excavation without linings thus causing the potential percolation of wastewater into the groundwater and eventually contaminating the water-ecosystem with nitrates emanating from the pig manure thereby leading to algae bloom that uses up most of the available oxygen in the water (Wanninger T. B., 2011). The impact to the environment is worsened when there is a lack of available land to build suitably sized lagoon and lack of finance to improve the wastewater management system.



(c) Treatment pond designed of a simple earth excavation without linings.

- iv. **Inappropriate Design of the Waste Treatment System.** The absence of a proper solid waste separation process has caused excessive accumulation of waste consisting of pig manure and feed waste in the lagoons that promotes bacteria's propagation in the wastewater. The readily available food source from the partially decomposed organic material within the pig manure causes the available oxygen to be used up, thereby elevating the Biochemical Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) concentrations in the wastewater.



- (d) Foamy and blackish appearance of wastewater discharged from the wastewater treatment system of a pig farm.

Table 4-1 presents the characteristics of raw and treated wastewaters in a conventional pig farm, in comparison to the discharge limits stipulated by the relevant authorities.

Table 4-1: Typical Characteristics of Wastewater from a Conventional Pig Farm

No	Parameter	Concentration		Discharge Limit		
		Raw	Treated	EPD ⁽¹⁾	DOE ⁽²⁾	DVS ⁽³⁾
1.	pH	5.12	5.27	NS	<6.8 – 7.3	NS
2.	Biochemical Oxygen Demand, BOD (mg/L)	1,030	449	20 – 250*	<20	50
3.	Chemical Oxygen Demand, COD (mg/L)	1,220	732	50 – 500*	<200	500
4.	Total Suspended Solids, TSS (mg/L)	304	31.0	50 – 500*	<50	100
5.	Ammoniacal Nitrogen, AN (mg/L)	152	74.2	NS	<80	NS
6.	Threshold Odour Number, TON (mg/L)	200	12	NS	-	NS
7.	Faecal Coliform Count, FCC (CFU/100 mL)	>16400	>16400	NS	<300	NS

Note sources: (1) Environment Protection (Control of Pig Farming Pollution) Rules 2008; (2) *Garis Panduan Sistem Pengolahan Efluen (SPE) Bagi Penternak Babi*, DOE, 2016; (3) *Garis Panduan Pengurusan Sisa Ternakan Babi*, DVS, 2019; "NS" denotes Not Specified; "*" denotes that the limits are allowed to be achieved in three phases for existing farms.

4.3 Solid Waste

The environmental issues associated with the improper solid waste management is commonly underlying the odour nuisance and water pollution issues. The causes of solid waste pollution are as follows:

- i. Unavailability of Solid Waste Separation Process.** Flushing of pig manure and feed waste directly into the lagoons system causes the increases the BOD and COD concentration in the wastewater; decreases the hydraulic retention time of the treatment ponds resulting in reduced pond treatment efficiency; generation of foul odour arising from the accumulation of manure in the lagoons; and uncontrollable lagoons overflow resulting from the excessive generation of pig manure in the case of overstocking pig population.
- ii. Improper Handling of Feed Wastes.** Exposing the feed wastes for extended periods under a damp condition provides a suitable breeding ground for the flies to regenerate. The number of flies causes increased annoyance for the residents living nearby the breeding grounds as the flies are difficult to control with insecticides.
- iii. Improper Disposal of Pig Carcasses.** Pig carcasses that are not promptly disposed of eliciting the generation of malodour due to natural decomposition of the carcasses; provides a suitable breeding environment for vectors and other pathogenic organisms, and attracts pig-hunting dogs to the farm compound. The hauling of the microbially contaminated carcasses to the local communities' home compounds promotes the potential spread of pathogens resulting from the carcasses' contaminated blood or tissue.
- iv. Uncontrollable Open-Pile Burning of Pig Carcasses.** The disposal of carcasses by employing open-pile burning leads to air pollution such that toxic compounds, including dioxins and furans, are released due to incomplete combustion (Gwyther C. L. et al., 2011).
- v. Unavailability of Proper Sludge Treatment System.** The absence of sludge storage allocation such as sludge drying bed or compost shed in most pig farms complicates lagoons desludging that it cannot be conducted frequently. Therefore, the poor upkeep of the lagoons leads to pond overflowing due to the increased sludge accumulation.

4.4 Logistic Issue

The vehicles may inevitably cover significant distances between farms, thereby resulting in increasing number of road potholes due to the trucks being laden with pigs, on top of contaminating the road with odorous wastewater and waste droppings from the vehicle.

5 Siting and Buffers

5.1 Siting of Existing Pig Farm

- i. The establishment of commercial pig farms in Sabah emerges mainly within nearby residential areas (**Plate 5-1**), at a distance ranging between 10 and 100 m. This is because most commercial pig farms evolved from family-sized subsistence pig farms, and some have also existed years before the development of the surrounding settlements.
- ii. The rapid development of urban areas, particularly within the close proximity of the commercial pig farms development, has profoundly raised concerns on the safety and security among the local communities and the government authorities alike.
- iii. The inappropriate siting of the present commercial pig farms near to watercourses or low-lying area also cause serious environmental concerns because they are likely to contain contaminants which include mostly pig manure or other chemical contaminants.



Plate 5-1: Establishment of a Pig Farm Nearby Settlements and River

- iv. All existing subsistence and commercial pig farms shall adopt the Best Management Practices (BMPs) (**Section 6**) to achieve a reduction in odour nuisance, water pollution, solid waste pollution and other environmental disturbances emanating from the pig farming activities.
- v. On the other hand, commercialised pig farms shall employ the Best Available Techniques (BATs) (**Section 7**) to ensure efficient management of wastes.
- vi. In terms of the siting and buffers, an Investigative or Enforcement Approach as elaborated in **Table 5-1** shall be adopted, particularly for existing pig farms that do not fulfil the proposed siting criteria as detailed in **Table 5-2**. By this investigative approach, an assessment of the level of odour intensity perceived by the identified nearest receptor, i.e., the residential areas, religious institution, school and public health facilities, can be carried out to determine the enforcement approach to be implemented on existing pig farms.

Table 5-1: Enforcement Approach for Odour Investigative Scenario

No.	D/T*	Description	Enforcement Approach
1.	<2	No odour is detectable or likely to be detectable.	No further action will be required.
2.	0		
3.	2	Odour is detectable and may or may not cause offense.	Remedial measures will be required from the pig operators.
4.	4		
5.	7	Strong odour is detectable.	If no appropriate measures have been adopted on-site, enforcement approach will be imposed towards pig operator. However, if appropriate measures have been adopted on-site, a level of residual odour will have to be accepted by the surrounding land uses.
6.	15	Very strong odour is detectable.	Enforcement approach will be imposed towards pig operator. It may be necessary to suspend or revoke the pig farm operation in full or in part.

Notes:

- (i) Measurement is conducted at nearest receptor using Nasal Ranger® Field Olfactometer.
- (ii) "D/T" denotes Dilution to Threshold value measured.

- vii. The measurement shall be carried out at four sides of the farm boundary to determine the perceived residual odour from the farm operation and at the identified sensitive receptors. The assessor shall identify the presence of the farm residual smell (if any) and quantify its perceived concentration (in D/T). The sampling shall be carried out three (3) periods of the day, i.e., morning, afternoon and night-time. Details with regards to the method statement of this odour sampling and determination exercise using the Nasal Ranger is appended in **Appendix 5**.

5.2 Siting for New Pig Farm

Table 5-2 outlines the key siting criteria that should be followed in setting up new pig farms.

Table 5-2: Criteria for New Pig Farm Establishment

Criteria	Description
Land zoning	Rural/ country-side area.
Land location	<ul style="list-style-type: none"> i. Minimum 20 m from any public or private road, or boundary of adjacent land. ⁽¹⁾ ii. The establishment of a new pig farm in an urban setting is not recommended.
Topography	Avoidance of low-lying areas near streams with flooding potential.
Hydrology	<ul style="list-style-type: none"> i. Minimum 200 m downstream from any potable water supply intake point; ⁽¹⁾ and ii. Minimum 50 m upstream and downstream from any watercourses. ⁽¹⁾
Water abstraction	Consultation and approval from the Department of Irrigation and Drainage (DID) must be obtained for the abstraction of water from the watercourses.
Road infrastructure	Area is served with good road infrastructure which allows easy access to the pig farm.
Implementation of the Best Management Practices (BMPs)	All subsistence and commercial pig farms shall adopt the BMPs (Section 6) to abate pollution.
Use of the Best Available Techniques (BATs)	The commercial pig farms shall apply the BATs (Section 7) to efficiently manage waste, including the treatment, storage, discharge and disposal of waste.
Buffer zone	Refer Section 5.3 .

Note sources: (1) Environment Protection (Control of Pig Farming Pollution) Rules 2008; Criteria not exhaustive.

5.3 Buffer Zone Recommendation

- i. Establishment of a new pig farm (commercialised) in an urban setting is not recommended.
- ii. Establishment of a new pig farm (commercialised) with a rural setting is, however, allowed, provided that the recommended minimum buffer distance measure from the pig farm boundary to the nearest receptor, i.e., the residential areas, religious institution, school and public health facilities, is complied.
- iii. The minimum buffer zone recommendation for a new pig farm establishment with a rural setting varies depending on the scale of pig farming and the BMPs and BATs implementation scenarios. There are five (5) sets of buffer zone scenario proposed in this Guideline as illustrated in **Plate 5-2** and **Plate 5-3** with details specified in **Table 5-4**.
 - a. In Scenario 1, depending on the size, for a new pig farm with BMPs without applying manure acidification and additives and a Wastewater Treatment System (WWTS) without installing a Biogas facility, the recommended minimum buffer zone ranges from 300 to 500 m.
 - b. In Scenario 2, the recommended minimum buffer zone is further reduced with buffer distance ranging from 275 to 450 m, with the additional implementation of odour BATs comprising of Windbreak and Odour Neutraliser, on top of the BMPs (without manure acidification or additives) application and WWTS (without Biogas facility) installation.
 - c. In Scenario 3, the recommended minimum buffer zone is even more reduced between 250 and 400 m with the application of manure acidification or additives as part of the BMPs, on top of the WWTS (without Biogas facility) and odour BATs (inclusive of Windbreak and Odour Neutraliser) installation.
 - d. In Scenario 4, for a new pig farm with BMPs implementation involving the utilisation of manure acidification or additives, installing a WWTS comprising of Biogas facility, and odour BATs inclusive of Windbreak, Odour Neutraliser, the recommended minimum buffer zone ranges from 225 to 350 m.
 - e. In Scenario 5, for a new pig farm with the implementation of BMPs involving the utilisation of manure acidification or additives, installation of WWTS comprising of Biogas facility and odour BATs inclusive of Windbreak, Odour Neutraliser and Air Pollution Control System (APCS), the recommended minimum buffer zone ranges from 200 to 300 m.

- iv. With more BATs in place, the buffer distances from the nearest receptors, i.e., nearest house/ residential areas, religious institution, school and public health facilities, can be reduced even further.
- v. The recommended minimum buffer zone presented in **Plate 5-3** and **Table 5-4** is based on flat terrain. For different terrain settings, the buffer zone may be adjusted considering the location of the odour sensitive receptors as further described in **Table 5-3**. **Table 5-3** is extracted from the 'Assessment and Management of Odour from Stationary Sources in NSW, Department of Environment and Conservation NSW, November 2006', mainly for pig farm.

Table 5-3: Ratio Consideration Based on Different Terrain Settings for Pig Farm

No	Type of Terrain	Ratio	Description
1.	Valley drainage zone	2.0	A valley drainage zone has topography at low relief with significant confining sidewalls.
2.	Low relief	1.2	Low relief is regarded as terrain which is generally below the 2% slope from the pigsties. Thus, the receptor will be downhill from the pigsties.
3.	Flat	1.0	Flat is regarded as less than 10% upslope, 2% downslope and not in a valley drainage zone.
4.	Undulating between farm and receptor	0.9	Undulating hills is regarded as terrain where the topography consists of continuous rolling, generally low-level hills and valleys with minimal vegetation cover, but without sharply defined ranges, ridges or escarpments.
5.	High relief or significant hills and valleys between farm and receptor	0.7	High relief is regarded as upslope terrain or a hill that projects above the 10% rising slope from the pigsties. Thus, the receptor location will be either uphill from the pigsties, behind a significant obstruction or comprise of significant hills and valleys between the pigsties and the receptor.

Source: Assessment and management of odour from stationary sources in NSW, Department of Environment and Conservation NSW, November 2006.

For example, a pig farm with SPP of 2,500 pigs located on Flat Terrain under rural setting, with BMPs with manure acidification and additives, WWTS without a Biogas facility and odour BATS comprising of Windbreak and Odour Neutraliser in place requires a recommended minimum buffer zone of 325 m (Scenario 3 of **Plate 5-3** and **Table 5-4**). With the ratio of 0.9 (Undulating Hills), the recommended minimum buffer zone considering the surrounding terrain that can be adopted for this pig farm will be about 293 m (i.e., 325 m x 0.9).

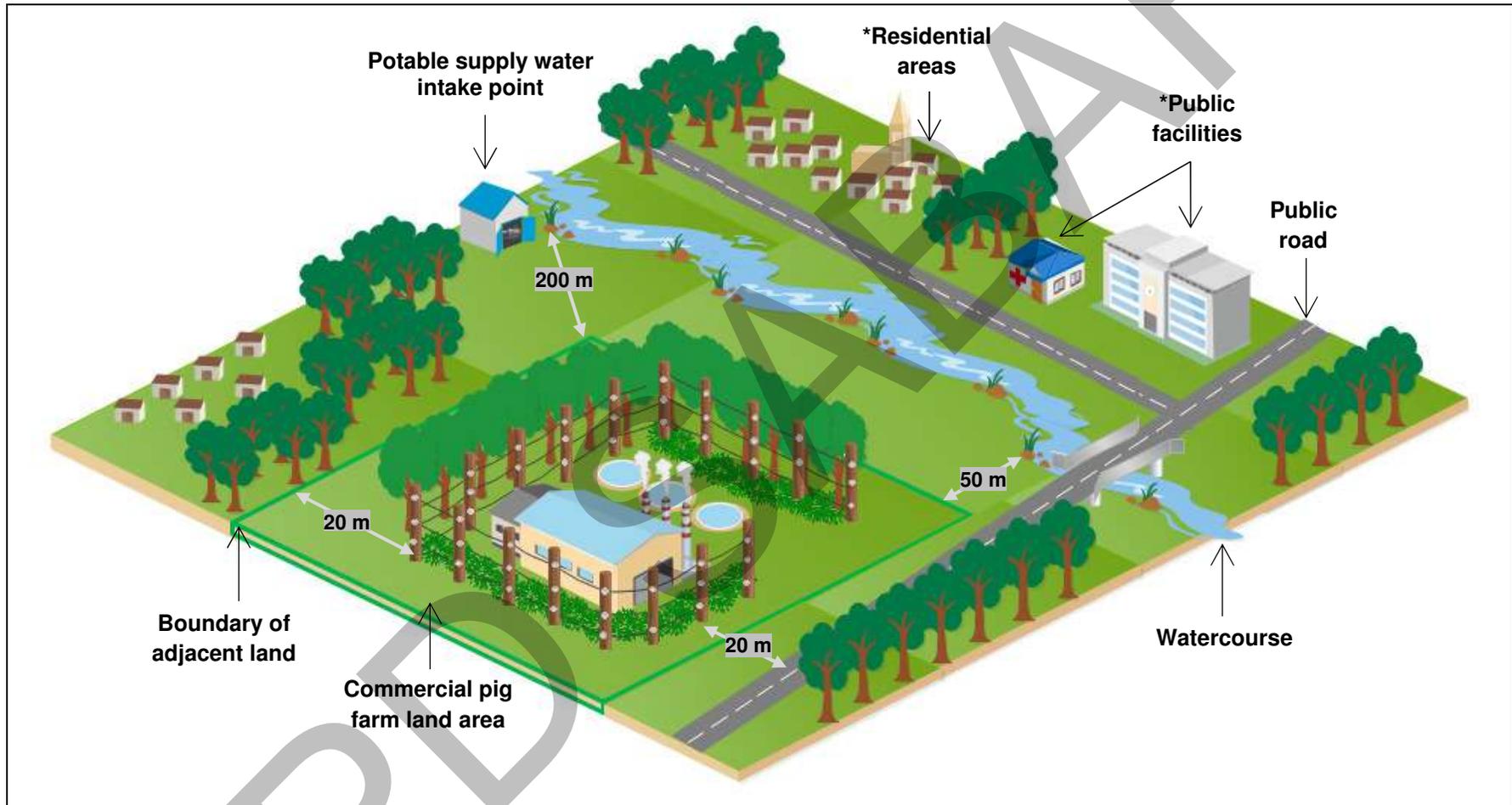


Plate 5-2: Pig Farm Establishment in Rural Setting

*Note: * The buffer zone between a pig farm and the nearest receptor (i.e., residential areas, religious institution, school and public health facilities) is subjected to the scale of pig farming and the BMPs and BATs implementation scenario (refer **Plate 5-3** and **Table 5-4**). The establishment of a new pig farm in an urban setting is not recommended.*

Guideline on Pollution Control for Pig Farming Activities in Sabah

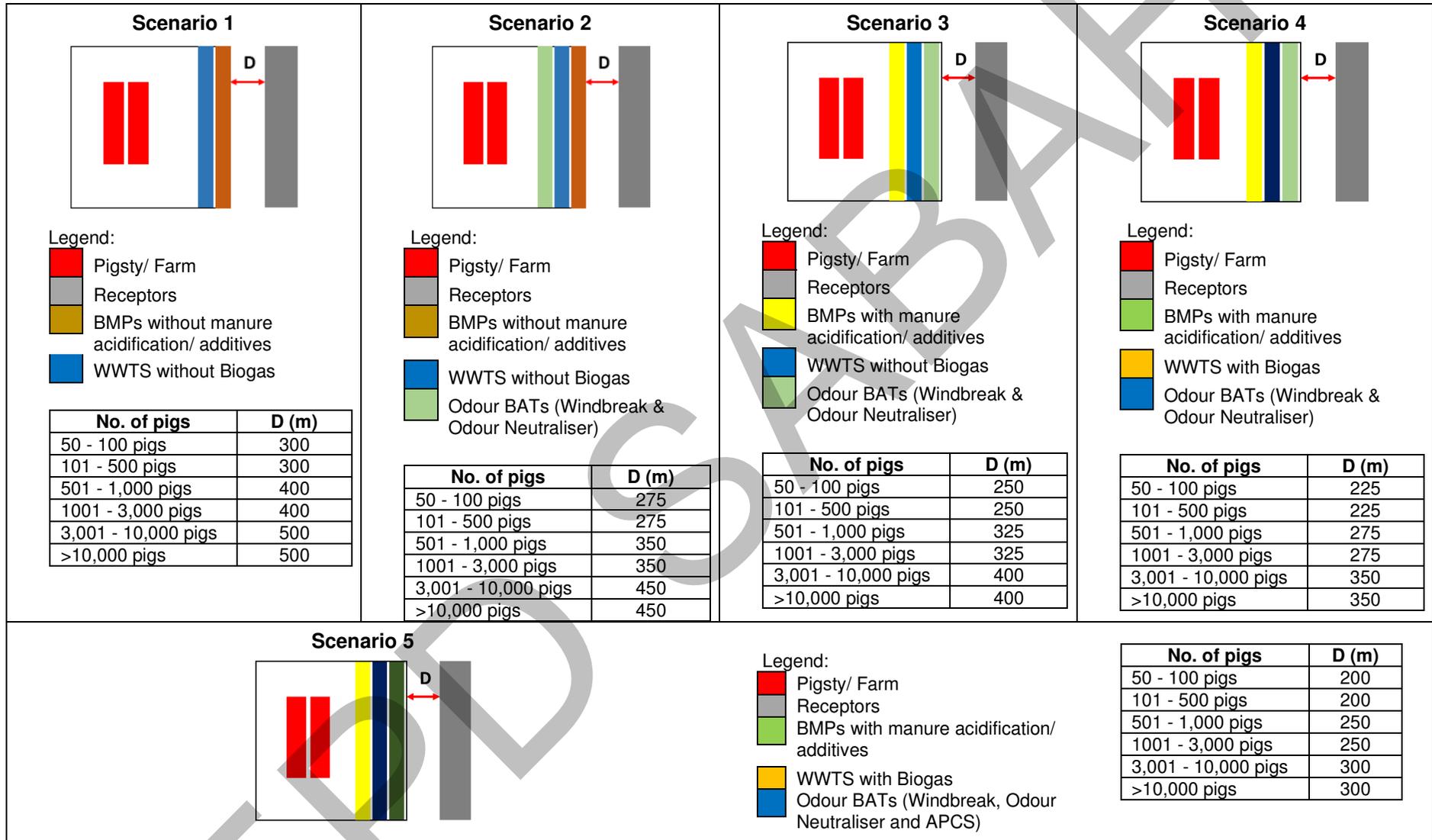


Plate 5-3: Recommended Minimum Buffer Zone for New Pig Farm (Rural Setting)

Table 5-4: Recommended Minimum Buffer Zone for New Pig Farm (Rural Setting)

Scale of Pig Farms	Recommended Buffer Zone (m)				
	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5
	✓ Best Management Practices (BMPs) – without manure acidification/ additives ✓ Wastewater Treatment System (WWTS) - without Biogas	✓ BMPs – without manure acidification/ additives ✓ WWTS - without Biogas ✓ Odour BATs - Windbreak and Odour Neutraliser	✓ BMPs – with manure acidification/ additives ✓ WWTS - without Biogas ✓ Odour BATs - Windbreak and Odour Neutraliser	✓ BMPs – with manure acidification/ additives ✓ WWTS - with Biogas ✓ Odour BATs - Windbreak and Odour Neutraliser	✓ BMPs – manure acidification/ additives ✓ WWTS - with Biogas ✓ Odour BATs – Windbreak, Odour Neutraliser and Air Pollution Control System (APCS)
50 - 100 pigs	300	275	250	225	200
101 - 500 pigs	300	275	250	225	200
501 - 1,000 pigs	400	350	325	275	250
1001 - 3,000 pigs	400	350	325	275	250
3,001 - 10,000 pigs	500	450	400	350	300
>10,000 pigs	500	450	400	350	300

Notes:

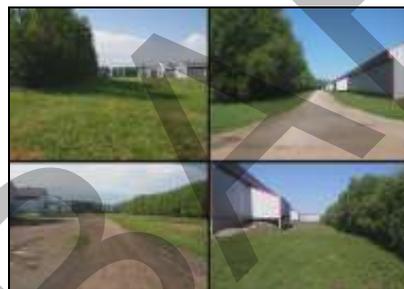
- (i) Residual odour at less than 7 D/T (determined by Nasal Ranger® Field Olfactometer) or noticeable level is anticipated occasionally during adverse meteorological condition. Refer to **Appendix 5** for the Odour Assessment by using Nasal Ranger® Field Olfactometer.
- (ii) Recommended minimum buffer zone above is based on flat terrain. For different terrain setting, the buffer zone may be adjusted in consideration of the location of the odour sensitive receptors. The ratio that can be considered is as follow:
 - (a) Valley drainage zone: 2.0
 - (b) Low relief: 1.2
 - (c) Flat: 1.0
 - (d) Undulating between farm and receptor: 0.9
 - (e) High relief or significant hills and valleys between farm and receptor: 0.7

6 Best Management Practices (BMPs)

All subsistence and commercial pig farms shall adopt the BMPs to maintain a sustainable direction and healthy development of the pig farming industry; and ensure the well-being of the community and the environment. The BMPs that can be suited in **all types and scales of pig farming activities** include the followings:

6.1 Pig Farm, Pig Stocking Density and Ventilation

- i. Allocation of the vegetative buffer by planting trees and shrubs surrounding the pig farm compounds is necessary to create a windbreak downwind and upwind to dilute and disperse odours and allow odorous dust from the pigsties and manure storage area to deposit. Where possible, planting fruit trees surrounding the pig farm compound shall be avoided to keep pests away.

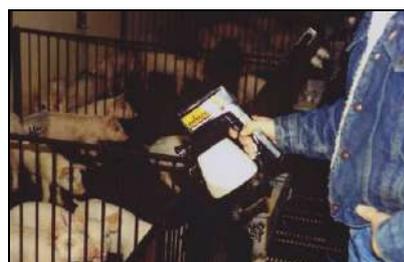


(Source: Tyndall, J. and J. Colletti. 2007)

- ii. A closed-shed pigsty is highly recommended as it has strong airflow characteristics as compared to an open-shed pigsty. A closed-shed pigsty can help to minimise odour dispersion to the surrounding environment and reduce the amount of water consumption and facilitate handling of manure.



- iii. Oil sprinkling by spraying vegetable oil within the pigsty can be considered to reduce dust formation and emissions. Misting oils into the odorous air within the pigsty reduces airborne bacteria and gaseous that cling to the dust particles as the odorants are absorbed into the tiny droplets of oil and subsequently degraded through chemical reactions.



(Source: University of Minnesota)

- iv. The stocking density on a farm shall be reduced to minimise the generation of waste. The number of livestock to be reared on a farm can be determined according to the pigsty's floor area and the pig classification, as shown in **Table 6-1**. The area and size of a pigsty shall be according to its optimum efficiency to operate and manage and not based on the optimum population. The size and pig population shall also be controlled based on the ratio of the local consumer.

Table 6-1: Stocking Density at Different Stages of Production

No	Classification of Pig	Body Weight or Age	Stocking Density (m ² /pig)
1.	Weaner ⁽¹⁾	Up to 25 kg or 12 weeks	0.25 – 0.35
2.	Grower ⁽¹⁾	Up to 40 kg or 17 weeks	0.40 – 0.50
3.	Finisher ⁽¹⁾	Up to 60 kg or 21 weeks	0.50 – 0.70
		Up to 90 kg or 27 weeks	0.60 – 0.90
		Up to 120 kg or 33 weeks	0.70 – 1.0
4.	Gestating sow ⁽²⁾	Up to 40 kg or 16 weeks	1.5 – 2.0
5.	Lactating sow ⁽²⁾	Up to 40 kg or 16 weeks	4 – 6

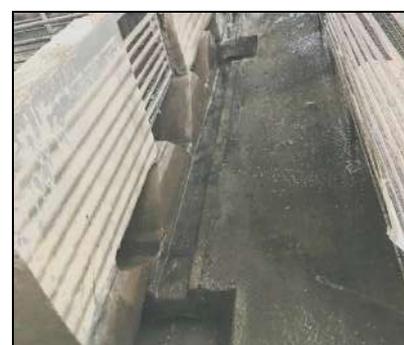
Sources: (1) *Floor Space Requirement for Housing and Welfare of Pigs Under Indian Perspective, 2019*; (2) *Farmer's Hand Book on Pig Production, FOA, 2019*.

- v. A separate drainage system for stormwater and wastewater shall be constructed. The stormwater drainage system shall be constructed outside of the pigsty, at uncovered areas. In contrast, the wastewater drainage system shall be located within the pigsty under covered areas.



(a) Concrete stormwater drainage at uncovered area.

- vi. A closed drainage system shall be constructed with impermeable materials to collect and transport wastewater to the wastewater treatment facilities.



(b) Concrete wastewater drainage at covered area.

- vii. The pigsty flooring shall be of cemented flooring and designed of sloping floors to direct all wastewater from the washing and bathing process into the drainage system. The concrete flooring shall also avoid seepage of wastewater onto the ground. The pigsty flooring shall be raised approximately 60 cm above the ground level, as demonstrated in **Figure 6-1**.



- viii. The use of slatted floors are highly encouraged as it can reduce the amount of water consumption for bathing of the pigs and washing of the floors. The small holes allow waste to fall directly into the drainage system, as illustrated in **Figure 6-1**.

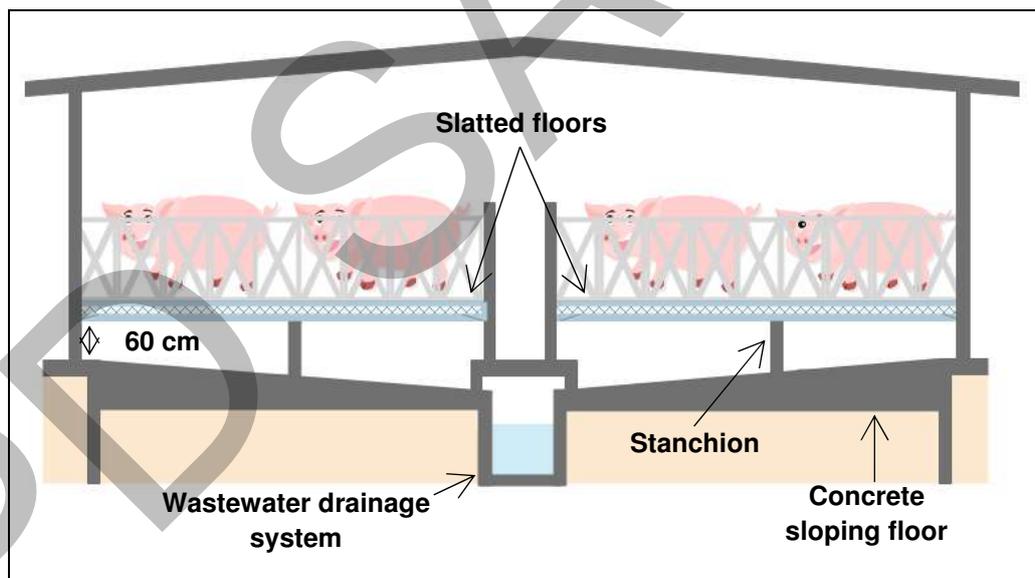


Figure 6-1: Recommended Flooring Design of a Pigsty

- ix. Subject to the type of ventilation used, the pig operators shall ensure that the ventilation is adequate according to the farm scale. Ventilation discharge points of the pigsty should be cleaned once a week to ensure that no accumulated dust could obstruct the airflow and affect the ventilation as it may lead to odour and air pollution.

- x. Where possible, the zero-discharge concept shall be practised such that no wastewater is discharged into the nearby watercourses. The treated wastewater can be reused or recycled for farm application purposes such as cleaning of pigsty or reused as bio-fertiliser for crops mainly grown within the pig farm compound to feed the pigs or for subsistence consumption, as indicated in **Figure 6-2**.



- (c) Treated wastewater is reused for the watering of crops to feed the pigs.

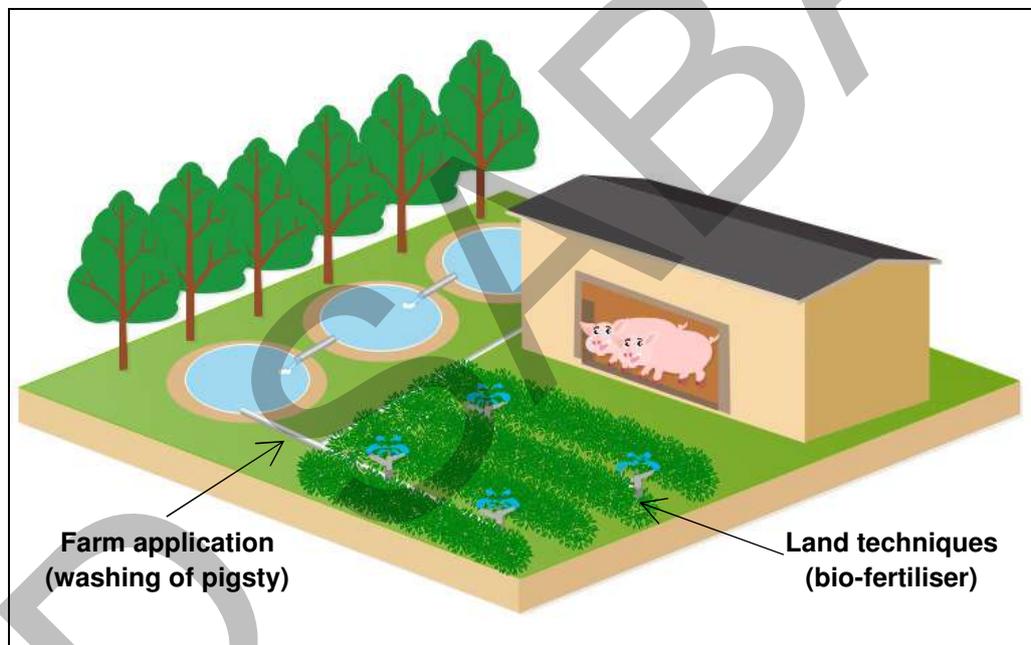


Figure 6-2: Application of Zero-Discharge Concept in a Pig Farm

6.2 Feed

- i. The use of enzymes on foods, drinking water, and manure can be applied to increase the waste treatment system's effectiveness and reduce odour.



(Source: DVS, 2019)

- ii. Diet manipulation can be employed to reduce emissions from pigsties and manure storage by improving feed efficiency (nutrient input reduction, nutrient form modification, phase/split sex feeding).



(Source: National Pork Board)

6.3 Pig Manure

- i. Manure acidification by using granulated ferric sulphate may improve in-barn air quality by reducing ammonia and methane emission from manure storages.



- ii. Application of manure additives can be considered to reduce the emission of odours and gases from the manure storage place by altering the manure's chemical or microbial properties. These substances may include enzymes as discussed in **Item 6.2(i)**, microbes, e.g., Effective Microbes and other chemical amendments, e.g., Photosynthetic Bacteria Powder.



- iii. Impermeable or permeable cover can be applied on manure storages to provide excellent odour, ammonia, and other emission control and minimise any infiltration. Installation of a geosynthetic cover shall be equipped with the fencing surrounding it to protect the cover from being walked on.



(Source: DOE, 2016)

- iv. Solid waste, including sludge and food wastes, shall be safely brought to an appropriate shaded area for composting. The surface of the solid waste collection area shall not be permeable to avoid water seepage contaminating the groundwater. Storing the solid waste away from rainwater exposure and providing a good drainage system will ensure low humidity content, which reduces odour pollution, speeds up the composting process, and prevents vectors' breeding.

6.4 Pig Carcasses

All carcasses shall be disposed of immediately at a location away from the pig farm area and avoiding waterlogged area for fear of water infiltration. No carcass shall be thrown, dumped or deposited into any watercourse or onto any public road.

The disposal of pig carcasses shall either be by deep burial or burning in a manner that would not cause pollution, nuisance or endanger public health and in accordance with the ***Arahan Prosedur Tetap Veterinar Malaysia (APTVM 22(e);1/2010)***. The proposed methods of carcasses disposal are as follows:

- i. Deep Pit Burial
 - a. Approval and consultation from the Department of Veterinary Services (DVS), Department of Irrigation and Drainage (DID), the Lands and Surveys Department (L&S) and the Department of Environment (DOE) shall be obtained prior to selecting the burial sites.
 - b. The proposed method of handling routine on-farm mortalities shall be by deep pit burial as illustrated in **Figure 6-3**. A layer of lime of about 5 cm thickness should be sprinkled in the pit to reduce the risk of virus propagation in the soil. After inserting the carcasses, the pit should be filled up with soil of about 0.2 m, followed by sprinkling another layer of lime before the pit is adequately loaded with soil.

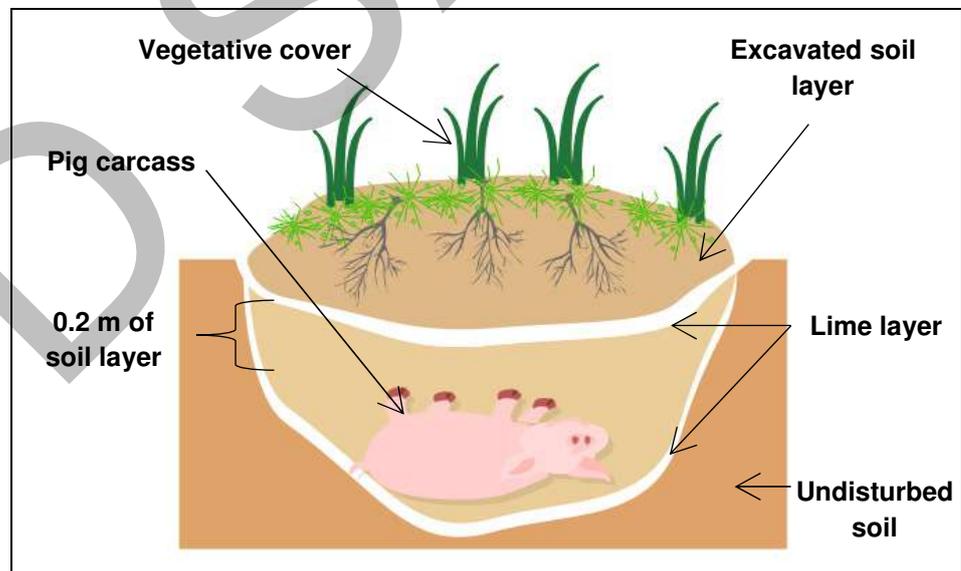


Figure 6-3: Deep Pit Burial of Pig Carcass

- c. Inspection shall be conducted upon completing the burial process to ensure proper filling of the pit and no occurrence of soil or water contamination.

- ii. Burning
 - a. Approval and consultation from the Department of Veterinary Services (DVS) and Department of Environment (DOE) shall be obtained in order to conduct open pile burning.
 - b. The management of pig carcasses by open pile burning shall only be performed at farms that does not have a suitable site for the carcass's burial, i.e., surrounded by waterlogged area and for pigs that are suspected of dying from infectious disease.
 - c. The disposal site shall be fenced to avoid access by wild animals or pig-hunting dogs.
 - d. Cleaning and disinfection of the burning site shall be conducted upon completing the burning process.
 - e. The burning site's location shall be marked by taking its GPS coordinate, and the number of carcasses burnt shall be recorded.
 - f. Should the carcass be incinerated, approval from the Department of Environment (DOE), Sabah must be obtained through an EIA application as this activity is classified as prescribed activities under **Item 14 (b)(i) in Environmental Quality (Prescribed Activities) Environmental Impact Assessment Order 2015.**

6.5 The Transportation of the Pig

The journey of pig transportation shall be carefully planned and prepared, particularly for long-distance journeys. The following practices shall be adopted to minimise the environmental impacts resulting from the pig transportation activity:

- i. A suitable vehicle or conveyance shall be chosen according to the type and number of pigs to be transported and the journey duration to avoid the truck from being laden with pigs;
- ii. Disinfection of the vehicle, particularly the tyres and underneath the truck shall be carried out prior to leaving or entering the premise to avoid spread of disease;
- iii. The vehicle shall be equipped with adequate cleaning kit and side protections to avoid pollution from the truck from contaminating the surrounding environments;
- iv. A fully conditioned truck with good ventilation systems is encouraged to be used for pig transportation to prevent dispersion of unpleasant odour; and

- v. Drivers shall avoid travelling during rush hour and hot weather to inhibit the build-up of gases from the pig wastes inside the trucks as well as to prevent stress on the pigs.

7 Best Available Techniques (BAT)

7.1 Application of the Best Available Techniques (BATs)

The implementation of the BATs is highly encouraged for commercial pig farms to ensure an enhanced growth and quality of pig production. As described earlier in **Section 5.3**, the BATs implementation level in a pig farm will influence the minimum buffer zone requirement. With more BATs are in-place, the buffer distances between a pig farm and the nearest receptor, i.e., the residential areas, religious institution, school and public health facilities, can be reduced accordingly.

Table 7-1 summarises the list of the BATs that can be implemented in a pig farm to abate pollution.

Table 7-1: Application of the Best Available Techniques (BATs)

Pollution	Best Available Techniques (BATs)
Odour	Chimney
	Windbreak Barrier
	Ultraviolet (UV) Light
	Biofilters
	Electrostatic Precipitators
	Wet Scrubber
	Odour Neutraliser/ Fogging System
Wastewater	Pre-manure storage
	Manure separation
	Anaerobic and Aerobic Tank/ Pond
	Settling Pond/ Tank
	Wetland
	Biodigester/ Biogas
	Sequencing Batch Reactor (SBR)
Solid waste	Solid Separator
	Faeces and Urine Segregator
	Pit Ventilation

Note: The above listed BATs are not prescriptive. Additional components/ replacement can be established if deemed necessary.

7.2 Description of the Best Available Techniques (BATs) for Odour

- i. **Chimney.** Installation of chimney allows air to be exhausted above or sidewall of pigsty with increased wind currents to dilute odour emission.



(Source: ISU Swine Teaching Farm)

- ii. **Windbreak Barrier.** Installation of barrier/windbreak wall on fan ventilated pigsty will help to reduce dust and odour emissions.



(Source: Agri Expo)

- iii. **Ultraviolet (UV) Light.** Installation of UV light within the pigsty can be applied as the photocatalytic oxidation process breaks down pollutants [bacteria and volatile organic compounds (VOCs)] into carbon dioxide and water vapour.



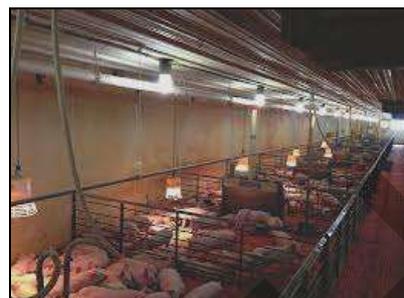
(Source: Airscience Technology Co., Ltd.)

- iv. **Biofilters.** Biofilters mitigate compounds in ventilated air released from pigsty through a series of biological material filter (wood chips) and microbe cultures.



(Source: DVS, 2016)

- v. **Electrostatic Precipitator.** Application of electrostatic precipitator within or when air leaves the pigsty can reduce particulate matter in ventilated air.



(Source: ISU, 2014)

- vi. **Wet Scrubber.** Wet scrubber or bio scrubber can be considered to reduce odour. Wet scrubbers use water or acid to trap dust and capture gases to minimise emission. Bio scrubbers allows growth of bacteria on biomass within the scrubber to convert ammonia into nitrate and nitrite.



(Source: Big Dutchman)

- vii. **Odour Neutraliser/ Fogging System.** Installation of odour neutraliser/ fogging system within the pig shed/ building is necessary to minimise the odour level.
- viii. **Biogas.** In biogas, manure is treated in an enclosed vessel at constant temperature which is ideal for methane production. The methane gas produced can be used as a source of energy.

(a) Biogas (digester type)



(Source: Hunan Along New Energy Technologies Co., Ltd.)

(b) Biogas (storage type)



(Source: Jet Sun Engineering & Trading Services Sdn Bhd)

The installation of Item (i), Item (iv), Item (v) and Item (vi) will require approval from the Department of Environment (DOE), Sabah as per stipulated under the **Environmental Quality (Clean Air) Regulation 2014.**

7.3 Description of the Best Available Techniques (BATs) for Wastewater

- i. Wastewater treatment facilities shall be made available at pig farms that are operated for commercial purposes. Pig operators are encouraged to upgrade the existing wastewater treatment ponding system to a high-rate mechanical system to increase the capacity and improve the quality of wastewater being treated.
- ii. The wastewater treatment pond shall be designed in a manner that it does not allow seepage of wastewater into the groundwater. Therefore, the base of the treatment pond shall be of concrete or PVC lining.
- iii. The proposed main components and arrangement of the wastewater treatment system for a commercialised pig farm is illustrated in **Figure 7-1**.

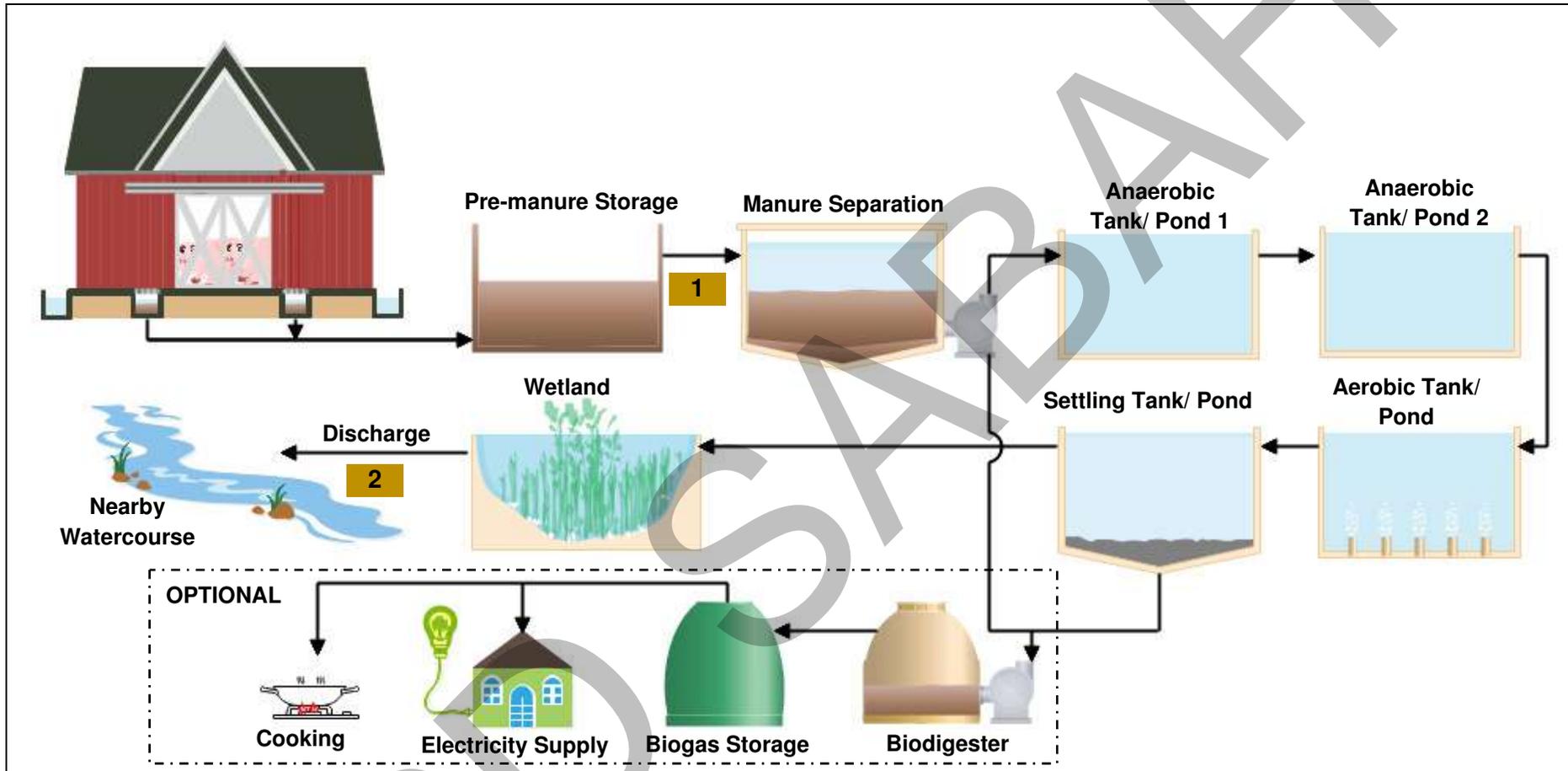


Figure 7-1: Proposed Arrangement of Wastewater Treatment System for a Pig Farm

Notes:

- (i) "1" denotes inlet sampling point and "2" denotes final discharge sampling point.
- (ii) The above arrangement is not prescriptive. Additional components/ replacement can be established if deemed necessary.

iv. The process and operation of each of the main components are further elaborated as follows:

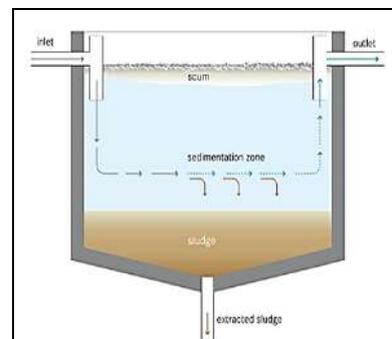
a. **Pre-manure Storage.** Wastewater shall be firstly introduced into pre-manure storage to ensure a homogenous concentration of the accumulated wastes prior to entering the wastewater treatment system, apart from facilitating the sampling process. The storage tank is equipped with a filtering screen to separate solid wastes from woods, aggregates, bones and others before entering the separation tank.



(Source: DOE, 2016)

b. **Manure/ Solid Waste Separation.**

- Waste from the pre-manure storage shall be further separated by using manure separation tank that is capable of isolating solid wastes from that of liquid through gravitational sedimentation at a typical retention time of 3 hours. Sludge generated at the bottom of the tank shall be pumped into an anaerobic digester for the generation of biogas. Liquid waste containing organic pollutants on the top part of the tank, on the other hand, shall be channelled into the anaerobic tanks for further treatment.



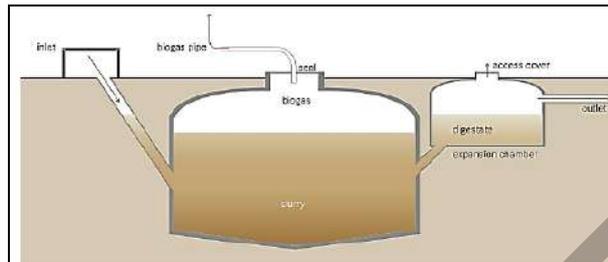
(Source: DOE, 2016)

- A mechanical screw press separator can also be utilised especially if space is a constraint. The screw press separates solids and liquids with a rotating auger inside a full floating screen. A dry matter content of 32% can be achieved.



c. **Anaerobic Tank/ Pond.** Wastewater from the manure separation tank shall then be introduced into the anaerobic tank, designed with a retention time of 24 hours to reduce BOD and TSS concentration and produce biogas. The high organic content in the tank causes the

absence of an aerobic zone; thus, natural microorganisms present in the wastewater promote the waste's organic decomposition. The anaerobic tank is a necessary component in a wastewater treatment system as it alleviates the aerobic tank's performance by reducing the amount of oxygen needed and time taken for the aerobic process to occur. Accumulation of sludge shall be periodically monitored, and desludging shall be conducted whereby the accumulated sludge is sent to the biodigester once in every three (3) months.

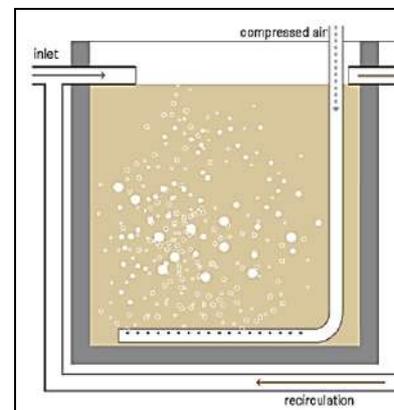


(Source: DOE, 2016)



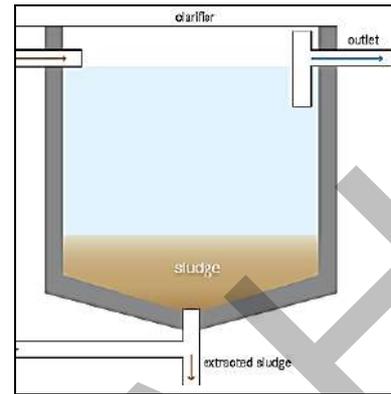
(Source: DOE, 2016)

- d. **Aerobic Tank/ Pond.** Wastewater from the **anaerobic** tank shall be further channelled into the aerobic tank, designed with a retention time of 24 hours to reduce organic content and BOD in the wastewater. The tank is equipped with a diffuser for the supply of oxygen through a blower to promote the growth of microorganisms. The recommended settings for the tank's operation to ensure aerobically stabilised organic compounds are 2 mg/L oxygen level and 2,000 – 3,000 mg/L bacteria concentration measured on the scale of Mixed Liquor Suspended Solids (MLSS).



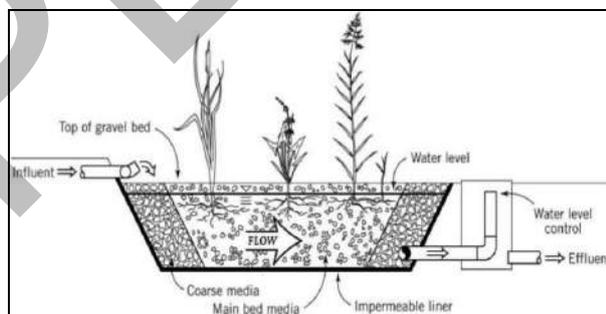
(Source: DOE, 2016)

- e. **Settling Tank/ Pond.** Wastewater from the aerobic tank shall be further treated in a settling tank, designed to reduce the amount of suspended solid via gravitational sedimentation with a retention time of 3 hours. From this tank, the wastewater may achieve Standard A discharge limit of BOD 20 mg/L and therefore may be discharged into the wetland. The sludge consisting of active bacteria that is accumulated at the bottom of the tank, on the other hand, shall be recirculated into the aerobic tank for further treatment. Once the MLSS concentration of 2000 mg/L in the aerobic tank has been achieved, the sludge may be pumped into the biodigester tank.



(Source: DOE, 2016)

- f. **Wetland.** Wastewater from the settling tank shall be channelled into the wetland treatment system consisting of an open pond with wetland plants, e.g., vetiver designed to complete the treatment process by providing reusable, clean water. Wetland plants shall absorb organic compound, mainly ammonia, phosphate and lead, within 1 hour retention time. Wetland can be operated by ensuring the plants thrive in the water within 1-2 weeks by adding a small amount of organic fertiliser. Vetiver is expected to grow to a height of 1 m after 4-6 months of operation. Thus, maintenance of the pond by trimming the vetiver shall be periodically conducted to ensure the pond is in an orderly manner.



(Source: DOE, 2016)

g. Biodigester. Sludge from the manure separation tank and settling tank shall be pumped and accumulated in the biodigester tank for the daily generation of biogas, designed with a retention time of 20 – 25 days. The anaerobic fermentation process occurring in the biodigester produces about 60% methane and 40% carbon dioxide, which is typically used as a source of fuel for cooking pig foods on the farm. This system shall also diminish the odour issue originating from the sludge as it is enclosed in the biodigester.



(Source: DVS, 2019)

- v. Maintenance and desludging of the ponding system shall be performed at least once a year to ensure optimum efficiency of the wastewater treatment facility. The elevation of the top of the embankment (freeboard) shall be a minimum of 3 feet above the water surface. This level is necessary to be maintained at all times.
- vi. The pig operators are encouraged to perform self-monitoring at the inlet point of the wastewater treatment system, as indicated in **Figure 7-1** for ease of performance monitoring. The record shall also be kept for inspection by the Government Authorities, when necessary. The recommended wastewater sampling parameter are as specified in **Table 7-2**.

Table 7-2: Parameter Analysis for the Inlet Point

Parameter	Recommended Range
BOD	0.13 – 0.38 kg/day-pig
COD	0.27 – 1.1 kg/day-pig
pH	6.8 – 7.5
AN	0.028 – 0.085 kg/day-pig
TSS	0.38 – 1.2 kg/day-pig

Source: Garis Panduan SPE Bagi Penternak Babi, DOE, 2016

- vii. Only one final treated wastewater discharge point shall be allowed for each farm and must be marked as “X” with proper signage erected on-site. Reference to the parameter limits for the final discharge point shall be made to the **Environment Protection (Control of Pig Farming Pollution) Rules 2008**, published by The State Attorney – General (AG) of Sabah.

- viii. A record of the discharge details, including the time and the discharge quality, should be maintained by the pig operator for the inspection of Government Authorities.
- ix. The pig operators may perform wastewater treatment system upgrading works by adding more ponds or combining the anaerobic treatment system so as to ultimately allow wastewater to be treated in the aerobic pond and biodigester, should they face difficulties in complying to the stipulated discharge limits. Additional components such as the Sequencing Batch Reactor (SBR) may also be installed, if deemed necessary.
- x. The pig operators are encouraged to conduct a Wastewater Characterisation Study (WWCS) to determine the most compatible and appropriate design of a wastewater treatment system that can be established according to the quantity and characteristics of the wastewater generated from the farm. The study is necessary to prevent the treatment facility from being under-designed or over-designed.
- xi. The farm's pig population shall not exceed the maximum number that the waste treatment system can handle to comply with the discharge standard limits allowed under the present legislation. The criteria that can be applied in designing the wastewater treatment ponding system in pig farming are summarised in **Table 7-3**.

Table 7-3: Typical Design Criteria of Wastewater Treatment Pond

Aspect	Unit	Anaerobic Pond	Aerobic Pond
Wastewater generation	L/ pig	40 L (0.4 m ³ / pig) ²	
Volume of pond	m ³ / pig	0.4	0.2
Surface area of pond (+20% safety factor)	m ² / pig	0.16	0.16
Depth of pond	m	3.0	1.5

Source: Garis Panduan Pengurusan Sisa Ternakan Babi, DVS, 2019

7.4 Description of the Best Available Techniques (BATs) Solid waste

- i. The solid separator application in pig farms will reduce the build-up of sludge in the lagoons, thereby reducing the odour impacts, improving the lagoons' capability to function appropriately, and reducing lagoons maintenance costs. The types of solid waste separator that can be considered are as follows:



(a) Gravity separation basins



(b) A mechanical inclined screen solids separator



(c) A free-fall inclined separator



(d) A centrifuge mechanical separator

- ii. Segregation of faeces and urine is essential to reduce the breakdown of urea into ammonia, which is more volatile, thereby reducing the emission of odours and gases from the pigsties and manure storage. A belt system or “V” scrapper can be used for faeces segregation.



(Source: Kroger et al 2014)

- iii. Installation of pit ventilation by mounting a fan on an under-building manure pit is encouraged to allow air to be drawn from the manure pit, reducing the emission rates while leaving the indoor air quality unaffected.



(Source: ISU, 2003)

- iv. Composting of solid wastes shall be practised to reduce odour emissions levels and increase nutrient density resulting from the aerobic biological process of microorganisms that convert organic material into a soil-like material (compost). The following composting methods may be considered:

- a. **Windrow Pile Composting:** Periodic turning of compost is required to maintain an aerobic environment of the windrow compost pile of manure. In cases where compost is not stored under cover, care should be taken in selecting a composting site away from locations where runoff channels and water pools.



(Source: Compost Turner)

- b. **Under-roof Static Pile Composting:** This composting method applies for mortality management. Adding sufficient bulking material (wood chips and corn stover in this facility) minimise odours. Piles are turned periodically and bins are used to keep new and old compost separated. Bins shall be sized to accommodate the loader bucket size.



(Source: O₂ Compost)

- c. **Drum-Style Windrow Composting:** The drum-style windrow compost turner is being used to flip the compost while releasing visible heat from the pile. When using this type of turner, the compost pile width and height must be less than the turner. Spacing between the windrows shall also accommodate the width of the tractor.



(Source: Sittler, 2018)

References

In addition to the relevant laws, regulations and guidelines, the following list includes general and specific literature, which may be useful for the reader.

1. Department of Veterinary Services Malaysia (DVS). (2020). *Livestock Statistics 2019/2020*.
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12. Food and Agriculture Organization of the United Nations (2019). *Farmer's Hand Book on Pig Production (for the small holders at village level)*.
13. European Commission (2017). *Guide to Good Practices for the Transport of Pigs*.

Appendices

Appendix 1: Glossary of Terms

Activity – Basic element of a project or plan that has the potential to affect any aspect of the environment. Projects are composed of activities. Activities are often called actions;

Best Available Techniques – Techniques which

- a) have been developed on a scale which allows implementation under economically and technically viable conditions, taking into consideration the cost and advantages, irrespective of whether or not the techniques are used or produced in Malaysia, as long as they are reasonably accessible to the owner of the pig farm;
- b) have been found to be the most appropriate in achieving a high general level of protection of the environment; and
- c) includes both the technology used and the way in which the application or installation is designed, built, operated and maintained;

Best Management Practice – A practice or combination of practices, that is determined to be an effective and practicable (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals;

Building – Any house, hut, shed or enclosure, whether roofed or not, used for sheltering or confining any pig and any pen, cage, wall, gate, pillar, post, paling, frame, hoarding, fence, platform, roadway, path, steps, staging, slip, wharf, dock, piles, jetty, landing stage or bridge, or any structure connected with the foregoing;

Commercial farming – Farming method in which livestock production is practiced with the intention of selling products on the market.

Existing – Existing on the date of passing of these Guideline;

Guideline – A detailed plan or explanation to guide an industry in setting standards or determining a course of action;

Land Techniques – The methods of spraying or spreading of birds' manure, litter or process wastewater onto the land surface as means of fertiliser.

Legislation – Law enacted by a legislative body;

Manure storage – An earthen, steel, concrete or synthetic material containment system, with or without a roof or covering enclosing the surface area of the container, used for the storage of liquid or solid livestock manure;

Pig – Any pig of any age, sex or type;

Pig farm – Any area of land, any confined space, premise or establishment used for pig farming;

Pig farming – The breeding, keeping, rearing, maintenance and treatment of pig including the treatment, storage, transportation and disposal of wastes, as a commercial undertaking or for sale regardless of standing population;

Pig operator – A person who owns the pigs, or is responsible for the care, control and management of the pigs;

Pigsty – A pen or enclosure for a pig or pigs;

Pollution – Any direct and indirect alteration of the environment or any part thereof by discharging, emitting, or depositing wastes or pollutants thereby causing hazard to the environment or causing a condition which is hazardous or potentially hazardous to public health and safety or welfare, or to animal, birds, fish, aquatic life or plants;

Regulation – An authoritative rule;

Sludge – Sludge extracted or pumped out from the liquid waste storage facilities;

Solid waste – Waste with an average dry matter content ranging from twenty to one hundred percent by weight;

Stanchion – An upright bar, post or frame forming a support or barrier;

Standing Pig Population – The total number of pigs kept in a pig farm at any time;

Subsistence farming – The practice of raising livestock sufficient only for one's own use, without any surplus for trade.

Waste – Faeces, urine, bedding materials, rejected carcass or body parts of pig, and includes leftover feed, water used for the washing, bathing or cleansing of pig, water or liquid used for the flushing and cleansing of any pig farm;

Watercourse – Any river, stream, canal, drain, well, spring, pond, pool, waterfall, reservoir, lake and any part of the sea abutting the foreshore, and any other water body, including water on wetlands.

Appendix 2: List of Abbreviations

AG	Attorney General
AN	Ammoniacal Nitrogen
APTVM	<i>Arahan Prosedur Tetap Veterinar Malaysia</i>
BAT	Best Available Technique
BMP	Best Management Practice
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DID	Department of Irrigation and Drainage
DOE	Department of Environment
DVS	Department of Veterinary Services
D/T	Dilution to Threshold value measured
EM	Effective Microbe
EPD	Environment Protection Department
FCC	Faecal Coliform Count (E-coli)
GHP	Good Husbandry Practices
GMP	Good Manufacturing Practice
HACCP	Hazard Analysis and Critical Control Point
HRT	Hydraulic Retention Time
H ₂ S	Hydrogen Sulphide
L&S	Lands and Surveys Department
MAFI	Ministry of Agriculture and Food Industries
MLSS	Mixed Liquor Suspended Solids
NH ₃	Ammonia
NS	Not Specified
SPE	<i>Sistem Pengolahan Efluen</i>
SPP	Standing Pig Population
TON	Threshold Odour Number
TRPD	Town and Regional Planning Department
TSS	Total Suspended Solids
UV	Ultraviolet
VOC	Volatile Organic Compound
WWCS	Wastewater Characterisation Study

Appendix 3: Contact Details

Contact details for other key government agencies related to pig farming activities are as following:

Department	Address	Contact Details	
Beaufort District Council	Majlis Daerah Beaufort Pekan Beaufort Peti Surat Bil. 181 89808 BEAUFORT	Tel No.:	087 – 211533/ 201208
		Fax No.:	087 – 211519
		Email:	-
Beaufort District Office	Pejabat Daerah Beaufort Tingkat 1, Bangunan Urusetia Peti Surat No. 38 89807 BEAUFORT	Tel No.:	087 – 211533/ 201208/ 209
		Fax No.:	087 – 211519
		Email:	-
Beluran District Council	Majlis Daerah Beluran Peti Surat 20 90107 BELURAN	Tel No.:	089 – 511272
		Fax No.:	089 – 512458
		Email:	-
Beluran District Office	Pejabat Daerah Beluran Peti Surat No. 1 90107 BELURAN	Tel No.:	089 – 511212
		Fax No.:	089 – 511255
		Email:	-
Department of Environment, Sabah	Aras 4, Blok A Kompleks Pentadbiran Kerajaan Persekutuan Sabah Jalan UMS-Sulaman 88450 KOTA KINABALU	Tel No.:	088 – 488166
		Fax No.:	088 – 488177/ 488178
		Email:	-
Department of Irrigation and Drainage	Aras 5, Wisma Pertanian Jalan Tasik, Luyang Off Jalan Maktab Gaya Beg Berkunci 2052 88767 KOTA KINABALU	Tel No.:	088 – 280500
		Fax No.:	088 – 242770
		Email:	did@sabah.gov.my
Department of Veterinary Services	Tingkat 3, Blok B Wisma Pertanian Sabah Jalan Tasik Luyang (Off Jalan Maktab Gaya) Beg Berkunci 2051 88999 KOTA KINABALU	Tel No.:	088 – 287 415
		Fax No.:	088 – 238 418
		Email:	-
Environment Protection Department	Tingkat 1-3, Wisma Budaya Jalan Tunku Abdul Rahman Beg Berkunci 2078 88999 KOTA KINABALU	Tel No.:	088 – 251290/ 251291/ 267572/ 268572
		Fax No.:	088 – 238120/ 238390
		Email:	jpas@sabah.gov.my

Guideline on Pollution Control for Pig Farming Activities in Sabah

Department	Address	Contact Details	
Kalabakan District Office	Pejabat Daerah Kalabakan Peti Surat No. 60746 91017 KALABAKAN	Tel No.:	089 – 799697
		Fax No.:	089 – 715153
		Email:	-
Keningau District Council	Majlis Daerah Keningau Peti Surat 181 89008 KENINGAU	Tel No.:	087 – 3411152 / 188/7
		Fax No.:	
		Email:	
Keningau District Office	Pejabat Daerah Keningau Tingkat 3, Bangunan Urusetia Peti Surat 10 89007 KENINGAU	Tel No.:	087 – 301507
		Fax No.:	087 – 331535
		Email:	-
Kinabatangan District Council	Majlis Daerah Kinabatangan W.D.T No.8 90200 KINABATANGAN	Tel No.:	089 – 560101/102
		Fax No.:	089 – 560109
		Email:	
Kinabatangan District Office	Pejabat Daerah Kinabatangan Bangunan Urusetia W.D.T No. 01 90200 KINABATANGAN	Tel No.:	089 – 561811
		Fax No.:	089 – 561009
		Email:	-
Kota Belud District Council	Majlis Daerah Kota Belud Peti Surat No. 8 89157 KOTA BELUD	Tel No.:	088-976529
		Fax No.:	088-976627
		Email:	md.kb@sabah.gov.my
Kota Belud District Office	Pejabat Daerah Kota Belud Peti Surat No. 1 89157 KOTA BELUD	Tel No.:	088 – 976622
		Fax No.:	088 – 977064
		Email:	-
Kota Kinabalu City Hall	No.1, Jalan Bandaran 88675 KOTA KINABALU	Tel No.:	088 - 521800
		Fax No.:	088 - 219175
		Email:	-
Kota Marudu District Council	Majlis Daerah Kota Marudu Peti Surat 129 89100 KOTA MARUDU	Tel No.:	088 – 661163
		Fax No.:	088- – 61323
		Email:	-

Guideline on Pollution Control for Pig Farming Activities in Sabah

Department	Address	Contact Details	
Kota Marudu District Office	Pejabat Daerah Kota Marudu Peti Surat 128 89100 KOTA MARUDU	Tel No.:	088 – 661321
		Fax No.:	088 – 661419
		Email:	-
Kuala Penyu District Council	Majlis Daerah Kuala Penyu Peti Surat No. 120 89740 KUALA PENYU	Tel No.:	087 – 884248
		Fax No.:	087 – 884709
		Email:	-
Kuala Penyu District Office	Pejabat Daerah Kuala Penyu Peti Surat 27 89747 KUALA PENYU	Tel No.:	087 – 884900
		Fax No.:	087 – 884229
		Email:	-
Kudat District Office	Pejabat Daerah Kudat Peti Surat No. 21 89057 KUDAT	Tel No.:	088 – 620410
		Fax No.:	088 – 611303
		Email:	-
Kunak District Council	Majlis Daerah Kunak Peti Surat Bil 15 91207 KUNAK	Tel No.:	089 – 851201
		Fax No.:	089 – 851206
		Email:	-
Kunak District Office	Pejabat Daerah Kunak Peti Surat No. 1 91207 KUNAK	Tel No.:	089 – 851478
		Fax No.:	089 - 851398
		Email:	-
Lahad Datu District Council	Majlis Daerah Lahad Datu Peti Surat 60249 91112 LAHAD DATU	Tel No.:	089 – 881501/ 2/ 3
		Fax No.:	089-881832
		Email:	-
Lahad Datu District Office	Pejabat Daerah Lahad Datu Peti Surat 60165 91111 LAHAD DATU	Tel No.:	089 – 881518
		Fax No.:	089 – 884518
		Email:	-
Lands and Surveys Department	Wisma Tanah dan Ukur Jalan Perwira Beg Berkunci No. 2044 88576 KOTA KINABALU	Tel No.:	088 - 527600/ 527601
		Fax No.:	088 - 413626
		Email:	-

Guideline on Pollution Control for Pig Farming Activities in Sabah

Department	Address	Contact Details	
Matunggong District Office	Pejabat Daerah Kecil Matunggong Peti Surat No. 1 89058 MATUNGGONG	Tel No.:	088 – 613760
		Fax No.:	088 – 613786
		Email:	-
Nabawan District Council	Majlis Daerah Nabawan Peti Surat No. 27 89957 NABAWAN PENSIANGAN	Tel No.:	087 – 366194
		Fax No.:	087 – 366195
		Email:	-
Nabawan District Office	Pejabat Daerah Nabawan Peti Surat Bil 66 89957 NABAWAN PENSIANGAN	Tel No.:	087 – 366211
		Fax No.:	087 – 366212
		Email:	-
Papar District Council	Majlis Daerah Papar Peti Surat 177 89608 PAPAR	Tel No.:	088 – 911 094
		Fax No.:	088 – 913 608
		Email:	Mazli.Mahali@sabah.gov.my
Papar District Office	Pejabat Daerah Papar Peti Surat No. 324 89608 PAPAR	Tel No.:	088 – 913 516/ 517/ 518
		Fax No.:	088 – 911 021
		Email:	-
Penampang District Council	Majlis Daerah Penampang Lorong Dewan Masyarakat Tun Fuad, Jalan Penampang-Tambunan 89500 PENAMPANG	Tel No.:	088 – 711 711
		Fax No.:	088 – 712 588
		Email:	-
Penampang District Office	Pejabat Daerah Penampang Bangunan Urusetia Penampang Peti Surat 320 89507 PENAMPANG	Tel No.:	088 – 711 054
		Fax No.:	088 – 711 003
		Email:	-
Pitas District Council	Majlis Daerah Pitas Peti Pos No. 47 Pos Mini Pitas 89100 PITAS	Tel No.:	088 – 622163
		Fax No.:	088 – 622163
		Email:	-
Pitas District Office	Pejabat Daerah Pitas Peti Surat No. 8 89100 PITAS	Tel No.:	088 – 615767
		Fax No.:	088 – 615521
		Email:	-

Guideline on Pollution Control for Pig Farming Activities in Sabah

Department	Address	Contact Details	
Putatan District Council	Majlis Daerah Putatan Dewan Mini Pejabat Daerah Putatan 88200 PUTATAN	Tel No.:	088 – 772823
		Fax No.:	088 – 772825
		Email:	-
Putatan District Office	Pejabat Daerah Putatan, Bangunan Mini Sekretariat Daerah Pusat Pentadbiran Daerah Putatan Jalan Pusat Bengkel, Pasir Putih 88200 PUTATAN	Tel No.:	088 – 762305/ 711501
		Fax No.:	088 – 771506
		Email:	-
Ranau District Council	Majlis Daerah Ranau Peti Surat No. 57 89308 RANAU	Tel No.:	088 – 879031/4
		Fax No.:	088 – 875542
		Email:	-
Ranau District Office	Pejabat Daerah Ranau Peti Surat 2 89307 RANAU	Tel No.:	088 – 875253
		Fax No.:	088 – 876754
		Email:	-
Sandakan Municipal Council	Majlis Perbandaran Sandakan Peti Surat 221 90702 SANDAKAN	Tel No.:	089 – 275400 (ext. 301)
		Fax No.:	089 – 228461
		Email:	-
Semporna District Council	Majlis Daerah Semporna Peti Surat Bil. 134 91308 SEMPORNA	Tel No.:	089 – 785350/ 781168
		Fax No.:	089 – 785484
		Email:	-
Semporna District Office	Pejabat Daerah Semporna Bangunan Urus Setia Jalan Habirun Peti Surat No. 1 91307 SEMPORNA	Tel No.:	089 – 781663/ 518
		Fax No.:	089 – 781472
		Email:	-
Sipitang District Council	Majlis Daerah Sipitang Peti Surat 28 89857 SIPITANG	Tel No.:	087 – 821701
		Fax No.:	087 – 821284
		Email:	-

Guideline on Pollution Control for Pig Farming Activities in Sabah

Department	Address	Contact Details	
Sipitang District Office	Pejabat Daerah Sipitang Peti Surat 26 89857 SIPITANG	Tel No.:	087 – 821963
		Fax No.:	087 – 822433
		Email:	-
Tambunan District Council	Majlis Daerah Tambunan P.O. Box 31 89650 TAMBUNAN	Tel No.:	087 – 770126/ 7/ 770132
		Fax No.:	087-774441
		Email:	-
Tambunan District Office	Pejabat Daerah Tambunan Peti Surat No. 25 89657 TAMBUNAN	Tel No.:	087 – 774225
		Fax No.:	087 – 773122
		Email:	-
Tamparuli District Office	Pejabat Daerah Kecil Tamparuli W.D.T No. 1 89250 TAMPARULI	Tel No.:	088 – 782154
		Fax No.:	088 – 782871
		Email:	-
Tawau Municipal Council	Majlis Perbandaran Tawau Peti Surat 412 91007 TAWAU	Tel No.:	088 – 701645
		Fax No.:	089 – 701613
		Email:	-
Telupid District Council	Pejabat Daerah Telupid Peti Surat No. 1 89320 TELUPID	Tel No.:	089 – 521732
		Fax No.:	089 – 521752
		Email:	-
Tenom District Council	Majlis Daerah Tenom Peti Surat 114 89907 TENOM	Tel No.:	087-735553
		Fax No.:	087-737552
		Email:	-
Tenom District Office	Pejabat Daerah Tenom Jalan Tenom Lama Off Jalan Hotel Perkasa Peti Surat 100 89907 TENOM	Tel No.:	087 – 735607
		Fax No.:	087 – 736334
		Email:	-
Tongod District Council	Majlis Daerah Tongod Pejabat Pos Mini Tongod Peti Surat 38 89300 TONGOD	Tel No.:	087 – 748828
		Fax No.:	087 – 748827
		Email:	-

Guideline on Pollution Control for Pig Farming Activities in Sabah

Department	Address	Contact Details	
Tongod District Office	Pejabat Daerah Tongod Peti Surat No. 1 89330 TONGOD	Tel No.:	087 – 748799
		Fax No.:	087 – 748880
		Email:	-
Town and Regional Planning Department	Tingkat 3, 4 dan 5 Blok B Wisma Tun Fuad Stephens KM 2.4, Jalan Tuaran 88646 KOTA KINABALU	Tel No.:	088 - 222336/ 222337/ 222031
		Fax No.:	088 - 222557
		Email:	-
Tuaran District Council	Majlis Daerah Tuaran Peti Surat Bil. 580 89208 TUARAN	Tel No.:	088 – 788 305/ 550
		Fax No.:	088 - 787573
		Email:	-
Tuaran District Office	Pejabat Daerah Tuaran Bangunan Urusetia Peti Surat 207 89208 TUARAN	Tel No.:	088 – 788 515
		Fax No.:	088 – 788 363
		Email:	-

Appendix 4: Existing Legislations, Guidelines and Certifications

Legal Documents	Applicability	Relevance
Legislation		
Laws of Malaysia, Act 647 , Animals Act 1953, The Commissioner of Law Revision, Malaysia, 2006.	Peninsular Malaysia	Prevents the introduction into, and the spreading within, Peninsular Malaysia of diseases of animals: <ol style="list-style-type: none"> For the control of the movement of animals into within and from Peninsular Malaysia; For the control of the slaughter of animals; For the prevention of cruelty to animals; and For measures pertaining to the general welfare, conservation and improvement of animals in Peninsular Malaysia.
Enakmen Memelihara Babi Negeri Terengganu 1976 , Department of Veterinary Services, Ministry of Agriculture and Food Industries (MAFI).	Terengganu	Outlines the requirements for pig farming licensing application and associated offenses relevant to pig discharges.
Rearing of Pigs Enactment (State of Malacca) 1980 , Department of Veterinary Services, Ministry of Agriculture and Food Industries (MAFI)	Malacca	Outlines the requirements for pig farming licensing application and associated offenses relevant to pig discharges.
Enakmen Pemeliharaan Babi Negeri Sembilan 1981 , Department of Veterinary Services, Ministry of Agriculture and Food Industries (MAFI)	Negeri Sembilan	Outlines the requirements for pig farming licensing application and associated offenses relevant to pig discharges.
Enakmen Pemeliharaan Babi Negeri Perlis 1987 , Department of Veterinary Services, Ministry of Agriculture and Food Industries (MAFI)	Perlis	Outlines the requirements for pig farming licensing application and associated offenses relevant to pig discharges.
Enakmen Pengawalan Penternakan Babi Negeri Selangor 1991 , Department of Veterinary Services, Ministry of Agriculture and Food Industries (MAFI)	Selangor	Outlines the requirements for pig farming licensing application and associated offenses relevant to pig discharges.

Guideline on Pollution Control for Pig Farming Activities in Sabah

Legal Documents	Applicability	Relevance
Enakmen Pengawalan Penternakan Babi Negeri Perak 1992 , Department of Veterinary Services, Ministry of Agriculture and Food Industries (MAFI)	Perak	Outlines the requirements for pig farming licensing application and associated offenses relevant to pig discharges.
Laws of Sarawak . The Veterinary Public Health Ordinance, 1999	Sarawak	Outlines the provisions related to pig farm licensing and conditions for renewal and relevant penalty.
Laws of Sarawak . The Veterinary Public Health Ordinance, 1999, The Veterinary Public Health (Control of Livestock Farming) Rules, 2003	Sarawak	The Rules established in exercise of the power conferred by Section 102 of the Veterinary Public Ordinance, 1999 [Cap. 32]. It outlines the requirements for: <ol style="list-style-type: none"> a. Pig farm licensing application and associated offenses relevant to pig farm license; b. Discharge of livestock wastes; c. Transportation of livestock; d. Disposal of carcass; e. Straying of livestock; f. Obstruction; and g. General penalty.
Environment Protection Enactment 2002 , The State Attorney General of Sabah.	Sabah	Outlines the provisions relating to the protection of environment.
Animal Act 1953 (Checked 2006) [Act 647] , Ministry of Agriculture and Food Industries (MAFI).	Kedah, Kelantan	Prevents the introduction into, and the spreading within, Peninsular Malaysia of diseases of animals; <ol style="list-style-type: none"> a. For the control of the movement of animals into within and for Malaysia; b. For the control of the slaughter of animals; c. For the prevention of cruelty to animals; d. For measures pertaining to the general welfare, conservation and improvement of animals in Peninsular Malaysia;

Guideline on Pollution Control for Pig Farming Activities in Sabah

Legal Documents	Applicability	Relevance
Environment Protection (Control of Pig Farming Pollution) Rules 2008 , The State Attorney – General of Sabah, 2008	Sabah	The Rules established in exercise of the power conferred by paragraph 60(2)(d) and (k) of the Environment Protection Enactment 2002.
Laws of Malaysia, Feed Act 2009 [Act 698] , Parliament of Malaysia.	Peninsular Malaysia, Federal Territory of Labuan	To establish Free Board to: <ol style="list-style-type: none"> a. Regulate feed quality by controlling the importation, manufacture, sale and use of feed and feed additive; b. Ensure the feed satisfies nutritional requirement of animals; and c. Ensure it is not harmful to animals and is not contaminated so that animals and its products are safe for human consumption and other usage.
Peraturan-Peraturan Makanan Haiwan (Pembuatan dan Penjualan Makanan Haiwan) 2012 [P.U.(A) 312/2012] , Federal Government Gazette	All states	Ensures effectiveness of the implementation of the Animal Feed Act 2009 as it explains the procedures for activities to be carried out such as; <ol style="list-style-type: none"> a. License for importers; b. Registration for manufacturers and sellers; and c. Monitoring and management procedures for animal feed samples or food additives in case of enforcement action.
Malaysia Livestock Breeding Policy 2013 , Department of Veterinary Services	All states	Enables the breeding of quality livestock through sound genetic principles and practices that satisfy the need for economic and sustainable livestock industry, and fulfil the market requirements.
Animal Welfare Act 2015 [Act 772] , Ministry of Agriculture and Food Industries (MAFI)	Peninsular Malaysia, Federal Territory of Labuan	Promotes welfare and responsible ownership of animals.

Guideline on Pollution Control for Pig Farming Activities in Sabah

Legal Documents	Applicability	Relevance
Guidelines		
<i>Garis Panduan Perancangan Perusahaan Ternakan Khinzir.</i> Department of Town and Country Planning Perak, 1999	Perak	To control and coordinate pig farming operation planning.
<i>Arahan Prosedur Tetap Veterinar Malaysia, Kepungan Babi,</i> Department of Veterinary Services, Ministry of Agriculture and Food Industries (MAFI), 2009	All states	Explains the requirements eligibility for the establishment of siege, roles, procedures and management including status, sampling, testing, records, audit, confirmation and cancellation of the siege.
<i>Garis Panduan Pelaksanaan Amalan Penternakan Baik bagi Pensijilan Skim Amalan Ladang Ternakan (SALT),</i> Department of Veterinary Services, Ministry of Agriculture and Food Industries (MAFI), 1st Edition, 2012.	All states	<ul style="list-style-type: none"> a. Includes management programs, livestock health, biosecurity programs, sanitary programs and phytosanitary as well as farm waste and pollution management programs. b. To establish standard sanitary practices of international livestock farms.
<i>Manual Prosedur Veterinary Health Mark,</i> Department of Veterinary Services, Ministry of Agriculture and Food Industries (MAFI), 2nd Edition, Mac 2012.	All states	<p>Highlights the necessary requirements in obtaining the Veterinary Health Mark logo*.</p> <p>*Note: The logo indicates that the abattoirs and the livestock feed products from processing plant has fully complied with the requirements for Hygiene and Sanitation, Good Manufacturing Practice (GMP), Hazard Analysis and Critical Control Point (HACCP) and Environmental Control.</p>
<i>Garis Panduan Kawalan Pencemaran Daripada Aktiviti Penternakan Babi,</i> Department of Environment, 2014	Peninsular Malaysia	<ul style="list-style-type: none"> c. Provides guidance to farmers towards the effort to reduce and minimise the generation of waste products at farms. d. Helps to improve the image of farmers, productivity and source of income, as well as minimise the impact of pollution due to livestock activities.

Guideline on Pollution Control for Pig Farming Activities in Sabah

Legal Documents	Applicability	Relevance
<i>Garis Panduan Sistem Pengolahan Efluen (SPE) Bagi Penternak Babi</i> , Department of Environment, 2016	All states	Proposes effluent or sewage treatment system based on the followings: a. Size of livestock; b. The viability of the breeders to operate the sewage treatment system of farm animals; and c. Performance monitoring and system maintenance.
<i>Penternakan dan Akuakultur</i> , Review of Standards Manual and Guidelines of the State of Johor, 2018	Johor	a. Emphasises on the requirements and control measures for livestock activities.
<i>Garis Panduan Pengurusan Sisa Buangan Ternakan Babi</i> , Department of Veterinary Services, Ministry of Agriculture and Food Industries (MAFI), 1st Edition, 2019	All states	b. Highlights the methods of pig farming waste management to ensure it is effective and systematic.
Certification		
Veterinary Health Mark Certification	All states	Indicates that the abattoirs and the livestock feed products from processing plant has fully complied with the requirements for Hygiene and Sanitation, Good Manufacturing Practice (GMP), Hazard Analysis and Critical Control Point (HACCP) and Environmental Control.

Appendix 5: Odour Assessment

In odour assessment, five (5) factors can be used as a basis to establish the nature of objectionable or offensive odour nuisance. The factors are referred to as the FIDOL factors and are as shown in **Table 1**.

Table 1: FIDOL Factors

No.	Factor	Remark
1.	F = Frequency	How often individuals are exposed to ambient odours
2.	I = Intensity	The perceived strength of the odour
3.	D = Duration	The amount of time people is exposed to the odour
4.	O = Offensiveness	A subjective rating of an odour's pleasantness
5.	L/R = Location/Receptor	Location of the odour or the receptor

In accordance to the United Kingdom (UK) Environment Agency as outlined in its document entitled "**H4 - Odour Management - How to comply with your environmental permit (March 2011)**", the dynamic olfactometry is not suitable for measuring odours in ambient context. While, in the guidance document by the United Kingdom (UK) Institute of Air Quality Management entitled "**Guidance on the Assessment of Odour for Planning**", the Nasal Ranger® Field Olfactometer had being identified as one of the portable fields olfactometry suitable for ambient measurements.

Nasal Ranger® Field Olfactometer

The Nasal Ranger® Field Olfactometer is a portable device with a source of clean filtered air and a dilution system based on several calibrated orifices: the assessor may gradually reduce the dilution of external air until he perceives its odour, obtaining its D/T value (**Dilution to Threshold**), according to the American Society for Testing and Materials technical standard namely **ASTM E679-04: 2011: Standard Practice for Determination of Odour and Taste Threshold by a Forced-Choice Ascending Concentration Series Method of Limits**. The Nasal Ranger® Field Olfactometer uses carbon filters to directly clean ambient air to be used as the odour-free diluting gas/air. The filtered air is mixed with odorous ambient air at discrete volume ratios.

**Note: Odour-free air = Air containing no odorous chemicals at all.
Source: Environment Agency (March 2007). Review of odour character and thresholds: Science Report: SC030170/SR2.*

The Nasal Ranger® consists of a nasal mask at the edge; two carbon filters are attached to the opposite sides of the Nasal Ranger® housing. Dilution ratio of clean air to sample air is controlled via the D/T dial, which contains six D/T positions (six orifices with traceable calibration namely 60, 30, 15, 7, 4 and 2), alternating with six blank positions for the user to inhale only odour-free filtered air. In determining of the odour detection level (D/T value), the assessor needs to place his nose firmly inside the nasal mask, sets the D/T ratio turning the

D/T dial, and inhales through the nasal mask; then the assessor turns the dial, slowly increasing concentration of the mix, until the odour in the ambient air is detected.

Where higher odour concentration is perceived, the assessor will utilise a **High Range Dilution to Threshold (D/T) Ratios** dial i.e., 60, 100, 200, 300, 400 and 500 D/Ts and also the **Standard D/T Ratios** dial i.e., 2, 4, 7, 15, 30 and 60 will be utilised. The photos of the dials are shown below:



Standard D/T Ratios:
2, 4, 7, 15, 30 and 60



High Range D/T Ratios:
60, 100, 200, 300, 400 and 500

An electronic flowmeter built into the Nasal Ranger® barrel measures the total volume of mixed airflow that is inhaled by the assessor and is travelling down the barrel on the way to the nasal mask: the inhalation flowrate should be within the factory calibration flowrate of 16-20 litre per minute.

**Note: *The Nasal Ranger® Field Olfactometer is only suitable for determination of perceived odour at ambient level. It is not suitable for perceived odour at high concentration (i.e., at source) in term of health aspect due to exposure to odourous pollutants to the assessor.*

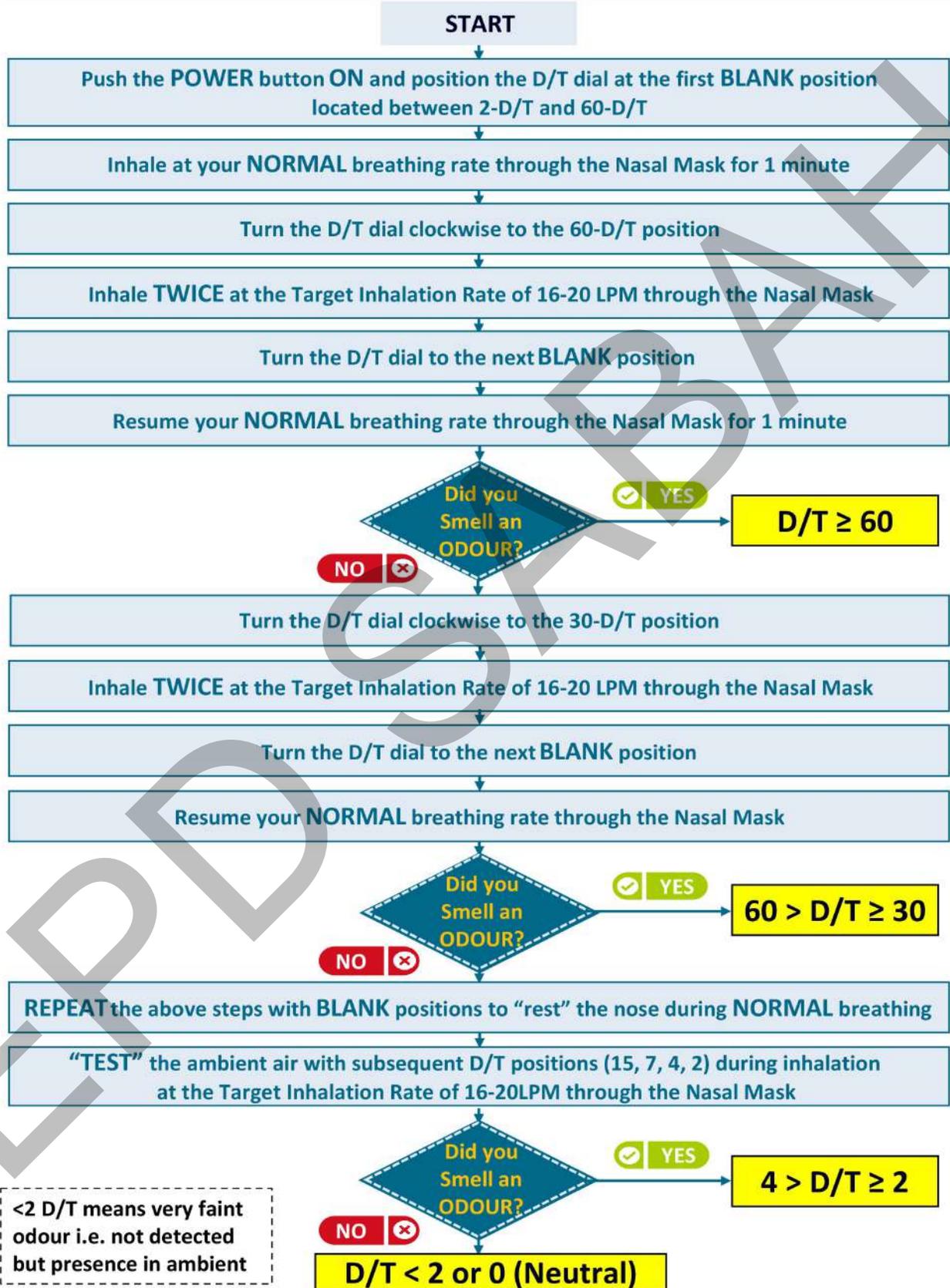
Currently, in Malaysia, there is no specific guideline formulated for odour measurement in ambient. Nevertheless, for the purpose of comparison, the following table from **Charles McGinley, P.E. (2000): Enforceable Permit Odor Limits** is being adopted.

D/T	Word Category
2	Noticeable
7	Objectionable
15	Nuisance
31	Nauseating

Source: Charles McGinley, P.E. (2000): Enforceable Permit Odor Limits.

It is proposed that the perceived odour level of 7 D/T to be adopted at the identified settlements.

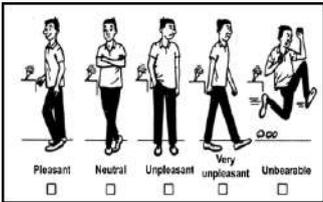
**NASAL RANGER® FIELD OLFACTOMETER
TEST PROCEDURE FLOW CHART**



Methodology of Odour Assessment

Item	Diagram	Description
1.		<p>Pre-determine sampling locations. The sampling locations shall be an open space with no obstruction and disturbance.</p>
2.		<p>Locate the identified sampling locations using any devices equipped with Global Positioning System (GPS).</p>
3.		<p>Two personnel shall conduct the odour sampling and determination. One personnel shall become the Nasal Ranger Field Olfactometer operator while another shall handle the anemometer. Both personnel shall position themselves in appropriate distance.</p>
4.		<p>Measure the wind direction ($^{\circ}$), ambient air temperature ($^{\circ}\text{C}$), wind speed (m/s) and relative humidity (%) by using a portable anemometer. Record the findings in appropriate datasheets.</p>
5.		<p>Meanwhile, the Nasal Ranger Field Olfactometer shall position himself at 90 degrees from dominant wind direction. Determine the odour concentration (D/T) and its character descriptor.</p>
6.		<p>The odour sampling and determination exercise shall be executed according to the flowchart. Photograph of activity at each sampling location shall be taken as evidence for reporting.</p>

Guideline on Pollution Control for Pig Farming Activities in Sabah

Item	Diagram	Description
7.		<p>Findings are recorded in appropriate datasheets. Hedonic tone of each smell perceived shall be determined.</p>

EPD SABAH



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