DANIDA-SARAWAK GOVERNMENT
Urban Environmental Management
System Project

TITLE Surveys on Plantations and Other
Potential Users for Organic Fertilizer
and on Potential Sources of Organic
Waste in the vicinity of Matang Septic
Sludge Treatment Plant in Kuching

Date February, 2004
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FINAL REPORT
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<th>Acronym</th>
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</thead>
<tbody>
<tr>
<td>DBKU</td>
<td>Kuching North City Hall</td>
</tr>
<tr>
<td>EFB</td>
<td>Empty Fruit Bunch</td>
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<tr>
<td>EIA</td>
<td>Environmental Impact Assessment</td>
</tr>
<tr>
<td>FELCRA</td>
<td>Federal Land Consolidation and Rehabilitation Authority</td>
</tr>
<tr>
<td>FFB</td>
<td>Fresh Fruit Bunch</td>
</tr>
<tr>
<td>GIS</td>
<td>Geographical Information System</td>
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<tr>
<td>GPS</td>
<td>Global Positioning System</td>
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<td>JKR</td>
<td>Public Works Department</td>
</tr>
<tr>
<td>Kg.</td>
<td>Village</td>
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<tr>
<td>LCDA</td>
<td>Land Custody and Development Authority</td>
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<td>MSSTP</td>
<td>Matang Septic Sludge Treatment Plant</td>
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<td>NREB</td>
<td>Natural Resources and Environment Board</td>
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<tr>
<td>PFA</td>
<td>Pig Farming Area, centralized area designed for intensive hog rearing/breeding in countries with extreme limitations</td>
</tr>
<tr>
<td>SALCRA</td>
<td>Sarawak Land Consolidation and Rehabilitation Authority</td>
</tr>
<tr>
<td>SPP</td>
<td>Standing Pig Population</td>
</tr>
<tr>
<td>SUD</td>
<td>Sustainable Urban Development</td>
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<td>SVA</td>
<td>State Veterinary Authority</td>
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1 Summary and Conclusion

This survey is a component study of the UEMS Project meant to assist the Sarawak government in coordinating large-scale environmental projects into the overall framework of UEMS. This report attempts to elaborate the “demand and supply” scenario related to organic waste in Kuching as part of the UEMS project. Particularly, various technical information on potential sources of organic waste (other than human septic waste) and possible users of recycled organic products are collected. All these data are subsequently coordinated to assess the environmental and economic viability of upgrading the MSSTP as “Outputs B3 Co-ordination of Large-scale Measures” of the UEMS project.

Presently, MSSTP is treating Kuching’s septic tank sludge through process of drying, stabilizing and landfilling. As the end sludge from the treatment facility is landfilled, achievable recovery of energy (i.e. Biogas – Methane) and recyclable nutrients (i.e. Organic fertilizer) are lost.

Essentially, the quantity of organic residues that can be environmentally and economically treated at MSSTP would depend predominantly on the demand for the recycled products for agriculture and green areas.

This study mainly concentrates on estimating both the amount of organic waste that can be provided by prospective suppliers and demand from consumers within the selected study area. Due to certain technical complications, this survey only manage to conduct assessment on pig farms, abattoirs, oil palm estates and palm oil mill (i.e. no food processing factories.)

The study area comprises of major sources of organic waste emission (a total of 70 swine husbandry, 2 slaughterhouses and 1 palm oil mill), major oil palm estates and agriculture plantations (a total of 10 oil palm estates and 1 mulberry tree plantation.) The study area is delineated to be any locations within a radius of 50 km from MSSTP which included the Petra Jaya district, city of Kuching, Samarahan, Asajaya, Sadong Jaya, Siburan district, area northwest of Serian, Bau, and area east of Lundu. The demarcated 50 km radius study area was selected because of its logistical practicality.

From a technical point of view, it had not been possible to carry out a better assessment program to estimate certain parameters in relation to the objectives of this survey. Moreover, certain queries were repeatedly raised by the lives-
tock farmers but because of the pilot status of the proposed waste collection system, some of the answers/information obtained might not accurately reflect the actual perceptions of the interviewees during the survey.

At this juncture, the best methods for organic waste collection at the livestock farms would depend on the coordination with the livestock farmers to ensure the least amount of water is channeled into the lagoons. Other steps such as provision of temporary waste storage tank in strategic area of the individual farm and formulation of well-round disinfection measures for the desludging tankers at each selected husbandry should also be considered. Furthermore, it was discovered that oil palm projects under Islamic management would never accept the use of materials originating from porcine derivatives, including swine manure because of its prohibitive nature with regards to their religion.

It should be noted that this is a pilot study, which has never been done before in Sarawak. Principally, the approximations of both the amount of organic waste that can be provided and quantity of organic fertilizer/soil conditioner required are based on numerous assumptions. Hence, it has not been possible to devise a more holistic measuring formula for the two figures.
2 Introduction

2.1 Background of UEMS Project

The UEMS project is successive venture to the SUD project. The UEMS project was commissioned on 1st of October 2002 chiefly to expand on the results accomplished during the SUD project. Essentially, the project endeavors for comprehensive implementation and operation of the UEMS within the regions of concern in terms of river water quality management and solid waste management. The overall objective of the project is to create sustainable, clean and healthy city surroundings for the state of Sarawak.

During the period of execution, from February to July 2003, the following activities were prioritized:

(a) Output A1 – Implementing the UEMS Steps

- Format report for the solid waste management
- NREB annual reporting on the state environmental level
- Monitoring of river state and load indicators

(b) Output A2 – Data Registration and Filing

- Database structure for solid waste management
- Development of GIS component
- Purchase and distribution of the environmental database
- Code lists
- Bintawa Industrial Estate test
- System for complaint handling

(c) Output B1 – Implementing Administrative and Legal Activities

- Internal workshop regarding rules on water pollution and land conversion
- Awareness as a measure to reduce littering and illegal dumping

(d) Output B2 – Implementation of demonstration projects
• Project on oil and grease from food outlets
• Project on ecological sanitation
• Project on backyard garden and kitchen waste composting

(e) Output B3 – Co-ordination of Large-scale Measures

• Upgrading of MSSTP
• Sg. Maong Ecological park
• Sg. Bintangor beautification project
• Treatment facility for recycling of construction waste
• Used tires recycling

(f) Output C1 – Organizational Development

• Organizational review of NREB
• Training

(g) Output D – Dissemination

2.2 Matang Septic Sludge Treatment Plant (MSSTP)

The State Government of Sarawak constructed the MSSTP after studies disclosed the critical deterioration of water quality of the Sarawak River, partly engendered by overflowing septic tanks directly to the open drainage system and ultimately, into the river. The MSSTP was built in 1999 and was commissioned to DBKU in June 2000. Later Sarawak Incorporated Sdn. Bhd. (wholly owned State Government Company) took ownership of the MSSTP and appointed Sar-Alam Indah Sdn. Bhd. as the management of the factory on 1st of September, 2002.

On any given day, the plant is capable of handling up to 350 m$^3$ of wet sludge. It has a maximum treatment capacity of 78,000 m$^3$ per year and 33 hectares of landfill area. By estimation, the plant is capable of receiving 280 MT of wet sludge daily, this figure is inclusive of all septic sludge from household, commercial, wastewater treatment plant in industries and communal water.

The MSSTP is designed first to mechanically dewatered the wet sludge using four screw presses, the liquid constituent is treated using Sequencing Batch Reactor. Then the dewatered sludge is stabilized with lime and bagged prior to being landfilled. As the end sludge from the treatment facility is landfilled, achievable recovery of energy (i.e. Biogas – Methane) and recyclable nutrients (i.e. Organic fertilizer) are lost. Worse still, improper handling of the sludge landfills may even lead to groundwater contamination and loss of otherwise valuable land. Incidentally, the landfilled 1-tonne polyethylene bags used to store the treated sludge are not covered (allow for possible future uses.) Hence, in light of an environmentally sustainable waste management system, the Sara-
Sarawak Government (i.e. Sarawak Incorporated) is examining the feasibility of integrating proven Danish Biogas Technology into MSSTP.

If the ecological sludge digester were successfully implemented in MSSTP, not only would it revolutionized the current septic sludge treatment, it would also be capable of handling other organic residues such as:

- Oil and grease from food outlets;
- Organic residues from abattoirs and food processing factories; and
- Livestock manures;

Thereby, minimizing the discharge of organic waste to Kuching’s waterways.

### 2.3 Biogas and Recycled Organic Fertilizer/Soil Conditioner

![Figure 1. Typical Biogas & Organic Fertilizer/Soil Conditioner Producing Digestion Process](image)

Conceptually, Biogas Technology is a follow-up or secondary digestive process of conventional sludge treatment methods. An archetypal anaerobic (i.e. without oxygen) digestion cycle for biogas (e.g. Methane-CH₄, Hydrogen-H₂, Carbon Dioxide-CO₂ and etc) is shown in Fig.1. Instead of disposing lime-stabilized and energy-heated/aerated sludge generated from usual treatment technology, sludge can be further fermented to produce useful energy and biomass.
Our septic sludge (human excreta) and animal waste (e.g. pig urea & manure) are rich in fats, carbohydrates, proteins, nitrogen (N), phosphorous (P), potassium (K) and other organic matters. By subjecting these elements to anaerobic microbial processes where free oxygen is absence, this synthesis will create energy, which is conserved in the Methane gas. Methane is a highly inflammable fuel. Moreover, the digestion of solids leads to reduction in overall biomass. This fraction of end product can serve as a soil ameliorant. It is particularly beneficial to soil structure, improving the water retention capacity.

Through careful planning and management of animal manure treatment or storage and handling (which will affect the final nutrient compositions available to plants) coupled with innovative engineering processes/mechanisms (e.g. mix & match different types of animal secretes such as chicken dung, pig manure, cattle manure, vegetative residues and etc), organic fertilizer can even be manufacture at custom N:P:K compositions comparable to fertilizer chemicals.
3 Immediate Objectives of Study

This survey is primarily aimed at providing information relevant in assessing the economic viability of upgrading MSSTP to manufacture organic fertilizer and Biogas from organic waste (i.e. raw material supplies and potential product users). The raw materials (i.e. organic waste) will mainly be sludge or slurry collected from the possible sources, specifically pig husbandries, abattoirs and edible oil processing plant. This survey is being conducted in a two-pronged manner;

(a) Collect relevant data from the suppliers of organic waste; and

(b) Procure pertinent information from the potential users, namely major agriculture estates and green areas for the end product (recycled organic fertilizer).

Both of these two set of data will then be coordinated to elaborate the demand and supply scenario of organic waste in Kuching.

The MSSTP is currently being managed, operated and maintained by Sar-Alam Indah Sdn. Bhd., a local environmental firm (appointed by Sarawak Incorporated Sdn. Bhd.) Sar-Alam Indah Sdn. Bhd. carried out evaluations on MSSTP and the following issues were earmarked for further improvement in the plant:

- Non-utilization of end sludge by-products, biogas and nutrient rich biomass;
- Non-environmentally friendly as treatment is space-consuming; and
- Non-conformity of treatment with the concept of Cleaner Development Mechanism (CDM).

In the effort of achieving the State Government’s goal for an Environmentally Sustainable Waste Management System, a MoU was signed on 10th April, 2003 between Sar-Alam Indah and Danish NIRAS A/S on the possible upgrade of the facility to Biogas and organic fertilizer generation. This advancement will then permit the plant to treat not only septic sludge but also other degrading organic residues. The residues will include organic wastes from livestock farms, abattoirs, wet markets, oil and grease traps from eateries, and food processing factories.
Furthermore, this endeavor will facilitate the implementation of Ecological Sanitation in Kuching. Ecological Sanitation in essence is an inexpensive (compare to centralized sewage treatment system) and innovative waste management system where septic tanks may be replaced by storage tanks for raw blackwater, which can be pumped and delivered to MSSTP for recycling. Under this method, greywater will be funneled through media filtrations (e.g. biofilter and constructed wetland) for cleansing before discharging to drains. Therefore, blackwater and greywater will be treated comprehensively; little or no pollutants will end up in our waterways.

In order to attain all the objectives listed above, it is thus imperative to assess the quantity of organic fertilizer that is required by the potential consumers and the amount of organic matters that can be provided by the likely generators. In short, this study is aimed at procuring data ensuring the economic sustainability of upgrading MSSTP.
4 Methodology of Survey

4.1 Overall Approach

The survey team approached the goals of the study through the following tasks:

- **Step 1** Review existing EIA reports and livestock lists at NREB resource centre to spot out potential targets relevant to the survey;

- **Step 2** Demarcate the geographical boundary of the survey as any where within 50 km radius from MSSTP;

- **Step 3** Identify all possible major oil palm and agricultural plantations;

- **Step 4** Identify all possible pig farms and sources of emission (liquid or solid organic waste);

- **Step 5** Meeting with relevant units within NREB such as the Livestock unit and Agriculture unit;

- **Step 6** Meeting with representatives from Sar-Alam Indah Sdn. Bhd. to further ensure the proposed method and data acquired during site interview/investigation were adequate;

- **Step 7** Discussion with appropriate governmental authorities and private bodies such as Department of Agriculture, SVA, JKR, SALCRA, FELCRA, LCDA and Kuching & Samarahan Divisions Livestock Breeders’ Association to gain their respective perceptions on the supply and use of recycled organic fertilizer;

- **Step 8** Conduct individual dialogue with person-in-charge of SALCRA, FELCRA and LCDA to obtain preliminary information concerning the estates under their managements and also to gain official approval to conduct survey on their plantations;

- **Step 9** Conduct field work at the rate of 1-2 sites per day (depending on time constraint) couple with standardized survey forms (Appendix 1)
• **Step 10**  
Assessment of potential overall organic load and projected organic fertilizer/soil conditioner needed and report all relevant technical information.

### 4.2 Mapping and Enumeration of Potential Suppliers and Users of Organic Waste

#### 4.2.1 Study Area

The study area encompasses any locations within a radius of 50 km from MSSTP which included the Petra Jaya district, City of Kuching, Samarahan, Asajaya, Sadong Jaya, Siburan district, area northwest of Serian, Bau, and area east of Lundu (Figure 2). The study area covers a total of 70 pig farms, 11 plantations (note: 1 estate is out of range of the study area), 2 slaughterhouses and 1 palm oil mill. The demarcated survey region was agreed at the UEMS meeting on 23rd June 2003 based on economic principle (i.e. reasonable logistic costs.)

#### 4.2.2 Selection of Major Livestock Farms

According to information furnished by NREB and Kuching & Samarahan Livestock Breeders Association, there were 81 licensed livestock farms altogether in the greater area of Kuching, Samarahan, Asajaya, Sadong Jaya, Serian, Bau, and Lundu. However, only the” Major Livestock Farm” was chosen for assessment. It was decided by the UEMS Steering Committee any facility sizing at \( \geq 1000 \) SPP would be considered as major livestock farm on account of the significant waste volume it generate. This criterion was later amended to include all licensed hog husbandries regardless of sizes within 30 km radius from MSSTP. The Committee with the beliefs that when enough number of smaller farms is accounted, the amount of waste would be noteworthy warranted this change. Besides, 30 km radius was still logistically inexpensive even for waste collection at smaller facilities. Initial screening of 81 farms also indicated \( > 70 \% \) of them was located within 30 km radius from MSSTP.

Eventually, the original list consisting of 81 livestock farms was condensed to 70 farms of which 17 farms were located between the 30 km and 50 km radius range (Appendix 2.) The GPS coordinates and concentration pattern are shown in Fig 3 & 4. The numbering of sites on Fig 3 & 4 corresponds to the numbering in the list presented in Appendix 2.
4.2.3 Selection of Other Sources of Organic Waste

At the interim phase of the study, the UEMS Steering Committee discussed about various type of industries or establishments other than pig farms such as wet markets, slaughterhouses, chicken farms, ruminant feedlots and food processing plants. Ultimately, only 2 abattoirs and 1 palm oil mill were chosen.

Perbadanan Pembangunan Ekonomi Sarawak Ternak Sdn. Bhd. (PPEST) and Central Coldstorage Kuching (CCK) abattoirs located in Bintawa Industrial District were the final representatives because of the following reasons:

- Both PPEST and CCK are the largest generators (beside swine farms) of organic waste within the study area;

- PPEST is actually a ruminant feedlot cum slaughterhouse, the data procured will provide for excellent baseline information to assess other ruminant farms (if any);

Bau Palm Oil Mill near Kg. Stom Muda along Jalan Bau/Lundu was the only other site targeted (under “Other Sources of Organic Waste” category) for evaluation. Largely because it makes perfect sense to recycle back the organic residues (EFB) from the mill to fertilize oil palm trees which in turn produce the raw materials (FFB) for the factory.

The committee recognized that hitherto, wet markets practice selling their organic waste to farmers for fodder and chicken dung is sold fully as inexpensive fertilizer (with proven vegetation yield). Due to the different ingredients used (inadequate information available) by the food processing establishments, which might complicate the processes and compositions of manufactured organic fertilizer or soil conditioner, these premises were omitted. Due to the time constraint, survey on food processing industries was not carried out. However, there are a number of food processing industries which are worthwhile to look into, whereby the waste product could be recycled are agriculture products processing, beverages manufacturing and fish preparation and preservation. Examples of these industries within 30 km radius are:

- Sundrop Fruit Juice Sdn Bhd – Beverages
- F & N CC Beverages Sdn Bhd - Beverages
- Yeo Hiap Seng (Sarawak) Sdn Bhd – Food and Beverages
- Seahorse Corporation Sdn Bhd – Shrimp and fish processing
The Fig. 5 above characterizes the essence of a sustainable waste management system where the nutrient loop is closed and emission of organic waste to environment is zero.

4.2.4 Selection of Major Oil Palm Plantations & Other Potential Users

The UEMS Steering Committee also agreed to select only oil palm and agriculture estates that ≥500 hectares in size for the purpose of this survey. The criterion is pre-set as such because:

- Estates sizing at ≥500 ha. will require significant volume of fertilizer where minute boost in plant yield (i.e. from better fertilizer) will amount to considerable increase in profit; and

- Under existing regulation, Environmental Quality (Prescribed Activities) (EIA) Order, 1987, Schedule 1(a) states any land development schemes covering an area of 500 hectares or more to bring forest land into agricultural production, will necessitate an EIA; Thus, it will facilitate the process of target selection.

In the course of the study, no discovery of planted forest, area slatted for rehabilitation and agriculture plantations (i.e. beside oil palm and ≥ 500 ha. in size) were made. Discussion with JKR also revealed most of the realty and infrastructure developments (under the agency’s jurisdiction) such as roads, bridges and etc are contracted to private construction firms. As these projects were
awarded (i.e. in an “open tender” manner) to individual development companies, JKR can put into their tender document with the condition to use organic fertilizer on the turfs and green areas of these undertakings.

After careful screening, the number of targeted estates was finalized at 11. 10 out of the 11 were oil palm projects with the exception of 1 Mulberry tree plantation (used as silk worms’ fodder.) Incidentally, the Mulberry tree plantation is located outside the study area and it only has 50 hectares of cultivated area.

The UEMS Steering Committee chose the Mulberry tree estate chiefly because unlike oil palm estates, which produced edible oil for human consumption, the Mulberry leaves were fed to silk worms. This scenario would negate religious sensitivity issue (i.e. Muslims are prohibited to have any contact with swine derivatives) regarding the use of pig waste as fertilizer. Furthermore, the result obtained from the estate would provide basis of comparison between agriculture estates that cultivate crops for human consumption or otherwise. A list of estates chosen for study is presented in Appendix 3. The individual boundary maps of the selected plantations are attached in Appendix 4.

4.2.5 Mapping of Potential Suppliers and Users

Detailed maps of main trunk roads, secondary roads, major rivers, districts, and cities, potential sources of organic waste and potential recipients of organic fertilizer/soil conditioner were plotted for the study (Fig. 2).

The LSD cadastral plans of scale 1:125,000 for Kuching, Lundu and Serian were used as base maps. The GPS coordinates and data were gathered from site investigation during the study. All pertinent data were manually transferred to the cadastral diagrams and then compiled in digital format using AutoCAD.

4.3 Assessment of Organic Waste Load from Various Sources

As noted in the beginning of this report, this survey is the first of its kind to be conducted in the State of Sarawak. Thus, the compiled data and information procured during field surveys offer only preliminary findings.

Particularly, the estimation of organic waste load for pig farm was adapted from design parameters of swine husbandry in Singapore (Taiganides E.P, 1992 “Pig Waste Management and Recycling-The Singapore Experience,” IDRC.) Published design values from Singapore were chosen because like Sarawak, Singapore sitting nears the equator in Southeast Asia experiences almost identical meteorological conditions as Sarawak (i.e. tropical climate, temperatures and humidity.)

To a great extent, the hog rearing/breeding industry in Sarawak is shrinking. Due to volatile market price of pork and uncertainty in government policies (i.e. mandatory relocation to proposed PFA), pig farmers are gradually reducing
their inventories at varying rate. This phenomenon further compounded to the difficulty in measuring several statistical values (e.g. total pig population, wastewater volume and etc) be that of the present time or future period. Hence, there is a need to monitor and update the data of pig farming industry regularly. Estimation of the quantity of organic waste generated in the abattoir was solely based on past experiences of the operators. Other than the aforementioned limitation, the abattoir/feedlot, PPEST is slatted for expansion and upgrades (soon) of their existing premises. This expansion and upgrades would inevitably affect the various technical criteria including the estimation of the lagoons’ sludge of any future organic waste collection system. As such additional in-depth study should be conducted subsequent to the expansion and upgrades to obtain a better estimate. Unfortunately, due to time clashes in scheduling survey appointments (i.e. year end grand audit at these establishments); the surveys on CCK and Bau Palm Oil Mill were not carried out.

4.4 Assessment of Recycled Fertilizer/Soil Conditioner Requirement of Plantations

The type and amount of fertilizers being applied to oil palm estates are governed by many factors. The topography and soil type of the estate will affect the planting density adopted, which will determine the quantity of fertilizer required. Different stages of palm growth or soil type also warrant dissimilar fertilizer’s nutrient compositions. Furthermore, estates located on mineral soil would require specific nutrient supplements from fertilizer while plantations situated on peat soil would perform better with the addition of soil conditioner. Soil conditioner is mainly aimed at complementing the overall soil volume of a particular site. All the amount of required fertilizers/soil conditioners calculated in subsequent section is based on the most current manuring programs collected during the field surveys.
5 Findings and Results

5.1 Livestock Farms

5.1.1 Range of Distance from MSSTP

Based on the measurements taken on the road, the distance between various farms and MSSTP ranges from 6 to 68 km (Table 1.)

<table>
<thead>
<tr>
<th>Livestock Farm:</th>
<th>Distance From MSSTP (One-way), km</th>
<th>Livestock Farm:</th>
<th>Distance From MSSTP (One-way), km</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Chang Chung Kong</td>
<td>6</td>
<td>2. Fook Ping Brothers</td>
<td>28</td>
</tr>
<tr>
<td>9. Tsai Tze Kho</td>
<td>18</td>
<td>10. Yin Yan</td>
<td>32</td>
</tr>
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<td>11. Nam Sam</td>
<td>18</td>
<td>12. Lee Shin Luk</td>
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<td>17. Henry's</td>
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<td>18. Chang Chung Mui</td>
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<td>19. Heng Seng</td>
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<td>20. Chai Tze Khim</td>
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<td>27. Chong Yee Lan</td>
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<td>29. Chan Ah Phoo</td>
<td>20.5</td>
<td>30. Shuan Ang</td>
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<td>31. Kim Huat</td>
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<td>33. Liaw Hian Jin</td>
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<td>47. Chian Nyan</td>
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<td>48. Jong Liu Jan</td>
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<td>49. Joon Thian</td>
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<td>25</td>
<td>54. Sing Jee</td>
<td>62</td>
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<tr>
<td>55. Lai Brothers</td>
<td>25.5</td>
<td>56. Soon Joo</td>
<td>62</td>
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<td>57. Voon Say Ping</td>
<td>26</td>
<td>58. Then Sian</td>
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<td>59. Chai Shong Len</td>
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<td>60. Then Hon Ted</td>
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<td>61. Howe Tat</td>
<td>26</td>
<td>62. Dong Miew</td>
<td>64</td>
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<td>63. Sing Hing Fatt</td>
<td>26</td>
<td>64. Richway Enterprise</td>
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<td>65. Kueh Su Chieng</td>
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<td>66. Fui Shin</td>
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<td>67. Chai Poh Wah</td>
<td>27</td>
<td>68. Heng Jee</td>
<td>68</td>
</tr>
<tr>
<td>69. Chin Shin &amp; Fatt</td>
<td>27</td>
<td>70. Liew Yu Chiok</td>
<td>n.a</td>
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</tbody>
</table>

All the recorded distances were measured by treating MSSTP as the starting point. Essentially, sites northwest, southwest of MSSTP were accessed by traveling from Jalan Matang/Batu Kawa due south into Jalan Batu Kawa. Then from Jalan Batu Kawa distances were calculated by heading west on the road. All livestock farms located in Musi, Kg. Moyan, Siniawan, Bau District was reached in this manner. While sites southeast of MSSTP were accessed by heading east on Jalan Batu Kawa and then turned south into Jalan Datuk Stephen Yong. From Jalan Datuk Stephen Yong, direction shifted again due east into Jalan Datuk Bandar Mustapha that led to Jalan Penrissen. All premises situated on Jalan Semaba, Jalan Sg. Tapang, Kota Sentosa, Jalan Stakan, Jalan Jamboree, Jalan Batu Kitang, Jalan Datuk Mohammad Musa (Kota Samarahan), Jalan Kg. Kuap, Jalan Kg. Landeh, Kota Padawan, and Jalan Kuching/Serian (inclusive of all its tributary roads) were reached using Jalan Penrissen as the main route. All the direction and traveled routes are shown in Figure 6.

5.1.2 Current Management and Treatment of Wastewater

It was discovered that the usual method of dealing with wastewater in almost all the pig farms in Kuching was “filtering” the wastewater through a series of lagoons. The fundamental principle of this treatment technique is providing ample settling and detention time for the denser particle within the wastewater to sink onto the bottom of the ponds to further decompose thus becoming sludge. Consequently, the lighter liquid portion of the wastewater is allowed to flow into consecutive lagoons (sometimes up to 4 ponds) undergoing the same process of detention and degradation before discharging into the drain/stream nearby the various farms.
Tabulated data (Table 2) showed that the sludge (predominantly accumulated in the 1st lagoon) in **61 out of the 70 farms (87%)** had never been bothered in any manner. It was also found that out of the 70 sites, only **7 (10%) were equipped with concrete lagoons** and another 5 were discovered to operate in the absence of lagoons. Notably, pig manure was only flushed down with water and directly discharged to the farm’s outer drain at Nam Sam, Kueh Su Chieng and Chian Nyan farms.

The wastewater on the other **58 farms (83%) was stored only in below ground earth lagoons** without any membranes or concrete walls to prevent leaching. Majority of the lagoons were also constructed without above ground berm (to divert surface run-off) and unshed from rain. Almost all 61 farms’ lagoons were never emptied, it was suspected that the wastewater at these premises was leaching from the lagoons or overflowing from the sides of the lagoons during rainy seasons or when they were full. From observations, the drains/streams which carried the wastewater (stemming from last lagoon) from all these 61 farms exhibited slight to severe contamination by excess sludge. This phenomenon was largely due to the ascending quantity of settlement accumulated at the bottom of the lagoons that caused a reduction in the effective volume of these lagoons. Hence instead of furnishing sufficient duration for the solids within to settle, wastewater flowed right through the series of lagoons and poured into the drains/streams. In 3 of the 70 farms (i.e. Lai Foh Shin, Nam Joon, Heng Jee and Success Portfolio site A) surveyed, severe surface solid mineralization had been found to occur. Presumably, after a long period of drought, the floating aerosols and solids within the wastewater had mineralized into a hardened mat on top of the first lagoon at these farms.

Of the 70 animal husbandries surveyed, only **3 (4%) were equipped with separators**, namely Sing Hing Fatt Farm, Then Brothers Farm and Tun Fa Brother Farm along Jalan Kuching/Serian. Essentially, the wastewater in these 3 hog farms was channel into separator and underwent “screw press” action. The liquid within was extracted and then diverted. In Sing Hing Fatt Farm, the liquid portion of the wastewater was directly discharged into its outer drain while the solid constituent was left to dry in the separator shed. According to the owner of Sing Hing Fatt Farm, he has planned to market the organic waste as fertilizer (when waste achieved 100% dry weight).

The Then Brothers Farm took a more holistic approach in their wastewater management. Instead of channeling wastewater straight into separator, it was passed through a stirrer meant to homogenize the solution and thus boosting the efficiency of subsequent separation mechanism. Again, the solid was left to dry in the separator facility. Finally, this accumulated waste was landfilled in a nearby valley while the aqueous constituent of the wastewater is conveyed into 3 consecutive lagoons for additional settlement before discharge into the farm’s outer drain. Tun Fa Brother Farm also practiced a similar wastewater management system but instead of landfilling the separated solids, portion of the dried up waste was used to fertilize its integrated fruit orchard within the farm.

There was also a case (Jee Tai Farm) whereby sludge from the first lagoon was excavated from time to time and left by the side of the lagoon. In two isolated
instances, the Fook Ping Brothers and Chong Yee Lan Farm actually collected 90% of its pig manure before flushing down their pig pens manually (on a daily basis) and later used the organic waste to fertilize their plantations (pepper, vegetables and durian.) Incidentally, according to these farmers the manure had sustained excellent growth rate and yield for their crops. Pictures in appendix 5 showcase some of the results of these claims.

**Table 2 – Livestock Farms’ Wastewater Management**

<table>
<thead>
<tr>
<th>Livestock Farm:</th>
<th>Type of Lagoon:</th>
<th>What happen to waste after collection in lagoons?</th>
<th>Livestock Farm:</th>
<th>Type of Lagoon:</th>
<th>What happen to waste after collection in lagoons?</th>
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</thead>
<tbody>
<tr>
<td>1. Fung Lee Hin</td>
<td>Concrete &amp; Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>2. Yin Yan</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<tr>
<td>3. Shong Shin</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>4. Lee Shin Luk</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<td>5. Chang Chung Kong</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>6. Jong Pian Sin</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<td>7. Nyan Yin</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>8. Liaw Kin Chwan</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<td>9. Kim Huat</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>10. Liew Yu Chiok</td>
<td>out of commission</td>
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<td>11. J.F. Trading</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>12. Voon Say Ping</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<td>13. Tsai Tze Kho</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>14. Henry’s</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<td>15. Chen Seng Hock</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby</td>
<td>16. Heng Seng</td>
<td>Concrete &amp; Earth</td>
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</tbody>
</table>

17. Nam Sam Unlined Earth No apparent lagoon existed, direct discharge to nearby landscape
18. Voon Sin Heo Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
19. Syn Syn Fatt Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
20. Liaw Hian Jin Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
21. Hen Choon Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
22. Chen Nyuk Poh Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
23. Chai Shong Len Concrete & Earth Excess wastewater was diverted from final pond to nearby stream/drain
24. Sing Loong Concrete & Earth Excess wastewater was diverted from final pond to nearby stream/drain
25. Howe Tat Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
26. Anthony Ho Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
27. Lai Brothers Concrete & Earth Excess wastewater was diverted from final pond to nearby stream/drain
28. Jee Yuan Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
29. Chang Chung Mui Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
30. Chai Poh Wah Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
31. Jong Jun Chiung Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
32. Foh Fat Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
33. Chan Ah Phoo Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
34. Cheng's Brother Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
35. Pang Kui Choon Unlined Earth Excess wastewater was diverted from final pond to nearby stream/drain
36. Jee Tai (formerly Evergain Agricultural) Unlined Earth Settlement of the 1st lagoon
<table>
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<tr>
<th>Livestock Farm:</th>
<th>Type of Lagoon:</th>
<th>What happen to waste after collection in lagoons?</th>
<th>Livestock Farm:</th>
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<tr>
<td></td>
<td></td>
<td>diverted from final pond to nearby stream/drain</td>
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<td>was excavated (whenever full) &amp; left by the side of the lagoon</td>
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<td>37. Sing Hing Fatt</td>
<td>Unlined Earth</td>
<td>Half of the wastewater was treated by separator then solids were left to fermentate. Other half of wastewater was diverted into 2 lagoons</td>
<td>38. Lai Foh Shin</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<td>39. Kueh Su Chieng</td>
<td>None</td>
<td>Direct discharge to drain outside the farm</td>
<td>40. Lo Liat Ping</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<tr>
<td>41. Chin Shin &amp; Fatt</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>42. Fui Fat Poultry</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
</tr>
<tr>
<td>43. Fook Ping Brothers</td>
<td>None</td>
<td>Manure (before flushing) was collected daily &amp; used for fertilizing pepper plantation</td>
<td>44. Kim Gian</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<td>45. Huo Wei</td>
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<td>46. Success Portfolio Site A</td>
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<td>47. Chai Mui Yaw</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>48. Success Portfolio Site B</td>
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<td>49. Nam Joon</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>50. Heng Jee (formerly Sing Jee Site B)</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<td>51. Fui Shin</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>52. Sing Jee</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<td>53. Dong Miew</td>
<td>Unlined Earth</td>
<td>Excess wastewater was</td>
<td>54. Richway Enterprise</td>
<td>Unlined Earth</td>
<td>Excess wastewater was</td>
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<td>Livestock Farm:</td>
<td>Type of Lagoon:</td>
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<td>diverted from final pond to nearby stream/drain</td>
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<td>diverted from final pond to nearby stream/drain</td>
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<td>55. Then Brothers</td>
<td>Unlined Earth</td>
<td>Wastewater was treated by separators then solids were landfilled</td>
<td>56. Jong Liu Jan</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<tr>
<td>57. Chong Yee Lan</td>
<td>None</td>
<td>Manure (before flushing) was collected daily &amp; used for fertilizing vegetable plantation</td>
<td>58. Kian Seng</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<td>59. Tiang Khiong Hin</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>60. Lai Agriculture</td>
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<td>61. Soon Joo</td>
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<td>62. Chai Tze Khim</td>
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<td>63. Shuan Ang</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>64. Chian Nyan</td>
<td>Unlined Earth</td>
<td>Lagoons are no in use, direct discharge to nearby drain</td>
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<td>65. Chong Soon Chung</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>66. Then Sian</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<td>67. Chai Thin Piau</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>68. Then Hon Ted</td>
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<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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<td>69. Tun Fa Brother</td>
<td>Concrete &amp; Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
<td>70. Joon Thian</td>
<td>Unlined Earth</td>
<td>Excess wastewater was diverted from final pond to nearby stream/drain</td>
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5.1.3 Estimation of Collectible Organic Waste Load

As noted in the beginning of this report, this survey is the first in its kind. Hence, many assumptions were established to estimate the range of collectible organic waste from the livestock farms.

Key assumptions included:

a) The flushing system practiced in the pig farms of Sarawak utilizes 30L/SPP per day of water to cool and clean the pens (Caveat: hog farms in Sarawak uses 100% harvested rainwater and groundwater that are free. Thus the water usage may deviate greatly from published data);

b) In the calculations, all generated and spent water/wastewater (i.e. urine, feces, cooling and cleaning water) ends up in the lagoons (Caveat: run-offs and other losses were not accounted for);

c) The lagoons were not leaching water from the bottoms and overflowing from the sides. Moreover, rainwater did not come in contact with the lagoons (Caveat: most lagoons were unlined earth storage and not sheltered from rain);

d) The ranges of pig population in the 70 farms were representative of the actual number (Caveat: majority of the farms were reducing the hog population of their farms, data were based on values taken during the survey);

e) The nutrient compositions (N, P and K) of the wastewater were identical to that of Singapore’s (Table 3 – Properties of pig wastes and wastewater in Singapore) (Caveat: Singapore’s study was conducted about 11 years ago, different type of feeds are being used now thus properties of pig waste and wastewater might be different)

Table 3 – Properties of pig wastes and wastewater in Singapore Farms

<table>
<thead>
<tr>
<th>Parameter:</th>
<th>Wastewater (kg/day per SPP)</th>
</tr>
</thead>
<tbody>
<tr>
<td>TWW (feces + urine)</td>
<td>4.54 (L/SPP per day)</td>
</tr>
<tr>
<td>TTS</td>
<td>0.45</td>
</tr>
<tr>
<td>TSS</td>
<td>0.37</td>
</tr>
<tr>
<td>TDS</td>
<td>0.08</td>
</tr>
<tr>
<td>TKN</td>
<td>0.03</td>
</tr>
<tr>
<td>TPO</td>
<td>0.01</td>
</tr>
<tr>
<td>TKO</td>
<td>0.005</td>
</tr>
<tr>
<td>Cooling &amp; Cleaning water</td>
<td>30 (L/SPP per day)</td>
</tr>
<tr>
<td>TWF</td>
<td>34.54 (L/SPP per day)</td>
</tr>
</tbody>
</table>
1. TWW = Total Wet Weight
2. TTS = Total Solids
3. TSS = Total Suspended Solids
4. TDS = Total Dissolved Solids
5. TKN = Total Kjeldahl Nitrogen
6. TPO = Total Phosphates
7. TKO = Total Potash
8. TWF = Total Waste Flow

*a. Adapted from Table 5.1-Properties of pig wastes and wastewaters in Singapore Farms, Taiganides E.P, 1992
“Pig Waste Management and Recycling: The Singapore Experience,” IDRC.*

From tabulated results (Appendix 6), the 69 pig farms (one out of commission) could supply a total range of:

(a) Minimum range of organic waste load (TTS):

Minimum Total Pig Population (SPP) X TTS content of pig farm wastewater

\[ = 100185 \text{ SPP} \times 0.45 \text{ kg/SPP of TTS per day} \]
\[ = 45083.25 \text{ kg} \]
\[ = 45 \text{ Metric Tonne (MT) per day of TSS} \]

Or

\[ = 100185 \text{ SPP} \times 34.54 \text{ L/SPP} \times (1 \text{ gal}/4.54609\text{L}) \times (0.0045461 \text{ m}^3/\text{gal}) \]
\[ = 3460 \text{ m}^3 \text{ of wastewater} \]

(b) Maximum range of organic waste load (TTS):

Maximum Total Pig Population (SPP) X TTS content of pig farm wastewater

\[ = 146390 \text{ SPP} \times 0.45 \text{ kg/SPP of TTS per day} \]
\[ = 65875.5 \text{ kg} \]
\[ = 66 \text{ Metric Tonne (MT) per day of TSS} \]

Or

\[ = 146390 \text{ SPP} \times 34.54 \text{ L/SPP} \times (1 \text{ gal}/4.54609\text{L}) \times (0.0045461 \text{ m}^3/\text{gal}) \]
\[ = 5056 \text{ m}^3 \text{ of wastewater} \]

Total Solids (TTS) was used in the estimation above because:

- \( \text{TTS} = \text{TSS} + \text{TDS} \);
- \( \text{TTS} \) represented all the weight of the solid constituents within pig farms’ wastewater (Caveat: not including alien solid constituents like loose soil, gravels, leftover feeds and waste other than pig feces); and
Nutrients such as N, P and K are found in the urine and the TTS fraction of pig wastewater (Incidentally, only a handful of farms were discovered to have added in nitrogen-reducing reagents in their feeds.)

Assuming all the nutrients within the pig wastewater for all 69 livestock farms were recovered by the proposed Biogas and Organic Fertilizer technology, the range of potentially recoverable individual nutrient is listed below:

**Table 4 – Range of Recoverable Nutrients in Pig Wastewater**

<table>
<thead>
<tr>
<th>Nutrient:</th>
<th>Total Weight of Nutrient(^a) (MT/day)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>TKN (Nitrogen)</td>
<td>2.96</td>
<td>4.32</td>
<td></td>
</tr>
<tr>
<td>TPO(^b) (Phosphates)</td>
<td>0.98</td>
<td>1.44</td>
<td></td>
</tr>
<tr>
<td>TKO(^c) (Potash)</td>
<td>0.49</td>
<td>0.72</td>
<td></td>
</tr>
</tbody>
</table>

\(^a\) Total weight of N, P & K in the pig wastewater from all 69 surveyed swine husbandries.

\(^b\) TPO = P \_O \_ Phosphorous ingredient in common fertilizer

\(^c\) TKO = K \_O Potassium ingredient in common fertilizer

5.1.4 Accessibility of Organic Waste Collection Point

In terms of accessibility, 31 out the 69 farms (45%) were deemed unreachable by organic waste transportation due to one or more of the following reasons; the waste lagoon/s is/are:

a) Located in the back end of the farm which measured at > 50m from the closest loading area (Note: the proposed desludging tankers can only carry up to a maximum of 50m of extension pipe);

b) Hindered by the farm’s infrastructures that cannot be relocated without major renovations;

c) Obstructed by the steep topography of the lagoon site;

d) Pumping pipes from the desludging tankers might have to arrange through the pig pens in order to reach the lagoon/s (Bio-security issues); and

e) No apparent wastewater storage at the farm.

On the other hand, the lagoons on 38 out of the 69 farms (55%) were easily reachable by the organic waste tankers. However, 16 out of these 38 farms would require slight modification to their existing infrastructure such as the building of a new entrance or trimming of small shrubs impeding the future passage of waste tanker.
5.1.5 Present Scenario on Bio-Security

Almost all 69 farms surveyed practiced the basic Bio-Security measures of:

- Disallowing uninvited person/s or vehicle/s from entering the compound of the farms. Particularly, non-workers were prohibited from coming in contact with the pig pens;

- Practiced fumigating the hogs and barns’ structures with various disinfectants (rotate among several brands) at least once every month (or when the farrowing sows and weaners/and piglets were relocated to new pens); and

- Prohibit vehicles or objects used to transport porker pigs out of the farms’ compound (before disinfection) from coming in contact with existing pigs in the farms upon re-entry.

Some of the common fumigating agents used at the farms are recorded in Appendix 7. Among the 69 farms, only 8 were equipped with sprinkler disinfection shed cum wheel washing trough at the entrance of the farm. The main ingredients found in almost all the disinfectants were quaternary ammonium and glutaraldehyde.

5.1.6 Willingness in Providing Organic Waste

Judging from the consensus obtained during the interview, it was discovered that:

(a) 34 of the 69 farmers (49%) agreed to cooperate in the program only if most of the following conditions were satisfied;

(i) "Free of charge” or reasonable pricing for the waste transporting service;

(ii) Prior disinfection measures fully conducted on the desludging tankers and its equipments before entering the farm or collection made outside the farm’s perimeter;

(iii) Reasonable frequency of any pumping and transporting routine (i.e. once a month at most to avoid inconvenience);

(iv) Allow only one-farm per trip (respective farm to MSSTP) scheduling system on the waste vehicle;

(v) Halting of transporting activity during disease outbreak to prevent transference; and
(vi) Participation in this waste transporting program nullifies the need to relocate their farms to proposed centralized Pig Farming Area (PFA);

(b) 14 out of the 69 farmers (20%) agreed to participate in the endeavor only if there were incentives involved such as:

(i) subsidy for the costs involved in setting up new bio-security measures/facilities on their farms and the expenses of retrofitting or maintaining their farms’ infrastructure to enable access to the waste outlet/collection point; and

(ii) remuneration (monetary or otherwise) for providing the organic waste;

(c) 9 out of the 69 farmers (13%) were not interested altogether in providing organic waste. The main reason was that these were small populated hog farms which only have generate small quantity of waste. These farmers were fearful over the disruptions (e.g. renovation of farm’s facilities) and expenses that might arise from participation in the program;

(d) 5 out of the 69 farmers (7%) were very willing to contribute to the waste transportation program with no reservation; and

(e) 3 out of the 69 farmers (4%) were unsure of their opinions towards this proposed waste transport program. They wanted to wait until the precise implementation plan is finalized before expressing their views.

Finally, 3 out of the 69 farmers were out of reach during the course of this study.

5.2 Abattoirs and Palm Oil Mill

Regrettably, survey was only conducted on one target (a total of 3 sites) owing to conflicts in time scheduling with the selected abattoirs and oil palm mill. Out of PPEST and CCK abattoirs and Bau Palm Oil Mill, only PPEST abattoir was visited. Furthermore, estimation of the quantity of organic waste generated in the abattoir was solely based on past experiences of the operators. Therefore estimation of the actual amount of settlement collected in the abattoir’s lagoons would prove to be the most challenging task in this survey. Chiefly, PPEST slaughterhouse/feedlot practices “continuous flushing” on their establishment. Cleaning water is being constantly sprayed to rid the feedlots of the ruminants’ manure. As the cleaning water stemmed from harvested rainwater, there is no record on the amount being used. Moreover, most of the wastewater produced at this abattoir is channeled into earth drains, which end up in lagoons. The steady flow of wastewater going through these earth drains would inevitably
dredge away portion of the sides and bottom of the drains or fraction of the solids may settle in the passageways. This would eventually complicate the estimation of the lagoons’ sludge. Apart from this uncertainty, the future expansion (ruminant’s population) and upgrades (structures) of PPEST would also add to the difficulty in designing a well-round organic waste collection system (if any.)

5.2.1 Range of Distance from MSSTP

The one-way distance (on-the-road) from MSSTP to PPEST abattoir/feedlot is 32.5 km. This value was measured in the following manner:


5.2.2 Current Management and Treatment of Effluent

Presently, PPEST abattoir/feedlot’s wastewater (feces, urine and blood) is channeled into 4 interconnecting earth ponds while its ruminant slaughterhouse’s animal waste (guts and parts) is packed in gunny sacks that ultimately get collected by garbage trucks. Additionally, adjacent to the ruminant abattoir is the pig slaughterhouse cum temporary pig pen. Though PPEST’s ruminant abattoir and pig slaughterhouse are in 2 separate buildings (different managements), they share the same 4 lagoons. On top of the 4 combined lagoons, the pig abattoir also had 2 more preliminary settling ponds (dedicated to the pig abattoir.) Fundamentally, the lagoons at PPEST abattoir/feedlot function in the same way as the lagoons found at livestock farms. The excess effluent from the final lagoon was diverted into the nearest public drain outside the establishment. Apart from collecting effluent, the final lagoon also served in harvesting rainwater (used to flush the feedlot and slaughterhouse.) As the unlined earth lagoons were never emptied, it was assumed that the wastewater was leaching from the bottom and overflowing from the sides of the storages. It was also evident that surface run-offs were flowing freely into all the lagoons.
5.2.3 Estimation of Collectible Organic Waste Load

The PPEST’s feedlot houses approximately 600 heads of ruminant that includes cattle, buffalo, camel, sheep, goat and deer. Over 80% of the ruminant population was made up of beef cattle weighing an average of 400 kg. 30 to 40 heads of cattle are being butchered per month at the slaughterhouse. In the following estimation, only cattle’s solid waste and organic waste were considered because cattle dominated in number in relative to other animals at this feedlot.

(a) Estimation of the solid waste (i.e. guts and parts of butchered beef cattle):

Based on the operator’s experience, 40% of cattle’s body weight was discarded at the abattoir. Thus;

Assuming 26 working day in a month,

(i) Minimum: 30/26 = 1.15 head of cattle is slaughtered per day

(ii) Maximum: 40/26 = 1.54 heads of cattle is slaughtered per day

Taking into account the discarded solid waste portion of the cattle;

(i) Minimum: 1.15 hd/day X 400 kg/hd X 40% = 184 kg

(ii) Maximum: 1.54 hd/day X 400 kg/hd X 40% = 246 kg

A range of 184 – 246 kg of solid waste is generated at PPEST abattoir at the present moment.

(b) Estimation of the organic waste (i.e. feces and urine of beef cattle):

Assuming 80% of the ruminant population is made up of cattle,

(i) Total population of cattle = 80% X 600 heads ruminant
   = 480 heads

Based on the operator’s experience, cattle generally could consume feed that weight up to 3% of their body weight on a daily basis. Furthermore, 10% of the fodder would eventually be excreted. Thus,

(ii) One cattle can generate = 3% X 400 kg X 10% = 1.2 kg of organic waste per day;

With a population of 480 cattle, PPEST abattoir/feedlot would be able to produce up to (1.2 kg/head/day X 480 head =) 576 kg of organic waste per day.

It must be stressed that the estimated organic load presented above were based solely on human experience. It is known that the type of housing and waste treatment/handling method would affect the final nutrient compositions of the
animal waste materials. Likewise, the nutrient contents of PPEST feedlot/slaughterhouse’s ruminant waste could not be assessed (with great accuracy) as no record of water usage was available and water tend to dilute the levels of nutrients. Besides, the slated expansion and upgrades would change virtually every aspects of the existing infrastructure including the population of ruminant.

5.2.4 Accessibility of Organic Waste Collection Point

As it stands at this moment, the first lagoon (where the most sludge accumulates) is situated at the back of PPEST’s abattoir and feedlot surrounded by adjacent industries (not under PPEST’s management.) There is no existing passageway to the first lagoons. Moreover, the lagoon was built on swampy ground (presumably deep peat soil) that could not sustain heavy machinery. However, the second, third and fourth ponds are located close to the main access route into the slaughterhouse.

Since the packaged solid waste (guts and parts of butchered cattle) is currently disposed of in pre-existing garbage dumpsters, it will be relatively easy to collect this portion of the animals’ organic residue.

5.2.5 Willingness in Providing Organic Waste

It turned out that the management of PPEST abattoir/feedlot had been plagued by the issue of excess organic waste for sometime now. Therefore, the establishment was more than willing to provide the animals solid waste and organic materials for recycling at MSSTP. The management had also planned for the inclusion of a blood tank and solid separator in their new expansion and upgrades that would further facilitate the collection of organic residues. However, it is imperative to conduct another study on the new premises in order to achieve greater degree of coordination between the organic waste treatment/handling method at the slaughterhouse and the proposed waste collection system from MSSTP.
5.3 Major Oil Palm Plantations & Mulberry Estate

5.3.1 Range of Distance from MSSTP

The distance (actual on-the-road) of these estates from MSSTP varies from 28 to 138 km (Table 5). It was also discovered that some of the plantations had more than one fertilizer storage facilities at different locations (usually different phases have separate fertilizer warehouses) even within a single project. The concentration pattern of the respective fertilizer stores are shown in Fig. 7, 8 & 9.

Table 5 – Range of Distance of Various Oil Palm Plantations & Mulberry Tree Estate

<table>
<thead>
<tr>
<th>Estate:</th>
<th>Distance of Fertilizer Storage from MSSTP (One-way), km</th>
<th>Estate:</th>
<th>Distance of Fertilizer Storage from MSSTP (One-way), km</th>
</tr>
</thead>
<tbody>
<tr>
<td>3. SALCRA Stenggang OPP</td>
<td>39</td>
<td>4. SALCRA Taee OPP</td>
<td>73</td>
</tr>
<tr>
<td>5. SALCRA Jagoi OPP</td>
<td>40</td>
<td>6. FELCRA Asajaya OPP</td>
<td>78-79 (3 storage areas)</td>
</tr>
<tr>
<td>7. FELCRA Kawasan Samarahan OPP</td>
<td>48-65 (7 storage areas)</td>
<td>8. FELCRA Tamang Sembawang OPP</td>
<td>87</td>
</tr>
<tr>
<td>11. SALCRA Undan OPP</td>
<td>53</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

All the recorded distances were measured by treating MSSTP as the starting point. Essentially, sites northwest, southwest of MSSTP were accessed by traveling from Jalan Matang/Batu Kawa southbound into Jalan Batu Kawa. Then from Jalan Batu Kawa distances were calculated by heading west on the road.
Plantations such as FELCRA Tamang Sembawang, SALCRA Stenggang, Undan and Zuhrah Pelangi were arrived at by heading west on Jalan Bau/Lundu. While estates situated in the Bau district were reached by heading southeast on Jalan Bau (SALCRA Bratak estate) into Jalan Bidi and then Jalan Krokkong (SALCRA Jagoi estate.) Sites southeast of MSSTP were accessed by heading east on Jalan Batu Kawa and then southbound into Jalan Datuk Stephen Yong. From Jalan Datuk Stephen Yong, direction shifted again due east into Jalan Da-tuk Bandar Mustapha that led to Jalan Penrissen. All estates (SALCRA Taee, FELCRA kawasan Belimbing and Samarahan Sdn. Bhd.)located on Jalan Kuching/Serian (inclusive of Jalan Padawan and Jalan Ensengei) were reached using Jalan Penrissen as the main route. All the directions and main routes traveled are shown in Figure 6.

Plantations found in the district of Samarahan (i.e. FELCRA Kawasan Samarahan and Asajaya) were arrived at by traveling east on Jalan Batu Kawa towards the 3rd Mile intersection. The following journey was taken to measure the distances of estates in Samarahan:

3rd Mile intersection → Jalan Laksamana Cheng Ho → Jalan Ong Tiang Swee → Simpang Tiga intersection → Jalan Tabuan Jaya → Jalan Tabuan Laru/Kota Samarahan → Jalan Datuk Mohammad Musa.

5.3.2 Present Types of Fertilizer and Nutrient Requirement

Since the raw materials used to manufacture the proposed recycled organic fertilizer in this case study contain high percentage of humus matters, it is thus suitable for production of nutrient supplements or soil conditioners (depending on the chemical and biological processes adopted at the manufacturing plant.)

Mineral soil is low in its organic contents compared to peat soil; as a result fertilizer used on such field should be augmenting the nutrients content of the soil rather than the volume. Conversely, peat oil is evidently high in its organic compositions (more nutrients in peat soil); therefore it is more important to apply fertilizer which complement the volume of peat soil land (i.e. soil conditioners.)

Out of the 10 oil palm plantations, only one of the estates is situated on 100 % peat soil, namely FELCRA’s Asajaya oil palm estate in Sadong Jaya. In addition, Samarahan Sdn. Bhd. oil palm project reportedly has 10-20% of peat soil and FELCRA Tamang Sembawang oil palm plantations have an undetermined (very small) percentage of peat soil. The other 7 oil palm plantations and the Mulberry estate are all located on mineral soil.

It was discovered through the survey, types of fertilizer applied varied from one estate to another. Generally, 2 kinds of compost, mixture and straight fertilizers were being applied to the field. Mixture fertilizers are made out of various nutrient compositions, specifically Nitrogen (N), Phosphate (P), Potassium (K), Magnesium (Mg) plus other trace elements. Compound fertilizers are normally prescribed to immature palms (2-4 year-old) while mixture/straight composts...
such as Urea (N), Rock Phosphate (RP), and Murtash of Potash (MOP) are more suitable for mature palms (4 and up year-old). Kieserite (K) and Borate (B) are usually ancillary trace elements aimed at improving the soil conditions. The frequency and percentage of each nutrients (mix & straight fertilizers) used on the estates surveyed were all determined by preceding foliar analysis (quarterly or yearly.) As nutrient requirements varied according to types of soil and growth stages of plant, some of the mixture fertilizers used on these estates was even tailor made to suit individual need of the estates. The straight composts are commonly marketed at pre-set level of single nutrient. For instances, Urea is manufactured to contain 46% of Nitrogen, Murtash of Potash contain 60% of Potassium Oxide, Rock Phosphate consist of minimum 30% Phosphate and etc.

Incidentally, 2 of the oil palm plantations (SALCRA Undan & Stenggang) had started applying HOEST ECO-Greenlife organic fertilizer on their fields. ECO-Greenlife organic fertilizer is currently marketed at an N:P:K:B compositions of 5/5/3/0.23. Table 6 on the next page lists the different kinds of fertilizer used at the surveyed estates.

### 5.3.3 Estimation of Quantity of Fertilizer/Soil Conditioner Required

Estimation of the different kinds of fertilizer was all based on the most up-to-date manuring programs prescribed by the respective agronomists of the estates. As mentioned in the preceding chapter, the types of fertilizer (i.e. nutrient compositions) required depended on many factors. For instance, soil type, growth phase, and foliar analysis. Table 7 lists the summary of the amount (of various types of fertilizer) currently applied to the estates.

#### Table 6 – Types of Fertilizer Used in the Estates

<table>
<thead>
<tr>
<th>Estate:</th>
<th>Fertilizer Nutrient Compositions:</th>
<th>Estate:</th>
<th>Fertilizer Nutrient Compositions:</th>
</tr>
</thead>
<tbody>
<tr>
<td>FELCRA Kawasan</td>
<td>(a) Urea = 46% N</td>
<td>FELCRA Tamang</td>
<td>(a) Urea = 46% N</td>
</tr>
<tr>
<td>Samarahan OPP</td>
<td>(b) MOP = 60% K₂O, 37% Cl</td>
<td>Sembawang OPP</td>
<td>(b) Rock Phosphate = 32% P₂O₅</td>
</tr>
<tr>
<td></td>
<td>(c) Rock Phosphate = 32% P₂O₅</td>
<td></td>
<td>(c) MOP = 60% K₂O, 37% Cl</td>
</tr>
<tr>
<td></td>
<td>(d) GML = 12% MgO, 44% CaO</td>
<td></td>
<td>(d) CCM 25 (N:P:K:Mg) = 14/13/9/2.5</td>
</tr>
<tr>
<td></td>
<td>(e) Zinc Sulphate = 23% Zn, 11% S</td>
<td></td>
<td>(e) CCM 44 N:P:K:Mg) = 12/6/22/3</td>
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<tr>
<td></td>
<td>(f) Copper Sulphate = 25% Cu, 12% S</td>
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<td></td>
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<td></td>
<td>(g) SOA = 21% N</td>
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<tr>
<td>FELCRA Kawasan</td>
<td>(a) Mix 44 (N:P:K:Mg) = 12/6/22/3</td>
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<td></td>
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<tr>
<td>Samarahan OPP</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Bratak OPP</td>
<td>(a) N:P:K:Mg = 10/6/14/3</td>
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<td></td>
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<tr>
<td></td>
<td>(b) N:P = 10.5/10.5/10.5</td>
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<tr>
<td></td>
<td>(c) Kieserite = 27% Mg, 22% S</td>
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<tr>
<td></td>
<td>(d) Borate = 48% B₂O₃</td>
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<tr>
<td></td>
<td>(e) Mix 44 (N/P/K/Mg) = 12/6/22/3</td>
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<tr>
<td>SALCRA</td>
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<tr>
<td>Bratak OPP</td>
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<tr>
<td></td>
<td>(a) N:P:K:Mg = 10/6/14/3</td>
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<tr>
<td></td>
<td>(b) N:P = 10.5/10.5/10.5</td>
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<tr>
<td></td>
<td>(c) Kieserite = 27% Mg, 22% S</td>
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<td></td>
<td>(d) Borate = 48% B₂O₃</td>
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<tr>
<td></td>
<td>(e) Mix 44 (N/P/K/Mg) = 12/6/22/3</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>FELCRA</td>
<td>(a) SOA = 21% N</td>
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</tbody>
</table>


<table>
<thead>
<tr>
<th>Estate:</th>
<th>Fertilizer Nutrient Compositions:</th>
<th>Estate:</th>
<th>Fertilizer Nutrient Compositions:</th>
</tr>
</thead>
</table>
| Jagol OPP | (b) N:P:K = 10.5/10.5/10.5  
(c) Kieserite = 27% Mg, 22% S  
(d) Borate = 48% B₂O₃ | Kawasan OPP | (b) MOP = 60% K₂O, 37% Cl  
(c) Rock Phosphate = 32% P₂O₅  
(d) Kieserite = 27% Mg, 22% S  
(e) Borate = 48% B₂O₃  
(f) CCM 25 (N:P:K:Mg) = 14/13/9/2.5  
(g) CCM 44 N:P:K:Mg) = 12/6/22/3 |
| 7 SALCRA Undan OPP | (a) N:P:K = 10.5/10.5/10.5  
(b) N:P:K = 5/5/3 + TE  
(c) N:P:K:Mg = 10/6/14/3  
(d) N:P:K:Mg = 9.7/4.8/17.6/2.5  
(e) Rock Phosphate = 32% P₂O₅  
(f) Borate = 48% B₂O₃ | 8 SALCRA Taee OPP | (a) N:P:K:Mg = 10/6/14/3  
(b) N:P:K:Mg = 9.7/4.8/17.6/2.5  
(c) N:P:K:Mg = 10.7/10.4/7.2/2.1 |
| 9 FELCRA Asajaya OPP | (a) Urea = 46% N  
(b) MOP = 60% K₂O, 37% Cl  
(c) Rock Phosphate = 32% P₂O₅  
(d) Kieserite = 27% Mg, 22% S  
(e) Borate = 48% B₂O₃  
(f) Copper Sulphate = 25% Cu, 12% S | 10 Zuhrah Pelangi Mulberry Plantation | (a) N:P:K = 12/5/8  
(b) Rock Phosphate = 32% P₂O₅  
(C) MOP = 60% K₂O, 37% Cl  
(d) Urea = 46% N  
(e) GML = 12% MgO, 44% CaO |
| 11 SALCRA Stenggang OPP | (a) SOA = 21% N  
(b) Rock Phosphate = 32% P₂O₅  
(c) N:P:K:Mg = 10/6/14/3  
(d) HOEST ECO-Greenlife = N:P:K:B = 5/3/3/0.23 | | |

**Note:**
1. MOP = Murtash of Potash  
2. GML = Ground Magnesium Limestone  
3. SOA = Ammonium Sulphate  
4. N = Nitrogen  
5. P = Phosphate  
6. K = Potassium  
7. Mg = Magnesium  
8. Ca = Calcium  
9. S = Sulfur  
10. TE = Trace Elements  
11. B = Borate
<table>
<thead>
<tr>
<th>Estate:</th>
<th>Size in Hectare:</th>
<th>Fertilizer Nutrient Compositions:</th>
<th>Quantity of Respective Fertilizer (MT):</th>
</tr>
</thead>
<tbody>
<tr>
<td>FELCRA</td>
<td></td>
<td>(a) Urea = 46% N</td>
<td>760.22</td>
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<tr>
<td>Kawasan</td>
<td></td>
<td>(b) MOP = 60% K₂O, 37% Cl</td>
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<td>Samarahan OPP</td>
<td>3041</td>
<td>(c) Rock Phosphate = 32% P₂O₅</td>
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<td></td>
<td></td>
<td>(d) GML = 12% MgO, 44% CaO</td>
<td>250.00</td>
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<td>(e) Zinc Sulphate = 23% Zn, 11% S</td>
<td>6.00</td>
</tr>
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<td></td>
<td></td>
<td>(f) Copper Sulphate = 25% Cu, 12% S</td>
<td>6.00</td>
</tr>
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<td></td>
<td></td>
<td>(g) SOA = 21% N</td>
<td>116.00</td>
</tr>
<tr>
<td>SALCRA</td>
<td></td>
<td>(a) N:P:K:Mg = 10/6/14/3</td>
<td>1368.34</td>
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<tr>
<td>Bratak OPP</td>
<td>2411</td>
<td>(b) N:P:K = 10.5/10.5/10.5</td>
<td>1922.94</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Kieserite = 27% Mg, 22% S</td>
<td>51.23</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) Borate = 48% B₂O₃</td>
<td>107.80</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(e) Mix 44 (N/P/K/Mg) = 12/6/22/3</td>
<td>359.32</td>
</tr>
<tr>
<td>SALCRA</td>
<td></td>
<td>(a) N:P:K:Mg = 10/6/14/3</td>
<td>n.a</td>
</tr>
<tr>
<td>Jagoi OPP</td>
<td>2785</td>
<td>(b) N:P:K = 10.5/5.5/10.5</td>
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</tr>
<tr>
<td></td>
<td></td>
<td>(c) Kieserite = 27% Mg, 22% S</td>
<td>n.a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) Borate = 48% B₂O₃</td>
<td>n.a</td>
</tr>
<tr>
<td>SALCRA</td>
<td></td>
<td>(a) N:P:K = 10.5/10.5/10.5</td>
<td>1747.90</td>
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<tr>
<td>Undan OPP</td>
<td>3062</td>
<td>(b) N:P:K = 5/5/3 + TE</td>
<td>1116.44</td>
</tr>
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<td></td>
<td></td>
<td>(c) N:P:K:Mg = 10/6/14/3</td>
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<td></td>
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<tr>
<td></td>
<td></td>
<td>(e) Rock Phosphate = 32% P₂O₅</td>
<td>n.a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(f) Borate = 48% B₂O₃</td>
<td>n.a</td>
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<tr>
<td>FELCRA</td>
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<td>(a) Urea = 46% N</td>
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<tr>
<td>Asajaya OPP</td>
<td>1002</td>
<td>(b) MOP = 60% K₂O, 37% Cl</td>
<td>540.70</td>
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<td></td>
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<td>(c) Rock Phosphate = 32% P₂O₅</td>
<td>337.25</td>
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<td>(d) Kieserite = 27% Mg, 22% S</td>
<td>14.70</td>
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<tr>
<td></td>
<td></td>
<td>(e) Borate = 48% B₂O₃</td>
<td>13.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(f) Copper Sulphate = 25% Cu, 12% S</td>
<td>13.20</td>
</tr>
<tr>
<td>SALCRA</td>
<td></td>
<td>(a) N:P:K:Mg = 10/6/14/3</td>
<td>1318.72</td>
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<td>Stenggang OPP</td>
<td>1085</td>
<td>(b) HOEST ECO-Greenlife = N:P:K:B = 5/3/3/0.23</td>
<td>1791.16</td>
</tr>
<tr>
<td>Estate:</td>
<td>Size in Hectare:</td>
<td>Fertilizer Nutrient Compositions:</td>
<td>Quantity of Respective Fertilizer (MT):</td>
</tr>
<tr>
<td>----------------</td>
<td>------------------</td>
<td>----------------------------------</td>
<td>----------------------------------------</td>
</tr>
<tr>
<td>FELCRA</td>
<td></td>
<td>(a) Urea = 46% N</td>
<td>161.77</td>
</tr>
<tr>
<td>Tamang</td>
<td></td>
<td>(b) Rock Phosphate = 32% P₂O₅</td>
<td>161.77</td>
</tr>
<tr>
<td>Sembawang OPP</td>
<td>570</td>
<td>(c) MOP = 60% K₂O, 37% Cl</td>
<td>161.77</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) CCM 25 (N:P:K:Mg) = 14/13/9/2.5</td>
<td>n.a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(e) CCM 44 N:P:K:Mg) = 12/6/22/3</td>
<td>n.a</td>
</tr>
<tr>
<td>FELCRA</td>
<td></td>
<td>(a) SOA = 21% N</td>
<td>459.05</td>
</tr>
<tr>
<td>Kawasan OPP</td>
<td>2268.9</td>
<td>(b) MOP = 60% K₂O, 37% Cl</td>
<td>407.55</td>
</tr>
<tr>
<td>Belimbing OPP</td>
<td></td>
<td>(c) Rock Phosphate = 32% P₂O₅</td>
<td>23.20</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) Kieserite = 27% Mg, 22% S</td>
<td>53.15</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(e) Borate = 48% B₂O₃</td>
<td>1.95</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(f) CCM 25 (N:P:K:Mg) = 14/13/9/2.5</td>
<td>n.a</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(g) CCM 44 N:P:K:Mg) = 12/6/22/3</td>
<td>14.70</td>
</tr>
<tr>
<td>Samarahan Sdn. Bhd. OPP</td>
<td>1585</td>
<td>(a) N:P:K:Mg = 5.7/12/15.9/4.8</td>
<td>2077.97</td>
</tr>
<tr>
<td>SALCRA Taee OPP</td>
<td></td>
<td>(a) N:P:K:Mg = 10/6/14/3</td>
<td>1287.82</td>
</tr>
<tr>
<td>Zuhrah Pelangi Mulberry Plantation</td>
<td>50</td>
<td>(a) Rock Phosphate = 32% P₂O₅</td>
<td>7.38</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) MOP = 60% K₂O, 37% Cl</td>
<td>4.92</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Urea = 46% N</td>
<td>24.60</td>
</tr>
</tbody>
</table>

Note:
1. OPP = Oil Palm Plantation
2. n.a. = Information not available or item no longer applied to plants

It should be noted that often time, the nutrient requirements for certain estate may vary from time to time depending on the recommendation made subsequent to the plantation’s yearly foliar analysis.

5.3.4 Current Method of Fertilizer Application

Almost all 11 estates were discovered to adopt manual labor in their method of fertilizer application. There was only one estate found to have experimented by
using modified mini agriculture tractor in their fertilizer application, FELCRA Kawasan Samarahan. However, the management had only had a few of these tractors that handled both harvesting and manuring operations. With the exception of FELCRA Kawasan Belimbing project and Samarahan Sdn. Bhd. estate, the rest of the estates’ management were planning to upgrade their method of manuring and harvesting palms from manual labor to full machinery. The wages for manuring application (human labor) ranges from RM 12 – 15 per day or 5¢ - 12¢ per palm or RM 8 – 10 per hectare. The usual method of applying fertilizer manually was by broadcasting and circling around the palms. All 11 estates are currently sowing solid granule form compost to their crops.

5.3.5 Consensus on Using Recycled Organic Fertilizer/Soil Conditioner (Liquid form)

Compilation of answers regarding the use of liquid form fertilizer (as opposed to conventional solid granule fertilizer) had shown that the managements of 4 out of the 11 estates would only switch to liquid form fertilizer provided it satisfied the following criteria:

(a) the price is sufficiently competitive (i.e. cost vs. performance/yield of palm);

(b) the boost in term of FFB yield is proven against solid fertilizer; and

(c) lesser manuring frequency with similar yield compare to solid fertilizer (i.e. reduction in labor costs).

Other estate managements had voiced diverse concerns over the possible switch to liquid fertilizer which included: (i) only using liquid fertilizer on their nursery where the landscape is level and would not give rise to fertilizer run-offs (compared to other hilly area of the plantation); (ii) the extra labor efforts that must be invested because of liquid fertilizer added weight; and (iii) only if the management practices (manuring & harvesting) of the estate were fully mechanized (e.g. field spraying/injecting equipments). Due to the high infiltration rate of peat land, FELCRA Asajaya estate’s management was not interested in changing their existing use of solid fertilizer. Its management was fearful over the possible nutrient loss before absorption by the palm could take place.

It was found that all surveyed estates under the management of FELCRA were not interested in using the recycled organic fertilizer. Largely, this is due to their religious conviction (Islam) which strictly prohibits them from any association with swine (including porcine derivatives). On the other hand, estates under SALCRA’s management were very enthusiastic about switching from chemical based fertilizer to organic fertilizer. This phenomenon was partly caused by the encouraging results shown at a couple of its estates (Undan OPP & Stenggang OPP) which had experimented with organic fertilizer. Presently, the organic fertilizer being applied at these sites are purchased from
HOEST. The key components of the HOEST’s organic fertilizer were mulching from oil palm’s EFB, a fungus named *Mycorrhiza* and etc. HOEST ECO-Greenlife compost is advertised to carry a nutrient composition of 5/3/3/0.23 (N/P/K/B). Appendix 8 lists the composite data obtained during this study.
## 6 Discussions and Conclusion

### 6.1 Demand and Supply of Organic Waste

Omitting the plantations that refused to use this recycled organic fertilizer due to its porcine component (religiously prohibitive) and unavailable data from SALCRA Jagoi project the total amount of individual nutrient required is presented in Table 8 below.

**Table 8 – Quantity of Individual Nutrient Required by Interested Plantations**

<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SALCRA Bratak OPP</td>
<td>2411</td>
<td>(a) N:P:K:Mg = 10/6/14/3</td>
<td>1368.34</td>
<td>136.83</td>
<td>82.10</td>
<td>191.57</td>
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<tr>
<td></td>
<td></td>
<td>(b) N:P:K = 10.5/10.5/10.5</td>
<td>1922.94</td>
<td>201.91</td>
<td>201.91</td>
<td>201.91</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) Kieserite = 27% Mg, 22% S</td>
<td>51.23</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) Borate = 48% B₂O₃</td>
<td>107.80</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(e) Mix 44 (N/P/K/Mg) = 12/6/22/3</td>
<td>359.32</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SALCRA Undan OPP</td>
<td>3062</td>
<td>(a) N:P:K = 10.5/10.5/10.5</td>
<td>1747.90</td>
<td>183.53</td>
<td>183.53</td>
<td>183.53</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(b) N:P:K = 5/5/3 + TE</td>
<td>1116.44</td>
<td>55.82</td>
<td>55.82</td>
<td>33.49</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(c) N:P:K:Mg = 10/6/14/3</td>
<td>n.a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(d) N:P:K:Mg = 9.7/4.8/17.6/2.5</td>
<td>n.a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(e) Rock Phosphate = 32% P₂O₅</td>
<td>n.a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>(f) Borate = 48% B₂O₃</td>
<td>n.a</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SALCRA Stenggang OPP</td>
<td>1085</td>
<td>(a) N:P:K:Mg = 10/6/14/3</td>
<td>1318.72</td>
<td>131.87</td>
<td>79.12</td>
<td>184.62</td>
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<td></td>
<td></td>
<td>(b) HOEST ECO-Greenlife = N:P:K:B = 5/3/3/0.23</td>
<td>1791.16</td>
<td>89.56</td>
<td>53.73</td>
<td>53.73</td>
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<td>SALCRA Taee OPP</td>
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<td>1287.82</td>
<td>128.78</td>
<td>77.27</td>
<td>180.29</td>
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<td>Zuhrah</td>
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<td></td>
<td></td>
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</tr>
<tr>
<td>Pelangi</td>
<td>50</td>
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<tr>
<td>Mulberry</td>
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<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>

Total Amount of Individual N, P & K Required by the Respective Estate = 939.62 735.85 1032.10
Alternatively, the results estimated for the 69 pig farms in terms of the different nutrients (by weight in Metric Ton) are presented in Table 9 below. The weights calculated in the table below:

- Excluded amounts of organic waste that can be supplied by farmers who refused to participate in the proposed waste collection program;
- Assumed all the other farmers (i.e. conditional consent, incentive driven and unsure categories) were convinced to participate in the program;
- Daily collectible amount of nutrients within the organic waste is based on the values in Table 4; and
- Assumed 365 days per year.

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Total Weight of Nutrient (MT/Year)</th>
<th>Minimum</th>
<th>Maximum</th>
</tr>
</thead>
<tbody>
<tr>
<td>TKN (N)</td>
<td>1053</td>
<td>1053</td>
<td>1530</td>
</tr>
<tr>
<td>TPO (P$_2$O$_5$)</td>
<td>351</td>
<td>351</td>
<td>510</td>
</tr>
<tr>
<td>TKO (K$_2$O)</td>
<td>175</td>
<td>175</td>
<td>255</td>
</tr>
</tbody>
</table>

By comparing the values estimated in Table 8 and 9, it can be concluded that the demand for individual nutrient at the estates (interested in using organic fertilizer) generally exceeded the supply of these nutrients from livestock farms (willing to provide their organic waste.) Hence, it is safe to assume that there is considerable demand for recycled organic fertilizer in Kuching.

### 6.2 Complications and Recommendations

As cautioned at the beginning of this report, this is a pilot study that had been funded by the limited budget of the UEMS project. Therefore, it had not been possible to carry out a more holistic measuring program to estimate certain parameters in relation to the objectives of this survey. Particularly, the amount of organic waste that could be supplied by the livestock farmers was based on design criteria established in another country (i.e. characteristics of pig wastes and wastewater in Singapore.) Moreover, certain queries were repeatedly raised by the livestock farmers but because of the pilot status of the proposed waste collection system, some of the answers/information obtained might not accurately reflect the actual perceptions of the interviewees during the survey. Listed below are some of the concerns of the farmers:
(a) What precisely is the government’s plan regarding pig farming in Kuching? Will the government relocate all the pig farms to the proposed centralized Pig Farming Area (PFA) at Pasir Puteh or promote the retrofitting of existing farm (at their original sites) to facilitate the transportation of organic waste to MSSTP?

(b) Who will be responsible for the cost of disinfection measures/facilities or modification to the farm’s infrastructure to enable safe and easy entry of the organic waste tankers?

(c) What is the exact method being proposed for the collection of organic waste?

   (i) Will it be direct pumping from the waste lagoons into the tankers? or

   (ii) Special containers will be provided to temporarily store the residue, for example drums? and;

   (iii) Will the farmers be required to change the way they manage the waste, for instance reduce the frequency and volume of flushing?

(d) Will the proposed service (i.e. transporting organic waste to MSSTP) be free-of-charge?

(e) What portion of the waste will be collected? Either both the liquid and solid waste and only the lagoon’s bottom sludge?

Therefore, it is paramount to conduct additional studies before the formulation of a “final” waste collection system. The following activities are crucial in the initiation of a feasible waste collection system and viable marketing plan for organic fertilizer/soil conditioner in Kuching:

- Conduct detail study on the livestock farms in Kuching to ensure greater accuracy in the measurement of organic waste generated; and

- Clarification of Sarawak government’s future plan in regards to the livestock farming industry.

As it stands, the best methods for organic waste collection at the livestock farms are:

- Coordination with the livestock farmers to ensure the least amount of water is channeled into the lagoons (i.e. reduce the quantity of water use to cool/clean the hogs);

- Provision of temporary waste storage tank in strategic area (preferably on the outskirt of the farm) of the individual farm (i.e. for the inaccessible lagoons of the 31 farms); and
• Formulation of well-round disinfection measures for the desludging tankers at each selected husbandry.

Furthermore, it should be noted that oil palm projects under Islamic management would never accept the use of materials originating from porcine derivatives, including swine manure because of its prohibitive nature with regards to their religion.
Appendix 1
Survey Form for Livestock Farm & Potential Source of Organic Waste
Survey Form for Oil Palm Estate & Potential Organic Waste User
Appendix 2
Listing of Livestock Farms Selected for Survey
Appendix 3
Listing of Plantations Selected for Survey
Appendix 4
Boundary Maps of Plantations Selected for Study

(Note: Boundary map of Estate A, Zuhrah Pelangi Sdn. Bhd. Sematan Silk Farm/Mulberry Tree Plantation was unavailable during the survey)
Appendix 5
Results of Using Organic Waste as Fertilizer
Appendix 6
Particulars of All Livestock Farms
Appendix 7
Various Bio-Security Disinfectants Used in Livestock Farms
Appendix 8
Particulars of All Plantations & Mulberry Tree Estate