

**ACCUMULATION RATES OF THICKENED-  
BOTTOM SLUDGE AND ITS CHARACTERISTICS  
FROM WATER-BASED ONSITE SANITATION  
SYSTEMS IN THAILAND**





## **1. Introduction**

## **2. Objective**

## **3. Materials and Methods**

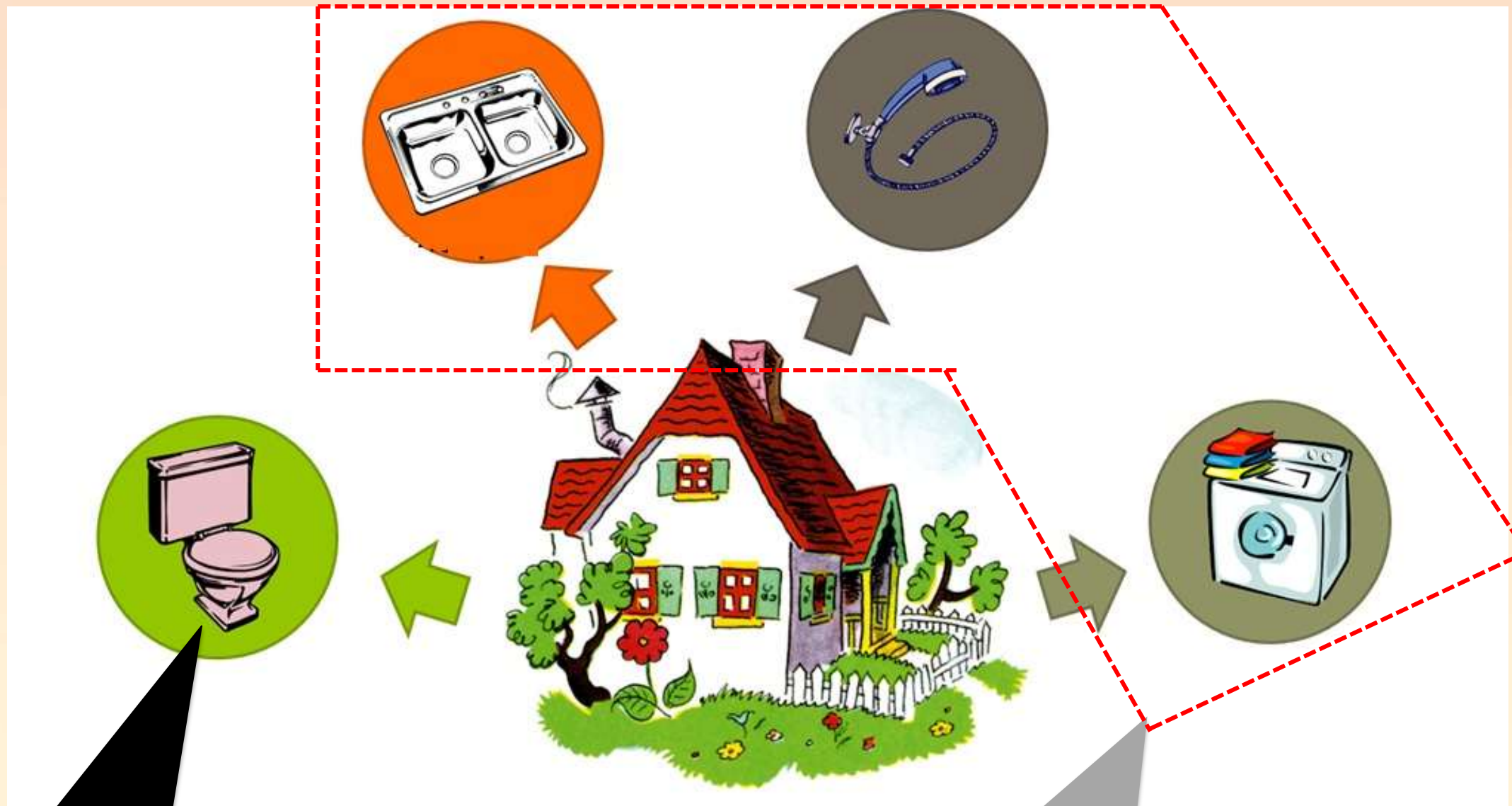
## **4. Results and Discussions**

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# Decentralized Wastewater Treatment

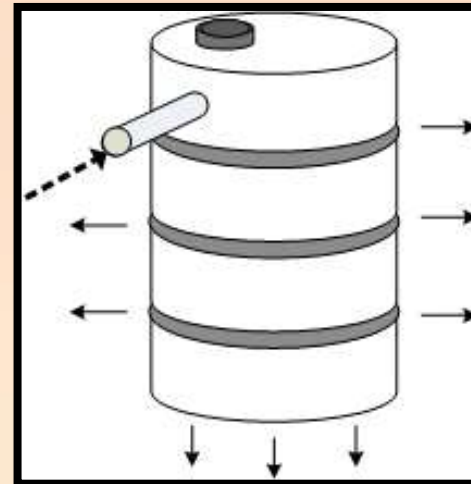
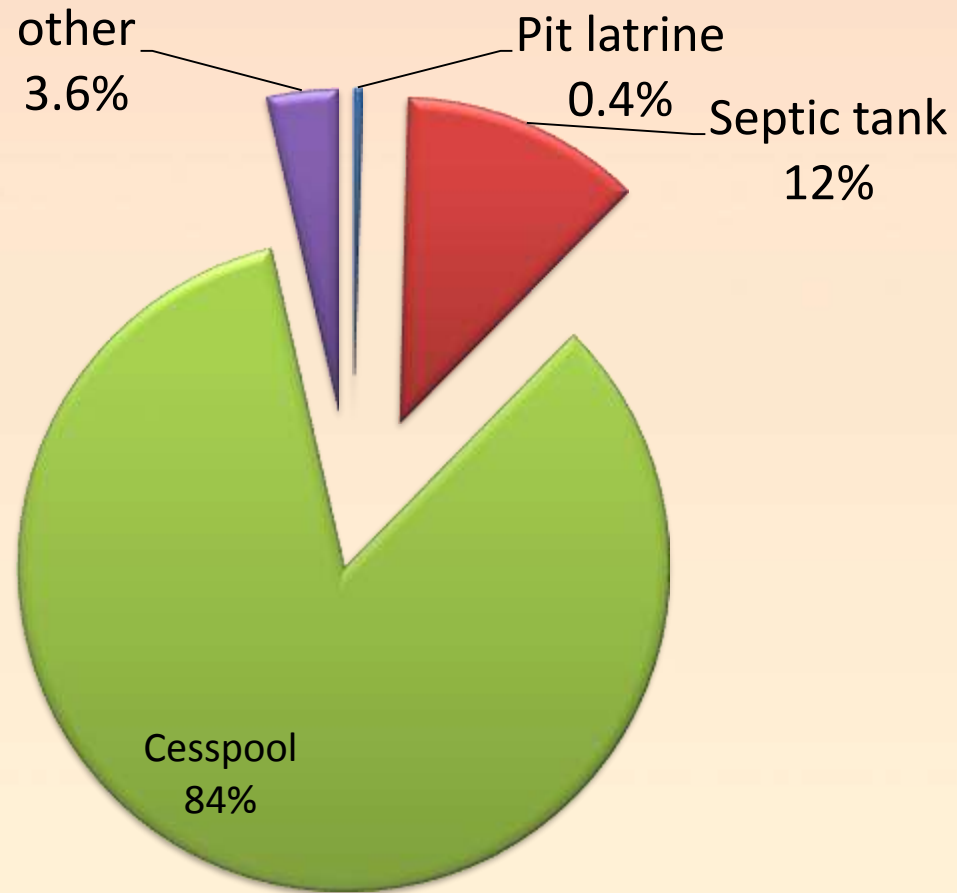


**15 - 35 % of Black water**

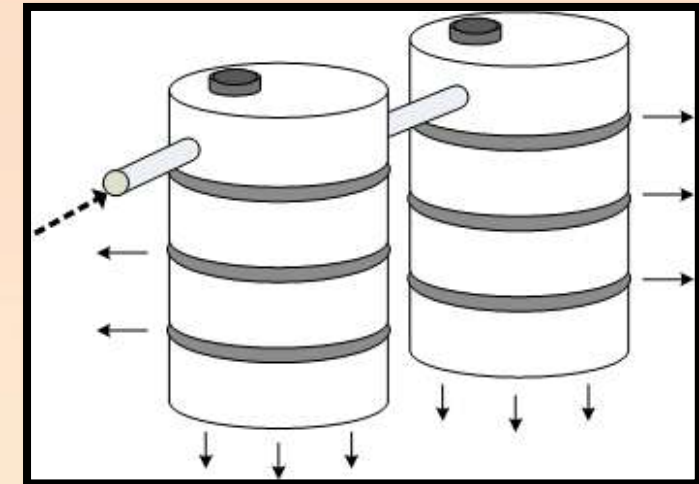
**65 – 85 % of Grey water**



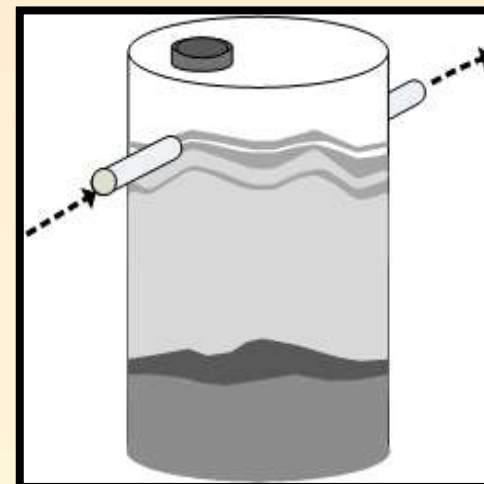
# Current DEWAT in Thailand



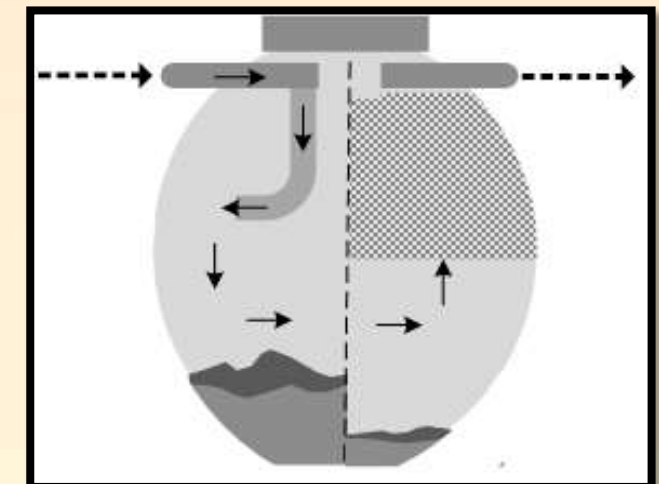
A single cesspool



Double cesspool in series



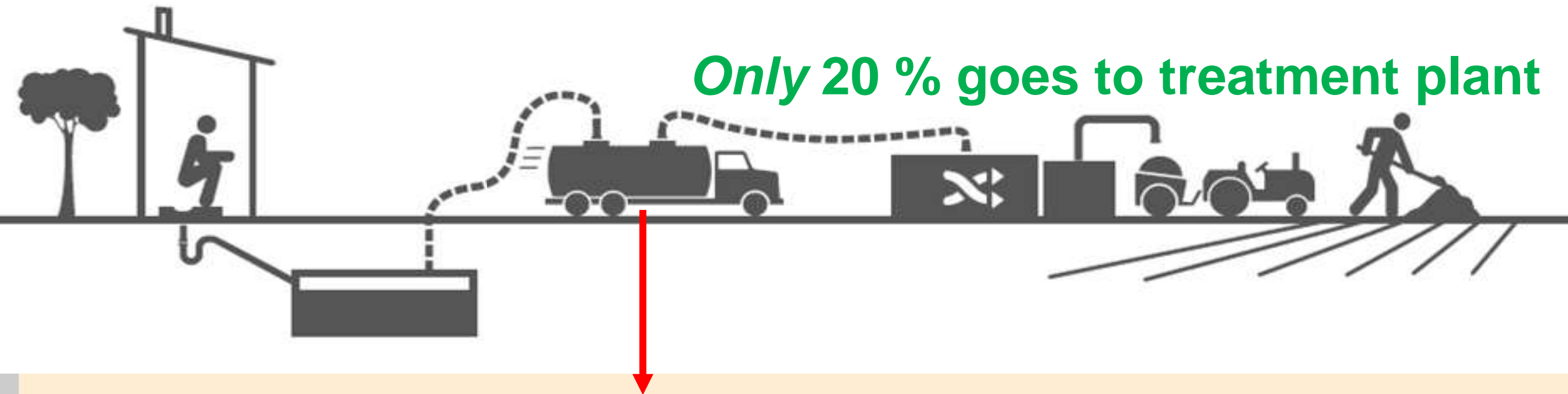
Manmade-cement septic tank



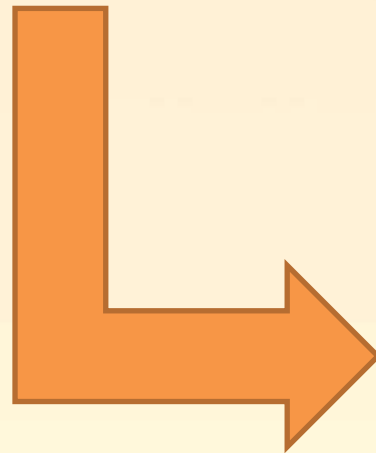
Commercial plastic treatment package



# Current situation in Thailand



**Where is the rest?**



Developing a promising  
technology for FS  
management



# Objectives

- Describe **characteristics of FS** from each type of onsite sanitation systems
- Correlation between FS management practices, **sludge quality and quantity**
- Factors influencing FS accumulations



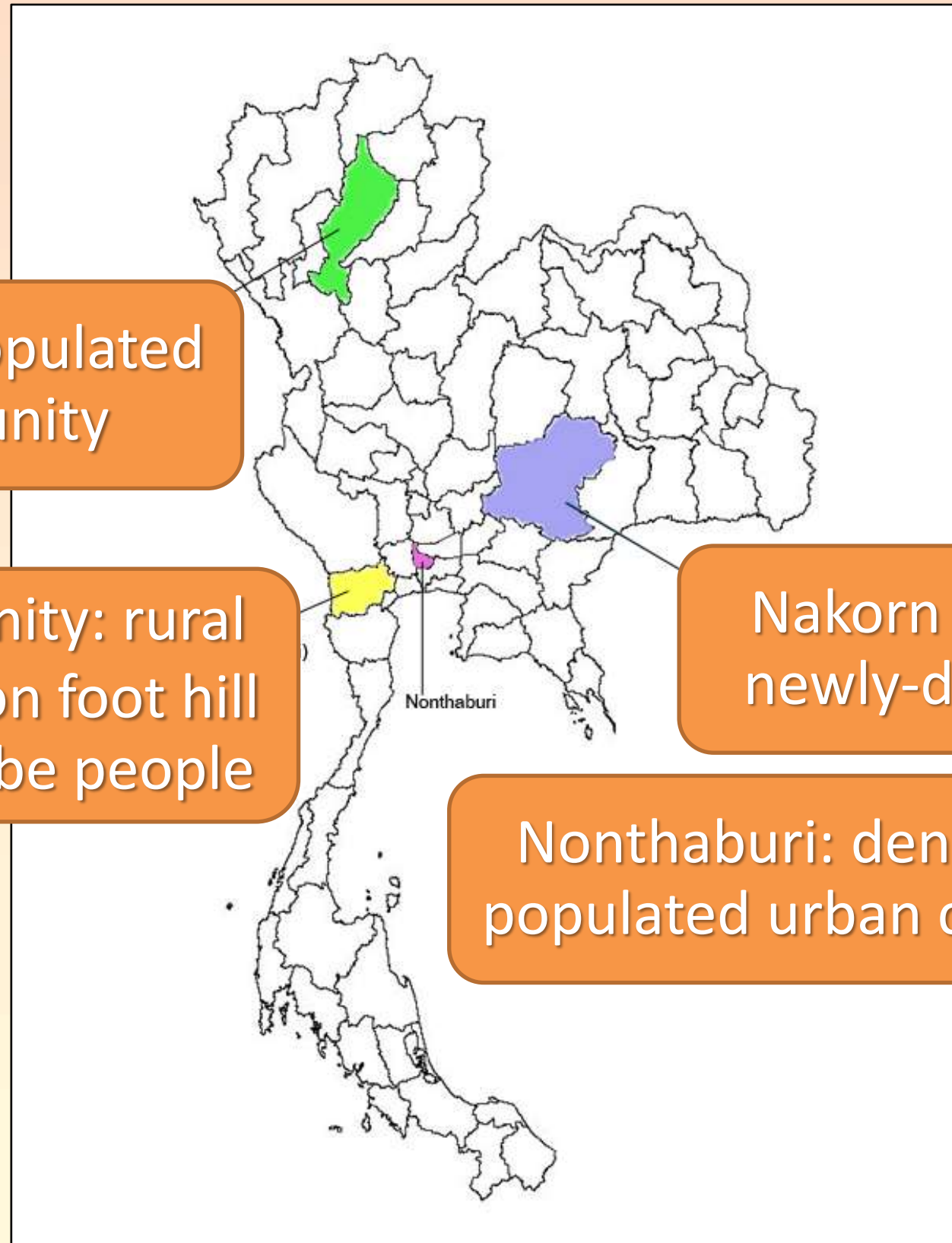
# Study Areas

Lampang: less-populated urban community

Suan Pheung community: rural district with location on foot hill and residing by hill tribe people

Nakorn Ratchasrima: newly-developed city

Nonthaburi: densely-populated urban center





# Sampling and Data Collection



**(a) Opened septic tank cover**



**(b) Sampling of liquid part**



**(c) Turn on vacuum pump**



**(d) FS Suction Process**



**(e) Turn off Controlling Valves**



**(f) Release FS from the hose**



**(g) Finish Sampling Process from Each Household**



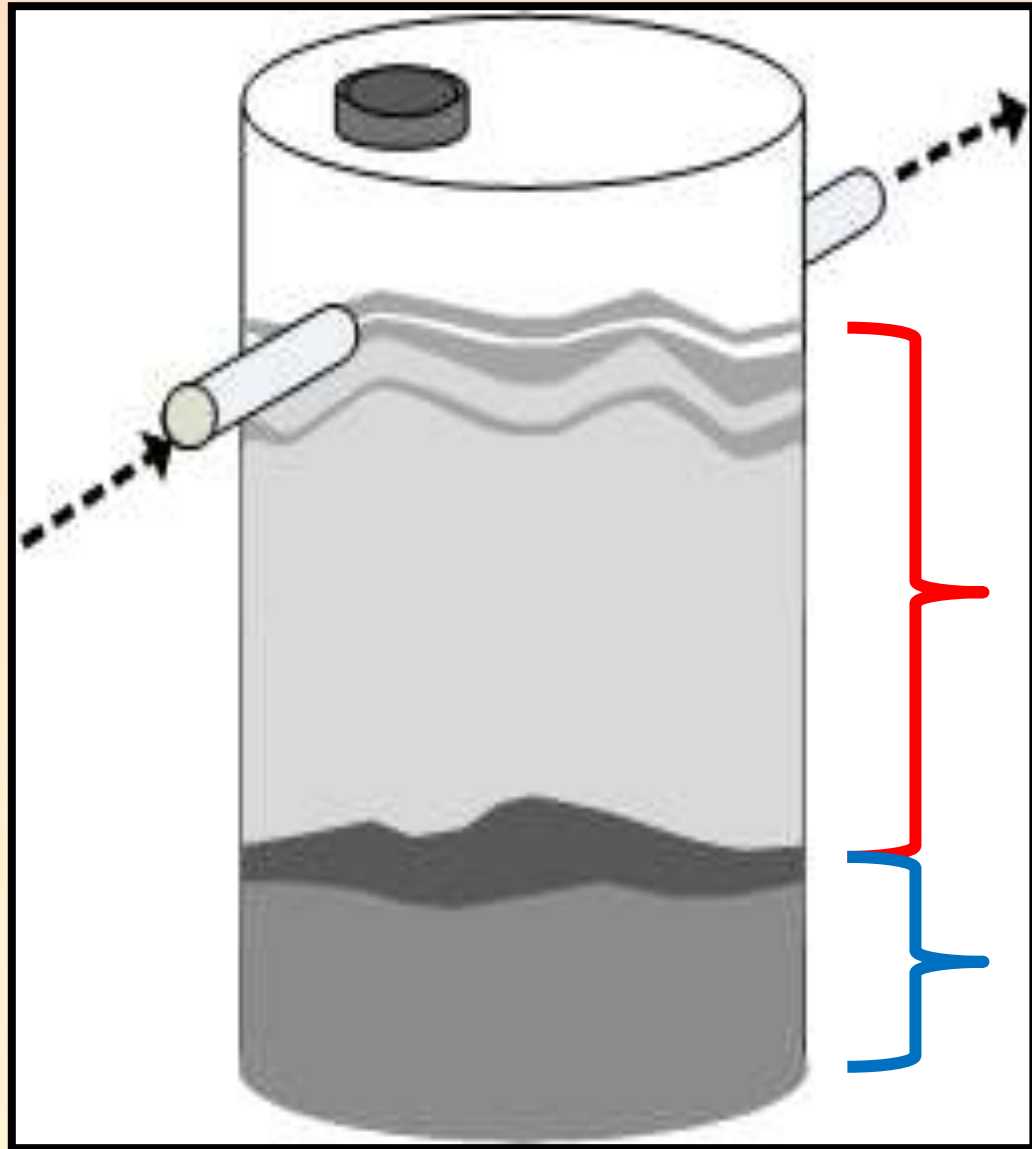
**(h) Washing**





# Sampling and Data Collection

- FS sample Collection



**Supernatant layer depth**

**Thickened-bottom sludge layer depth**

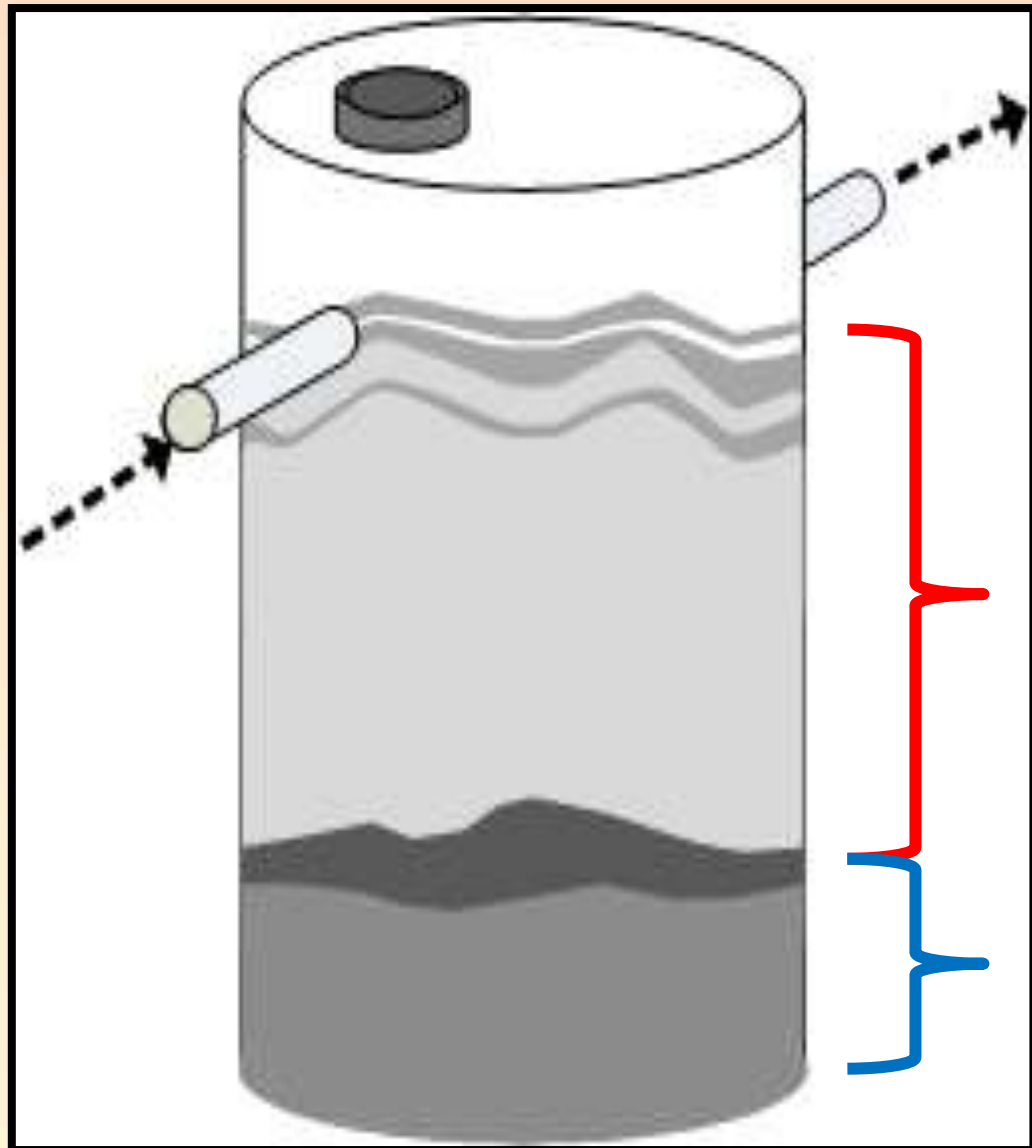


**FS level measure method**



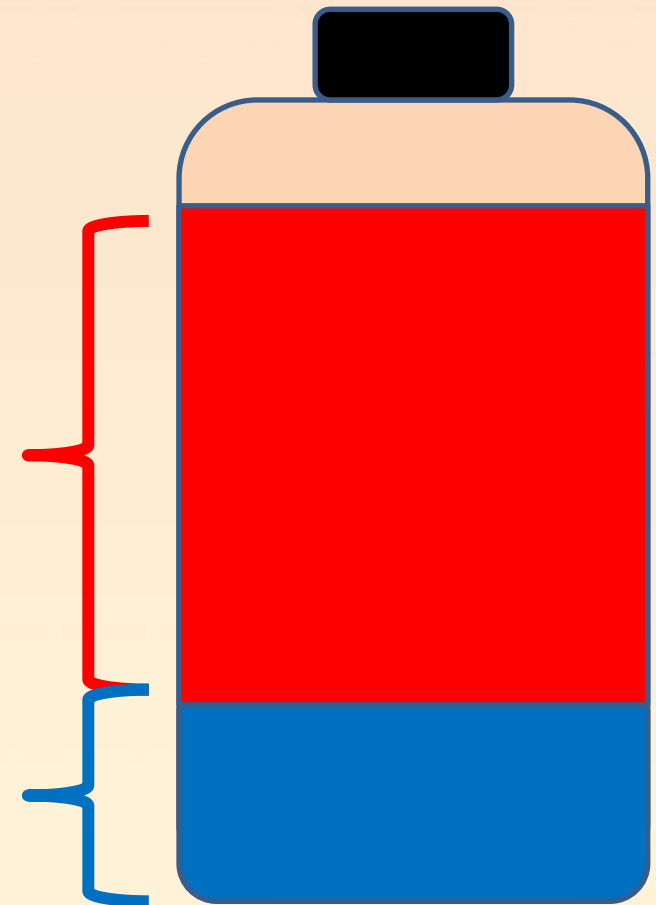
# Sampling and Data Collection

- FS sample for laboratory analysis



Supernatant layer

Thickened-bottom  
sludge layer



Proportional of Fluidized  
Sludge Sample Model  
-1 liter by volume



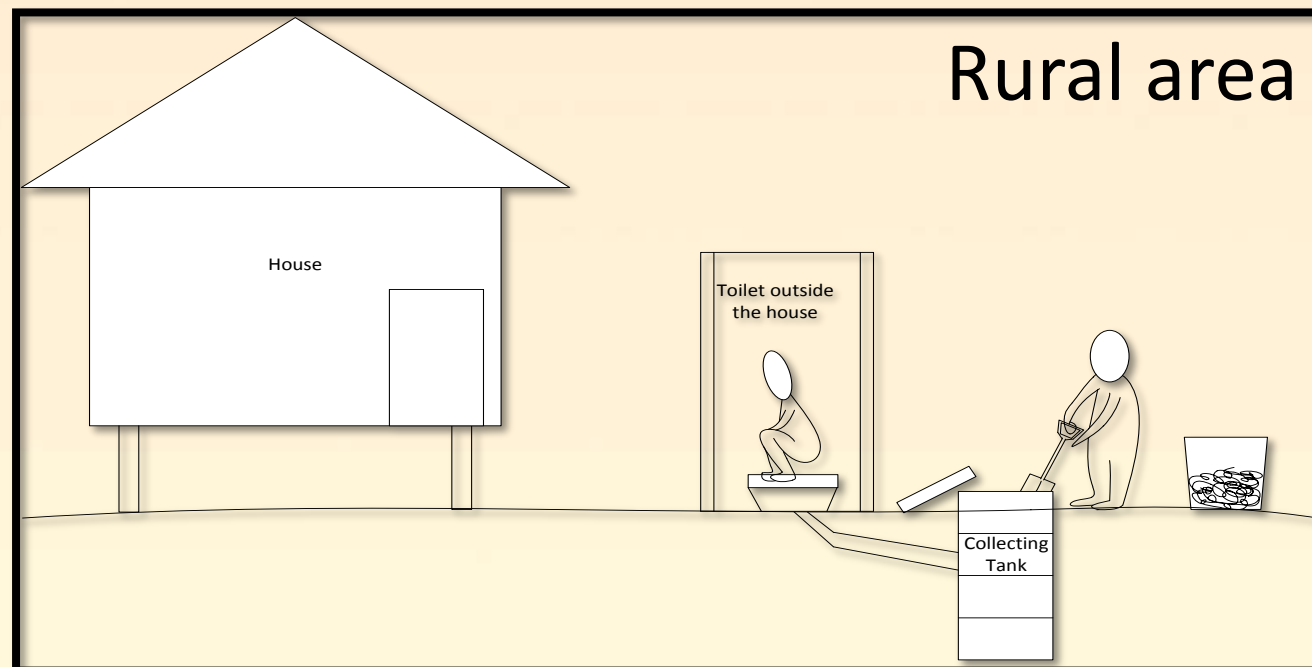
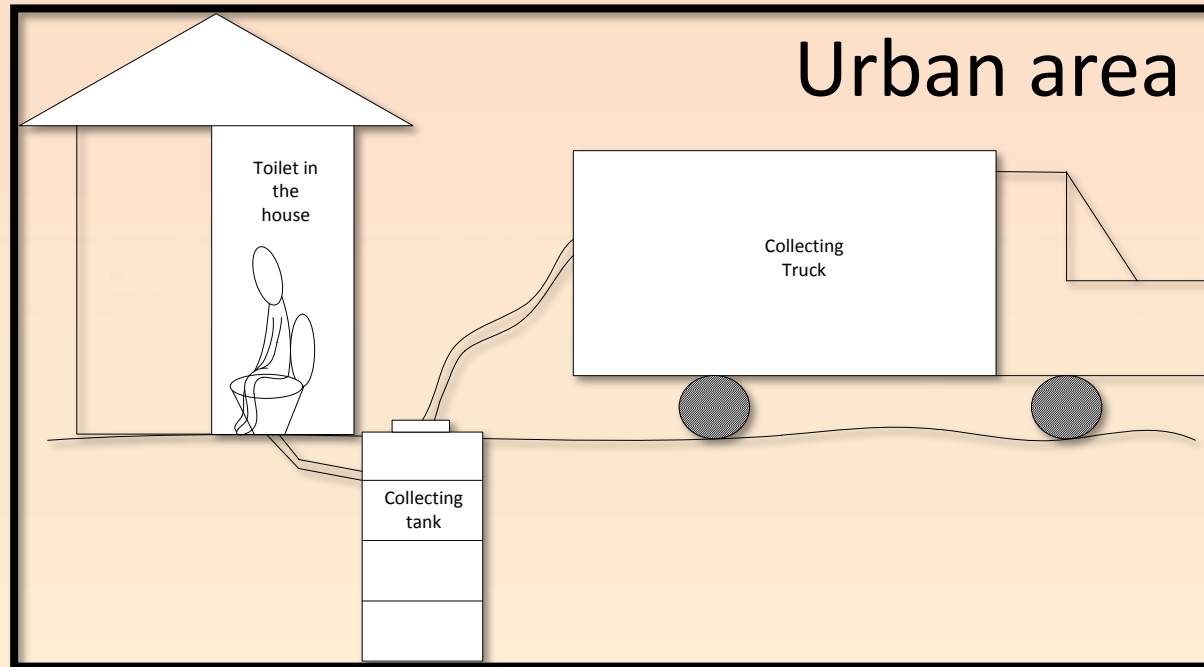
# Sampling equipment





# Results and Discussions

- FS emptying practices in Thailand

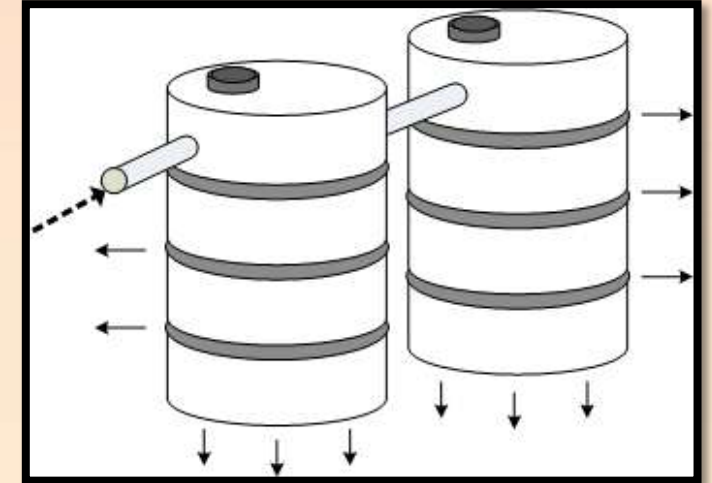
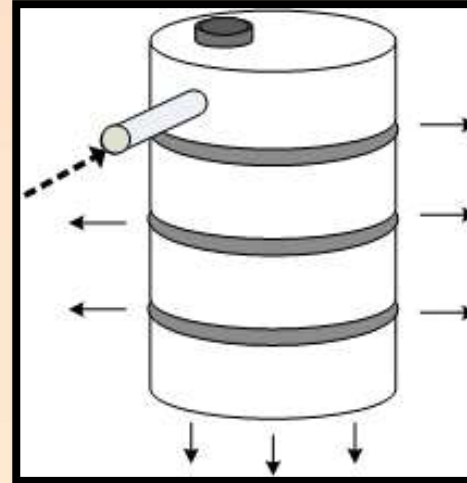




# Results and Discussions

## *Onsite Sanitation Systems*

Rural area with no drainage system use a single and double cesspool systems

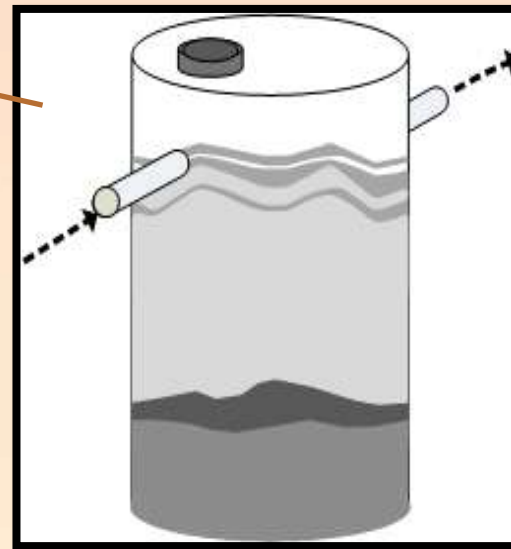




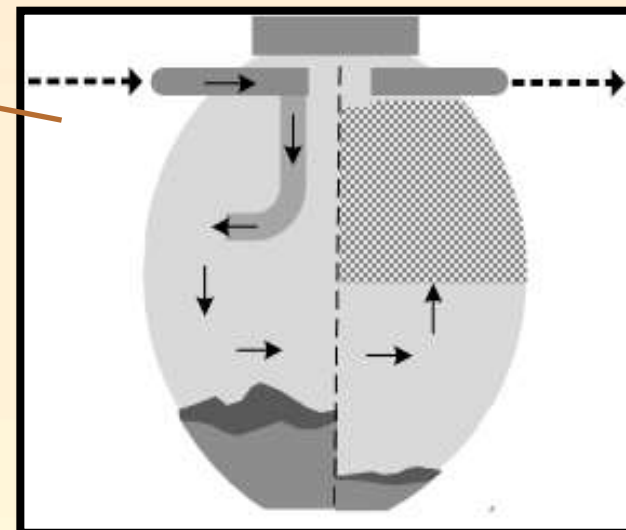
# Results and Discussions

## *Onsite Sanitation Systems*

A typical manmade-cement septic tank is mostly used in city or urban areas where drainage system avails



Newly-developed areas such as housing estate or newly-built house use commercial plastic treatment package





# Results and Discussions

## *Effects of OSS types and locations*

Type of onsite sanitation system	Location	Land use	Soil percolation type	Number of user (cap/unit)	Emptying period (years)	Volume of FS (m <sup>3</sup> )	Volume of thickened-bottom sludge (m <sup>3</sup> )
Manmade-cement septic tank	Nonthaburi	Densely urban area	Clay soil	4.3±2.7	1.8±1.7	1.2±1.1	0.4±0.2
A single cesspool	Nonthaburi	Densely urban area	Clay soil	3.8±1.5	2.0±1.7	0.8±0.3	0.2±0.1
	Lampang	General urban area	Loamy soil	3.6±1.3	0.7±0.3	1.3±0.2	0.6±0.3
	Ratchaburi	Rural area	Sandy soil	5.2±2.1	5.5±4.3	1.0±0.5	0.4±0.1
Double cesspool in series	Nonthaburi	Densely urban area	Clay soil	3.5±1.6	1.5±1.0	0.8±0.4	0.3±0.1
	Lampang	General urban area	Loamy soil	3.5±1.7	2.3±1.8	1.9±0.7	0.9±0.3
Commercial plastic treatment package	Nonthaburi	Densely urban area	No soil percolation, effluent dispose to drainage	4.1±1.0	1.5±1.2	1.0±0.3	0.5±0.1
	Nakorn Ratchasrima	Newly developed area	No soil percolation, effluent dispose to drainage	2.7±0.5	2.5±0.0	1.5±0.0	0.46±0.1



# Results and Discussions

## *Effects of OSS types and locations*

Type of onsite sanitation system	Location	Land use	Soil percolation type	FS production rate (L/cap/year)*	Rate of sludge accumulation depth (cm/m <sup>2</sup> /year)**
Manmade-cement septic tank	Nonthaburi	Densely urban area	Clay soil	340±245	57±42
A single cesspool	Nonthaburi	Densely urban area	Clay soil	270±196	49±22
	Lampang	General urban area	Loamy soil	1,610±500	42±29
	Ratchaburi	Rural area	Sandy soil	40±25	28±12
Double cesspool in series	Nonthaburi	Densely urban area	Clay soil	220±141	67±48
	Lampang	General urban area	Loamy soil	355±209	26±0.2
Commercial plastic treatment package	Nonthaburi	Densely urban area	No soil percolation, effluent dispose to drainage	230±80	75±45
	Nakorn Ratchasrima	Newly developed area	No soil percolation, effluent dispose to drainage	300±20	92±25

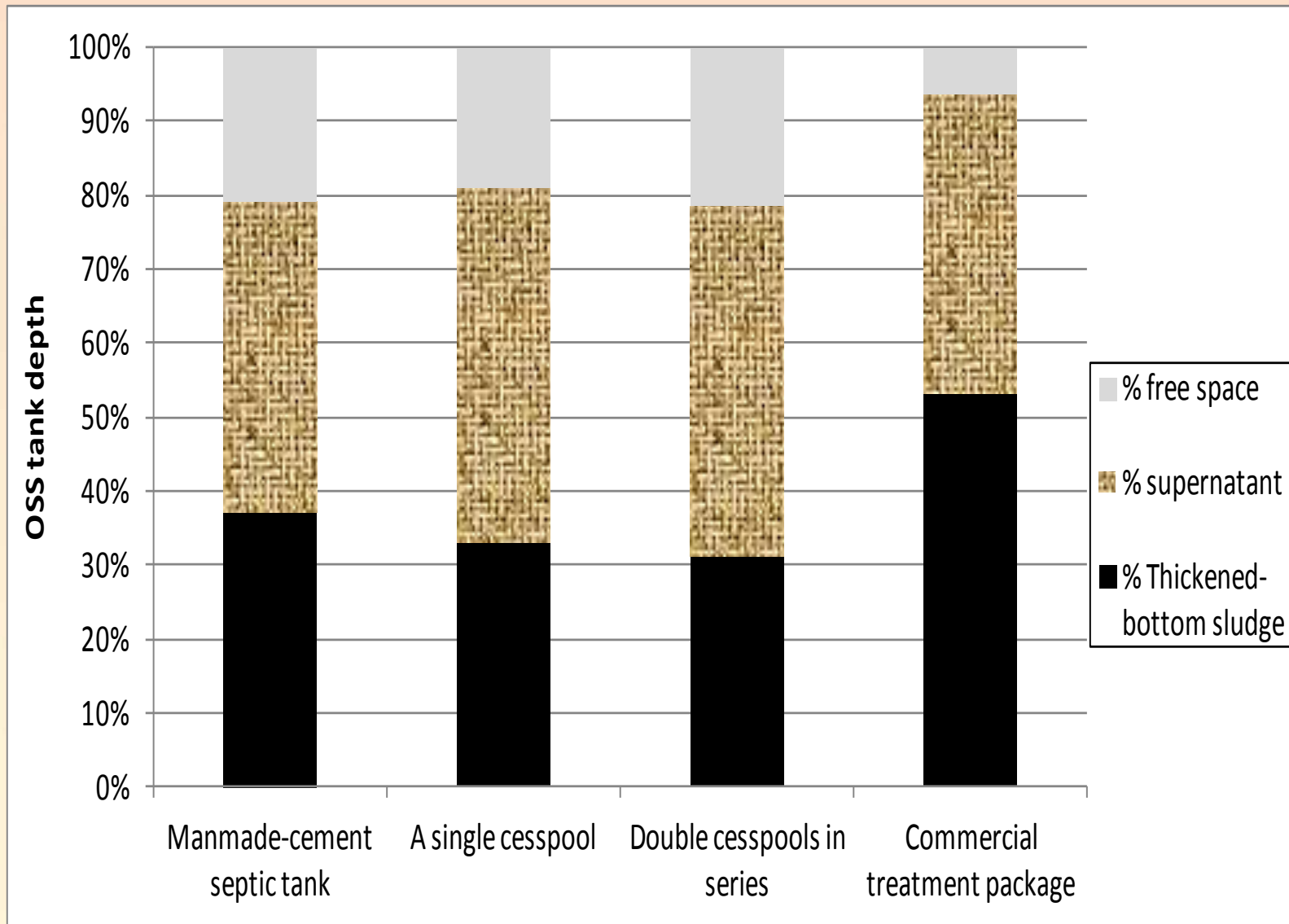
- Types of OSS seemed not significantly affects FS generation rate but likely depending on soil type and location
- Urban area with loamy soil (Lampang province) presented the highest average value of 1,610 L/cap/year
- FS production rate could depend on the emptying period due to stabilization or biodegradation processes of organic contents in the sludge





# Results and Discussions

## Percentage of sludge level in OSS tank before emptying



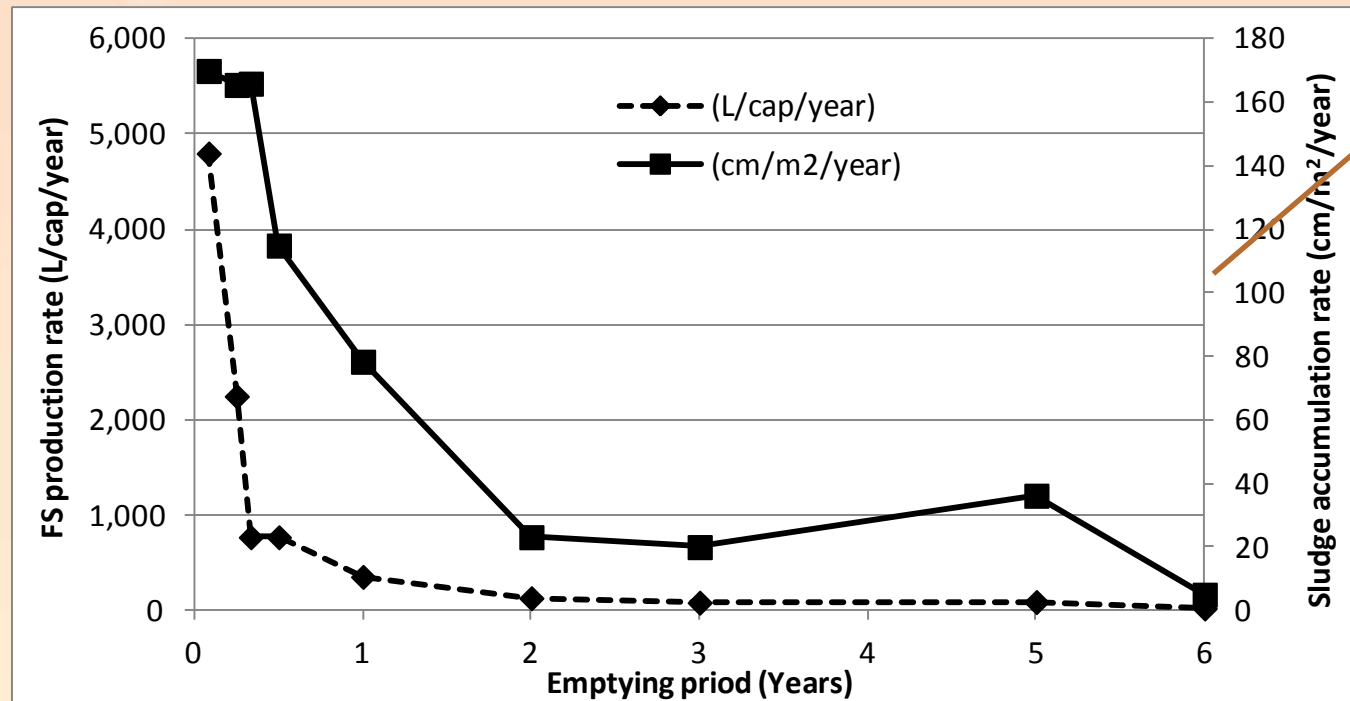
- **Commercial treatment package** → the highest thickened-bottom sludge depth of about 50%
- **Groundwater** table is relatively **low** → a single cesspool can increase greater than 69%

The selection of the level at which to remove the solids from the tank → a large impact on the pump out period and a large impact on the pump out period

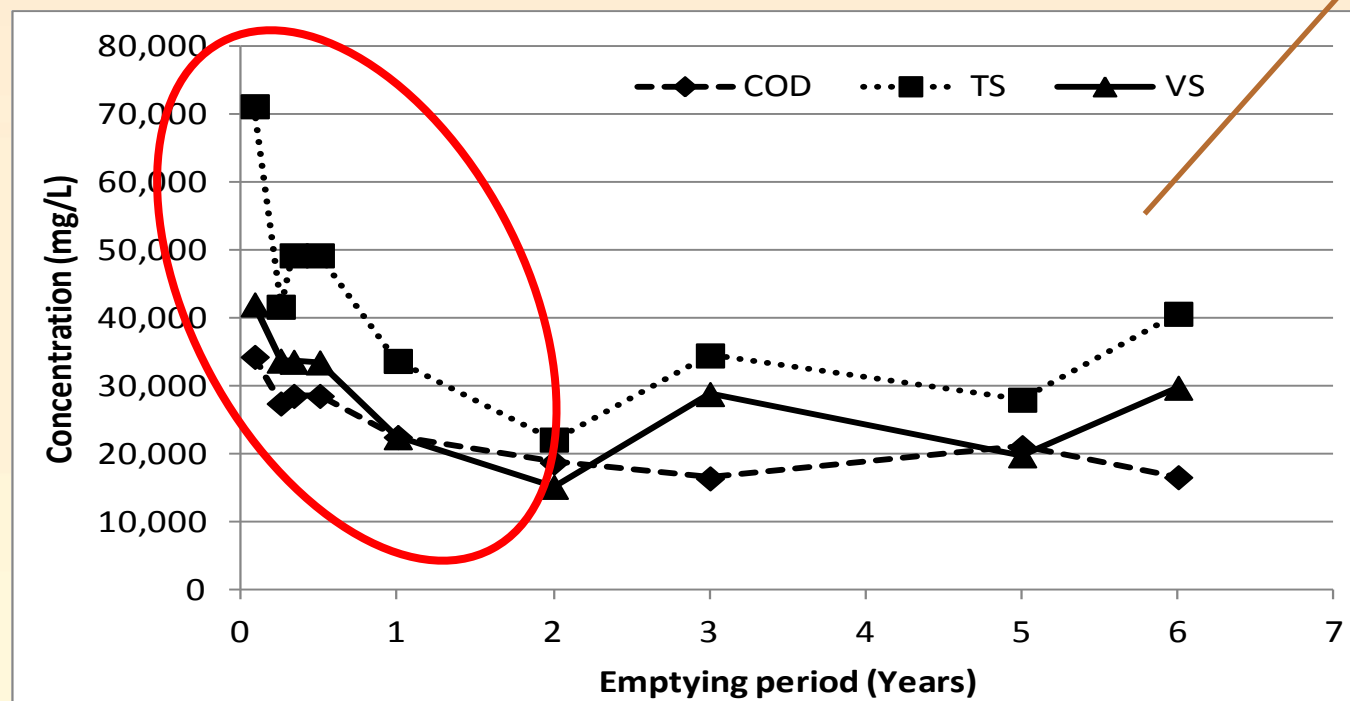


# Results and Discussions

## *Effects of emptying period in a single cesspool*



• The longer the emptying period required by OSS unit, the lower the sludge accumulation rate could be obtained



• Concentrations sharply decreased at the emptying period of no longer than 2 years

• Incidence could indicate biodegradation → an appropriate emptying period is more than every 2 years in order to ensure efficient biodegradation



# Results and Discussions

## *Solid characteristics of FS from different OSS types*

Type		Sample size (N)	Total Solid (mg/L)	Volatile Solid (mg/L)	Fixed Solid (mg/L)	Dried Solid (%)**
Thickened-bottom sludge	Manmade-cement septic tank	10				
	A single cesspool in clay and loamy soil areas	21				
	A single cesspool in sandy soil areas	12				
	Double cesspool in series	12				
	Commercial plastic treatment package	10	217,189 ± 107,840	25,245 ± 9,711	191,945 ± 108,116	22.85 ± 11.08
Fluidized sludge*	Manmade-cement septic tank	10	17,425 ± 23,474	12,273 ± 18,051	5,152 ± 6,441	1.78 ± 2.32
	A single cesspool in clay and loamy soil areas	21	10,054 ± 5,822	7,199 ± 4,419	2,292 ± 2,494	1.12 ± 0.84
	Double cesspool in series	12	10,958 ± 8,500	7,206 ± 5,153	4,498 ± 4,12	1.13 ± 0.86
	Commercial plastic treatment package	10	189,974 ± 109,143	10,581 ± 10,805	181,308 ± 108,387	19.47 ± 11.12

The highest TS concentrations in thickened-bottom sludge of commercial system → greatly contributed by the fixed solids which could likely result from the uses of toilet papers



# Results and Discussions

## *Rheological properties of thickened-bottom sludge from different OSS types*

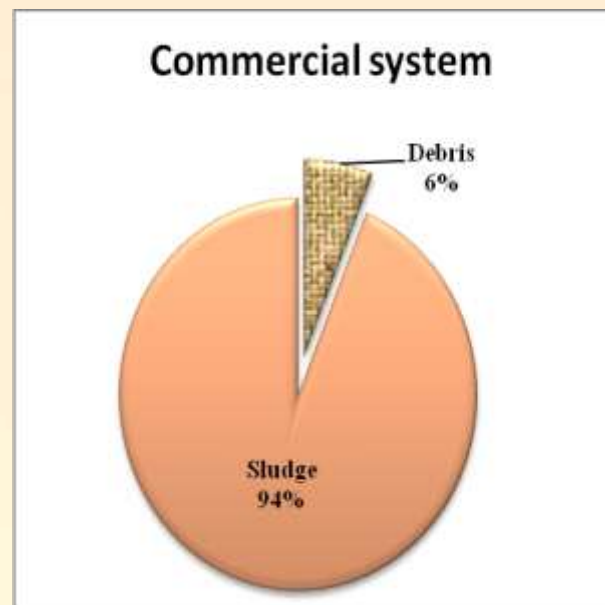
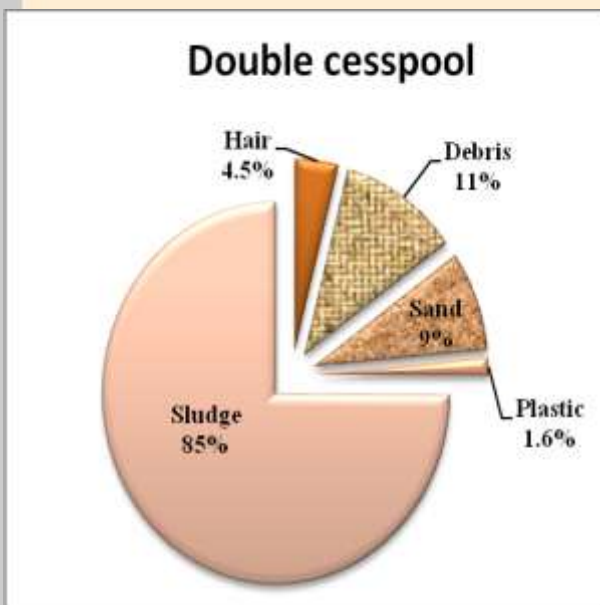
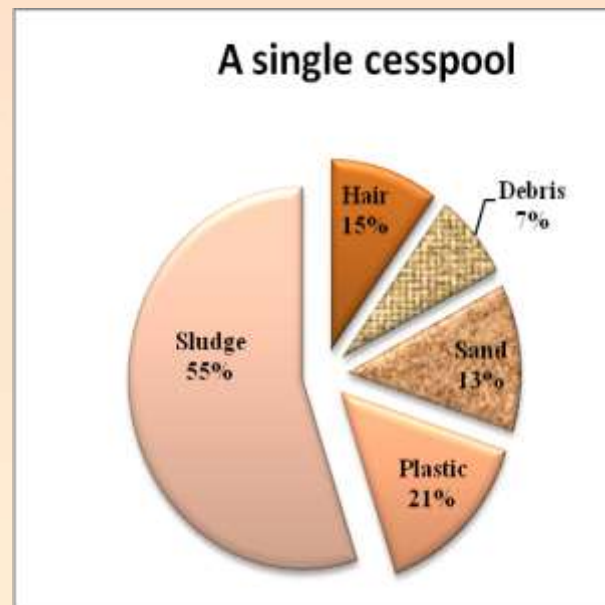
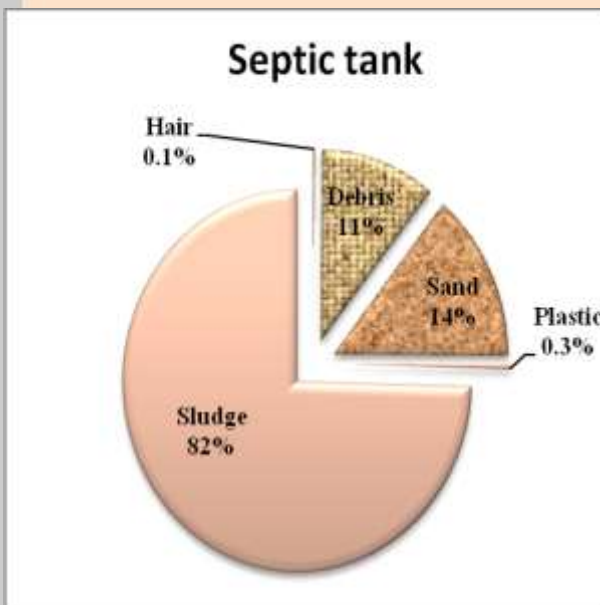
Type	Sample size (N)	Viscosity (cP)	Shear stress (D/cm <sup>2</sup> )	Density (g/cm <sup>3</sup> )
Manmade-cement septic tank	10	30.8	64.3	1.11
A single cesspool in clay and loamy soil areas	21	58.6	105.1	1.12
Double cesspool in series	12	79.6	144.2	1.13
Commercial plastic treatment package	10	82.0	139.7	1.10

- **Double cesspool and commercial** systems showed the relatively **higher value of Viscosity and shear stress**
- Viscosity and shear rate of the thickened-bottom sludge in this study were **higher than** those investigated in **wastewater sludge** before dewatering which reported at a range of 1.63 to 2.81 cP
- Unlike viscosity and shear stress, the density and conductivity values do not express any significant difference from various OSS types.



# Results and Discussions

## *Sludge composition of different Onsite Sanitation System*



- **Commercial package** system contain **the lowest contaminants** with only 6% of debris → a pre-fabricated material and a screen unit
- **A single cesspool, double cesspools in series and manmade septic tank systems** have the accumulated sludge at the **higher solid contaminants**
- The rate of contaminants could result from **behavior of toilet users**
- Unsealed bottom of a single or double cesspool would be a cause of sand and debris contamination during sludge emptying at high speed



# Conclusions

- A single cesspool is widely used in rural or peri-urban areas
- Commercial treatment package is selected in newly-developed urban areas
- For more than 10 years old houses → manmade septic tank and double cesspools in series
- Sludge emptying frequency, the commercial plastic package system requires every 2.5 years while an average frequency of once in 1.5 years is for the others.
- The difference in accumulation rate of the thickened-bottom sludge is probably due to the higher infiltration rate of difference soil types.
- Some rheological properties of the thickened-bottom sludge in this study should be helpful in the design of emptying facilities especially for those areas having no vacuum trucks.



# Thank you very much





# Thongthawil Service Co.,Ltd

Rayong, THAILAND



- **Sewage Pumping Service**
- **Portable Toilet**
- **Demin Water & Treat Water**
- **Unplug Drain Line Service**





**FS collection truck**



**Uniform**

FS emptying truck



FS flow through screening



Remove garbage



Reduce FS flow



Liquid part



Overflow



Activated Sludge



Constructed Wetland



Pond



UV filter and RO plant



Tap water storage



Covered Lagoon



Electricity Generator from Biogas



Sludge



Drying bed





# By-product from FSM Business!!

