APPENDICES

APPENDIX A

Procedures for Wastewater Analysis

A-1 Dissolved oxygen (DO) and biochemical oxygen demand (BOD_5)

APHA 4500-0 C Azide Modification method

Reagent preparation

a) Manganese sulfate solution: 364 g of $MnSO_4.H_2O$ was dissolved in distilled water. The solutions were filtered and diluted to 1 L. The manganese sulfate solution should not give a color with starch when added to an acidified KI solution.

b) Alkali-iodide-azide reagent: 500 g of NaOH and 135 of g NaI were dissolved in distilled water and diluted to 1 L. 10 g sodium azide, NaN_3 was dissolved in 40 mL distilled water and added to the potassium or sodium solution. Be careful that this reagent should not show a color with starch solution when diluted and acidified.

d) Starch solution: To prepare the aqueous solution, 2 g laboratory-grade soluble starch and 0.2 g salicylic acid (as a preservative) were dissolved in 100 mL of hot distilled water.

e) Standard sodium thiosulfate titrant: 6.205 g $Na_2S_2O_3.5H_2O$ was dissolved in distilled water. 0.4 g NaOH pellet was diluted to 1,000 mL and was added into the sodium thiosulfate solution. Then solution was standardized with bi-iodate solution.

f) Standard potassium bi-iodate solution, 0.0021 M: 812.4 mg KH $(IO_3)_2$ was dissolved and diluted in distilled water to 1,000 mL in volumetric flask.

Analytical procedure

1 mL of $MnSO_4$ solution was add into the Winkler bottle and, followed by 1 mL alkalide-iodide-azide reagent. Pipet tips were hold just above liquid surface when adding reagents. Stopper was recapped carefully to exclude air bubbles and mixed by inverting bottle a few times. When precipitate was settled sufficiently (to approximately half the bottle volume) to leave clear supernatant above the manganese hydroxide floc, 1.0 mL of conc H_2SO_4 was add into the bottle. Stopper was recapped and mix by inverting several times until dissolution is complete. After complete the dissolution, 100 mL sample was poured into the Erlenmeyer flask and titrate with 0.025M $Na_2S_2O_3$ solution to a pale straw color. Few drops of starch solution were adding into the solution and continued titration to first disappearance of blue color and record the end point (V_1). If endpoint overrun, back titrate with 0.0021 M standard potassium bi-iodate solution.

1 mL 0.025 M of $Na_2S_2O_3$ = 2 mg/L dissolved Oxygen

Collected samples ware diluted with necessary dilution factor and keeps them in incubator (20 ºC) for 5 days. DO_1 (DO concentration in day one) and DO_5 (DO concentration in day 5) ware measured by using the same method.

Calculation: BOD (mg/L) = DO_1-DO_5

A-2 Nitrate Nitrogen analysis, Cedergreen N, Madsen TV (2002) Method

Reagent preparation

a) Standard Potassium nitrate, Nitrate stock solution: Potassium nitrate (KNO_3) was dried in an oven at 105 ºC for 24 h. 0.7218 g of KNO_3 was dissolved and diluted in distilled water to 1,000 mL; 1.00 mL = 100 mg NO_3^- - N. Two milliliter of $CHCl_3$ per liter was used for preservative. This solution was stable for 6 months.

Analytical procedure

The water samples were transferred into 25 ml volumetric flask. Standard nitrate solution series ware prepared using stock solution. The absorbance was measured using a 10mm quarts cuvette at wavelengths 203nm.

A-3 Ammonium Nitrogen analysis

Modified salicylate method (Quikchem Method no. 10-107-06-3-B; Lachat Instruments, Milwaukee, WI, USA)

Reagent preparation

a. Dissolve 0.4717 g ammoniumsulfate, $(NH_4)_2SO_4$ (dry at 105 C) with water and adjust the volume to 100 mL in volumetric flask. The solution can be kept in glass container with cover for 1 week.

b. Reagent A 200 ml : Add 6.8 g of Na salicylate, 8 g of tri-sodium citrate and 0.08 g of sodium nitroprusside ($Na_2[Fe(CN)_5NO].2H_2O$) in distilled water 200 ml.

c.Reagent B: Add 0.16 g of Dichloroisocyanuric acid Sodium salt ($C_3Cl_2N_3NaO_3.2H_2O$) and 2 g of NaOH in 200 ml distilled water.

Analytical procedure

pH of water sample was measured by pH meter and pH was adjusted to range of 5-8 with NaOH by using pH meter. Then 5 mL of water sample was pipetted as well as standard solution into 10 mL test tube. Next, 0.5 mL of Reagent A was added into the water sample and shake well.Then 0.5 mL of Reagent B was added and mixed thoroughly.Solutions were kept 30 minutes for color development. Color solution into cuvette and measure the absorbance at 690 nm wavelength.

A-4 Orthophosphate analysis

APHA method 4500-P D. Stannous Chloride Method

Reagent preparation

a. Phenolphthalein indicator aqueous solution.

b. Ammonium molybdate reagent : 25 g of $(NH_4)6Mo_7O_{24}\cdot 4H_2O$ was dissolved in 175 mL distilled water. Cautiously 280 mL conc H_2SO_4 was added to 400 mL distilled water. Solution was cooled, add the molybdate solution, and dilute to 1 L.

c. Stannous chloride reagent 2.5 g of fresh $SnCl_2\cdot 2H_2O$ in was dissolved in 100 mL glycerol. Then it was heated in a water bath and stir with a glass rod to hasten dissolution.

d. Standard phosphate solution: 219.5 mg of anhydrous KH_2PO_4 was dissolved in distilled water and diluted to 1000 mL

Analytical procedure

a. Preliminary sample treatment: To 100 mL sample containing not more than 200 µg P and free from color and turbidity, add 0.05 mL (1 drop) phenolphthalein indicator. If sample turns pink, add strong acid solution dropwise to discharge the color. If more than 0.25 mL (5 drops) is required, take a smaller sample and dilute to 100 mL with distilled water after first discharging the pink color with acid.

b. Color development: Add, with thorough mixing after each addition, 4.0 mL molybdate reagent I and 0.5 mL (10 drops) stannous chloride reagent I. Rate of color development and intensity of color depend on temperature of the final solution, each 1°C increase producing about 1% increase in color. Hence, hold samples, standards, and reagents within 2°C of one another and in the temperature range between 20 and 30°C.

c. Color measurement: After 10 min, but before 12 min, using the same specific interval for all determinations, measure color photometrically at 690 nm and compare with a calibration curve, using a distilled water blank.

A-5 Total Suspended Solids analysis

2540 D. Total Suspended Solids Dried at 103–105°C

Preparation of glass-fiber filter disk: pre-prepared glass fiber filter Dry in an oven at 103 to 105°C for 1 h. Cool in desiccator to balance temperature and weigh. Assemble filtering apparatus, filter, and begin suction. 20mL of water sample was filtered. Carefully remove filter from filtration apparatus and transfer to an aluminum-weighing dish as a support. Dry for at least 1 h at 103 to 105°C in an oven, cool in a desiccator to balance temperature, and weigh until obtain constant weight.

$$\text{Total suspended solid } (\frac{\text{mg}}{\text{L}}) = \frac{(A - B)\ X\ 1000}{sample\ volume}$$

where:

A = weight of filter + dried residue, (mg)
B = weight of filter, (mg).

APPENDIX B

Table B 1: Data of Temperature (T)ºC ,pH, EC (µs/cm) , TSS(mg/L) on HRT 6,12 &18h

Date	Day	HRT	Inlet				Outlet of AS System				Outlet of FFM CW			
			T	pH	EC	TDS	T	pH	EC	TDS	T	pH	EC	TDS
26/07/2017	1	12	26.3	5.17	548	282	26.5	4.73	575	294	NR	NR	NR	NR
29/07/2017	4	12	27.2	5.53	343	168	27.6	7.53	281	146	26.4	7.42	276	131
1/8/2017	7	12	28.8	5.91	337	174	29.2	7.32	214	92	29.1	7.13	352	172
4/8/2017	10	12	28.8	5.93	340	170	29.1	7.11	350	176	29.2	7.34	213	96
7/8/2017	13	12	28.1	5.81	342	176	28.3	7.31	330	167	27.9	7.21	242	118
		Average	**27.8**	**5.7**	**382**	**194**	**28.1**	**6.8**	**350**	**175**	**28.2**	**7.3**	**271**	**129**
		SD	**1.1**	**0.3**	**93**	**49**	**1.1**	**1.2**	**136**	**74**	**12.6**	**3.3**	**132**	**64**
16/08/2017	1	6	26.0	5.27	523	267	25.6	6.87	520	265	25.6	5.61	422	214
19/08/2017	4	6	27.1	5.51	456	227	26.9	6.43	442	219	26.8	6.21	452	228
22/08/2017	7	6	27.8	5.87	391	194	28.1	6.31	389	196	27.8	6.32	455	227
25/08/2017	10	6	27.6	5.44	453	234	26.9	6.30	452	227	27.1	6.27	465	234
28/08/2017	13	6	27.7	5.63	452	226	27.1	6.48	438	224	27.0	6.51	448	221
		Average	**27.2**	**5.5**	**455**	**230**	**26.9**	**6.5**	**448**	**226**	**26.9**	**6.2**	**448**	**225**
		SD	**0.7**	**0.2**	**47**	**26**	**0.9**	**0.2**	**47**	**25**	**0.8**	**0.3**	**16**	**8**
6/9/2017	1	18	28.2	5.61	351	176	31.0	7.05	361	180	NR	NR	NR	NR
9/9/2017	4	18	26.0	5.27	393	191	25.7	6.87	382	180	25.6	6.81	176	89
12/9/2017	7	18	28.4	4.99	415	212	31.2	6.32	381	192	28.3	6.29	145	72
15/9/2017	10	18	29.6	7.05	421	210	30.0	7.41	279	133	28.7	7.34	181	86
18/9/2017	13	18	28.7	5.63	386	192	29.1	7.32	263	136	29.0	7.12	174	80
		Average	**28.2**	**5.7**	**393**	**196**	**29.4**	**7.0**	**333**	**164**	**27.9**	**6.9**	**169**	**81**
		SD	**1.3**	**0.8**	**28**	**15**	**2.2**	**0.4**	**58**	**28**	**1.5**	**0.5**	**16**	**8**

Table B 2: Concentrations & removal efficiencies of total suspended solid in pilot scale reactor on HRT 6h, 12h and 18h

Date	Day	HRT	TSS concentration (mg/L)			Removal efficiency (%)		
			Inlet	Outlet of AS System	Outlet of FFM CW	AS system	FAM CW System	Overall
26/07/2017	1	12	181.66	171.60	NR	5.5	NR	NR
29/07/2017	4	12	173.33	142.00	92.46	18.1	34.9	46.7
1/8/2017	7	12	205.00	108.33	23.33	47.2	78.5	88.6
4/8/2017	10	12	195.00	30.00	11.66	84.6	61.1	94.0
7/8/2017	13	12	203.00	28.00	10.50	86.2	62.5	94.8
		average	**191.6**	**96.0**	**34.5**	**48.3**	**59.2**	**81.0**
		SD	**13.7**	**65.1**	**39.1**	**37.1**	**18.0**	**23.1**
16/08/2017	1	6	175.00	118.00	65.00	32.6	44.9	62.9
19/08/2017	4	6	181.00	142.50	108.00	21.3	24.2	40.3
22/08/2017	7	6	163.30	131.70	102.00	19.4	22.6	37.5
25/08/2017	10	6	210.00	161.60	115.00	23.0	28.8	45.2
28/08/2017	13	6	192.00	149.40	104.00	22.2	30.4	45.8
		average	**184.3**	**140.6**	**98.8**	**23.7**	**30.2**	**46.4**
		SD	**17.7**	**16.7**	**19.5**	**5.2**	**8.8**	**9.8**
6/9/2017	1	18	76.70	23.30	NR	69.6	NR	NR
9/9/2017	4	18	140.00	21.67	16.67	84.5	23.1	88.1
12/9/2017	7	18	138.33	18.33	15.00	86.7	18.2	89.2
15/9/2017	10	18	136.67	16.67	6.67	87.8	60.0	95.1
18/9/2017	13	18	142.00	17.00	6.50	88.0	61.8	95.4
		average	**126.7**	**19.4**	**11.2**	**83.3**	**40.7**	**91.9**
		SD	**28.0**	**2.9**	**5.4**	**7.8**	**23.3**	**3.9**

Table B 3: Concentrations & removal efficiencies of biological oxygen demand in pilot scale reactor on HRT 6h, 12h and 18h

Date	Day	HRT	BOD concentration (mg/L)			Removal efficiency (%)		
			Inlet	Outlet of AS System	Outlet of FFM CW	AS system	FAMCW System	Overall
26/07/2017	1	12	294.00	264.00	NR	10.2	NR	NR
29/07/2017	4	12	264.00	210.00	160.00	20.5	23.8	39.4
1/8/2017	7	12	296.00	48.00	20.00	83.8	58.3	93.2
4/8/2017	10	12	240.00	38.00	16.00	84.2	57.9	93.3
7/8/2017	13	12	252.00	38.00	16.00	84.9	57.9	93.7
		average	**269.2**	**119.6**	**53.0**	**56.7**	**49.5**	**79.9**
		SD	**25.0**	**108.9**	**71.4**	**37.9**	**17.1**	**27.0**
16/08/2017	1	6	452.00	328.00	304.00	27.4	7.3	32.7
19/08/2017	4	6	436.00	316.00	284.00	27.5	10.1	34.9
22/08/2017	7	6	460.00	368.00	180.00	20.0	51.1	60.9
25/08/2017	10	6	426.00	306.00	170.00	28.2	44.4	60.1
28/08/2017	13	6	428.00	287.00	167.00	32.9	41.8	61.0
		average	**440.4**	**321.0**	**221.0**	**27.2**	**31.0**	**49.9**
		SD	**15.0**	**30.3**	**67.2**	**4.6**	**20.6**	**14.7**
6/9/2017	1	18	496.00	136.00	NR	72.6	NR	NR
9/9/2017	4	18	456.00	48.00	24.00	89.5	50.0	94.7
12/9/2017	7	18	472.00	36.00	20.00	92.4	44.4	95.8
15/9/2017	10	18	460.00	30.00	18.00	93.5	40.0	96.1
18/9/2017	13	18	436.00	28.20	18.00	93.5	36.2	95.9
		average	**464.0**	**55.6**	**20.0**	**88.3**	**42.7**	**95.6**
		SD	**22.1**	**45.6**	**2.8**	**8.9**	**6.0**	**0.6**

Table B 4: Concentrations & removal efficiencies of nitrate nitrogen in pilot scale reactor on HRT 6h, 12h and 18h

Date	Day	HRT	N- NO_3^- concentration (mg/L)			Removal efficiency (%)		
			Inlet	Outlet of AS System	Outlet of FFMCW	AS system	FAMCW System	Overall
26/07/2017	1	12	29.79	27.60	NR	7.4	NR	NR
29/07/2017	4	12	28.02	24.30	19.26	13.3	20.7	31.3
1/8/2017	7	12	27.02	13.39	12.56	50.4	6.2	53.5
4/8/2017	10	12	29.64	13.31	12.34	55.1	7.3	58.4
7/8/2017	13	12	44.25	18.69	10.89	57.8	41.7	75.4
		average	**31.7**	**19.5**	**13.8**	**36.8**	**19.0**	**54.6**
		SD	**7.1**	**6.4**	**3.7**	**24.4**	**16.5**	**18.2**
16/08/2017	1	6	41.14	26.35	20.39	36.0	22.6	50.4
19/08/2017	4	6	34.52	27.32	24.63	20.9	9.8	28.7
22/08/2017	7	6	29.88	26.92	25.70	9.9	4.5	14.0
25/08/2017	10	6	32.65	29.79	28.32	8.8	4.9	13.3
28/08/2017	13	6	33.72	28.26	27.12	16.2	4.0	19.6
		average	**34.4**	**27.7**	**25.2**	**18.3**	**9.2**	**25.2**
		SD	**4.2**	**1.3**	**3.0**	**11.0**	**7.9**	**15.4**
6/9/2017	1	18	24.47	9.96	NR	59.3	NR	NR
9/9/2017	4	18	23.23	9.52	7.15	59.0	24.9	69.2
12/9/2017	7	18	21.73	9.11	6.08	58.1	33.3	72.0
15/9/2017	10	18	24.75	10.10	4.86	59.2	51.9	80.4
18/9/2017	13	18	22.31	9.20	3.82	58.8	58.5	82.9
		average	**23.3**	**9.6**	**5.5**	**58.9**	**42.1**	**76.1**
		SD	**1.3**	**0.4**	**1.4**	**0.5**	**15.7**	**6.5**

Table B 5: Concentrations & removal efficiencies of ammonium nitrogen in pilot scale reactor on HRT 6h, 12h and 18h

Date	Day	HRT	$N - NH_4$ concentration (mg/L)			Removal efficiency (%)		
			Inlet	Outlet of AS System	Outlet of FFM CW	AS system	FAM CW System	Overall
26/07/2017	1	12	0.21	0.40	NR	-92.3	NR	NR
29/07/2017	4	12	0.43	0.61	2.16	-41.9	-254.1	-402.3
1/8/2017	7	12	0.69	1.47	2.76	-113.0	-87.8	-300.0
4/8/2017	10	12	1.57	0.56	0.88	64.3	-57.1	43.9
7/8/2017	13	12	2.00	0.19	0.75	90.5	-294.7	62.5
		average	**1.0**	**0.6**	**1.6**	**-18.5**	**-173.4**	**-149.0**
		SD	**0.8**	**0.5**	**1.0**	**91.8**	**118.4**	**237.3**
16/08/2017	1	6	0.70	0.24	0.44	65.7	-83.3	37.1
19/08/2017	4	6	1.43	0.19	0.87	86.7	-357.9	39.2
22/08/2017	7	6	1.65	0.08	1.12	95.2	-1300.0	32.1
25/08/2017	10	6	2.08	0.13	1.32	93.8	-915.4	36.5
28/08/2017	13	6	1.92	0.15	1.18	92.2	-686.7	38.5
		average	**1.6**	**0.2**	**1.0**	**86.7**	**-668.7**	**36.7**
		SD	**0.5**	**0.1**	**0.3**	**12.2**	**474.1**	**2.8**
6/9/2017	1	18	0.72	0.31	NR	56.9	NR	NR
9/9/2017	4	18	0.83	0.28	0.19	66.3	32.1	77.1
12/9/2017	7	18	1.10	0.22	0.09	80.0	59.1	91.8
15/9/2017	10	18	0.79	0.16	0.06	79.7	62.5	92.4
18/9/2017	13	18	0.91	0.18	0.05	80.2	72.2	94.5
		average	**0.9**	**0.2**	**0.1**	**72.6**	**56.5**	**89.0**
		SD	**0.1**	**0.1**	**0.1**	**10.6**	**17.2**	**8.0**

Table B 6: Concentrations & removal efficiencies of Ortho -Phosphate in pilot scale reactor on HRT 6h, 12h and 18h

Date	Day	HRT	$O - PO_4$ concentration (mg/L)			Removal efficiency (%)		
			Inlet	Outlet of AS System	Outlet of FFM CW	AS system	FAM CW System	Overall
26/07/2017	1	12	2.91	1.40	NR	51.9	NR	NR
29/07/2017	4	12	3.01	1.26	0.46	58.1	63.5	84.7
1/8/2017	7	12	2.89	1.18	0.00	59.2	100.0	100.0
4/8/2017	10	12	3.21	0.63	0.00	80.4	100.0	100.0
7/8/2017	13	12	3.14	0.61	0.00	80.6	100.0	100.0
		average	**3.0**	**1.0**	**0.1**	**66.0**	**90.9**	**96.2**
		SD	**0.1**	**0.4**	**0.2**	**13.5**	**18.3**	**7.6**
16/08/2017	1	6	7.84	2.75	1.38	65.0	49.7	82.4
19/08/2017	4	6	6.92	2.64	0.97	61.8	63.3	86.0
22/08/2017	7	6	8.71	1.29	0.62	85.2	51.9	92.9
25/08/2017	10	6	8.12	1.24	0.59	84.7	52.4	92.7
28/08/2017	13	6	7.63	1.18	0.57	84.5	51.7	92.5
		average	**7.8**	**1.8**	**0.8**	**76.3**	**53.8**	**89.3**
		SD	**0.7**	**0.8**	**0.4**	**11.8**	**5.4**	**4.8**
6/9/2017	1	18	2.74	1.32	NR	51.8	NR	NR
9/9/2017	4	18	5.21	2.85	1.02	45.3	64.2	80.4
12/9/2017	7	18	7.59	4.94	0.95	34.9	80.8	87.5
15/9/2017	10	18	3.68	1.78	0.09	51.6	94.9	97.6
18/9/2017	13	18	3.21	1.67	0.07	48.0	95.8	97.8
		average	**4.5**	**2.5**	**0.5**	**46.3**	**83.9**	**90.8**
		SD	**2.0**	**1.5**	**0.5**	**6.9**	**14.8**	**8.4**

APPENDIX C

Statistical Analysis – Principal Component Analysis

Table C. 1 Principal components of variables at HRT 6

Variable	PC1	PC2	PC3	PC4	PC5
TI	0.231	0.005	0.013	0.136	-0.488
pHI	0.177	0.245	-0.028	0.252	0.360
ECI	-0.206	-0.187	0.071	0.008	0.008
TDI	-0.197	-0.205	0.130	-0.076	0.006
TSI	0.065	-0.384	0.124	-0.143	0.161
BOI	-0.071	0.382	0.108	-0.149	0.242
NOI	-0.226	-0.090	0.055	0.052	0.069
NHI	0.217	-0.143	0.062	0.052	-0.010
POI	0.079	0.202	0.596	-0.271	-0.024
TA	0.208	0.179	-0.074	0.069	-0.318
pHA	-0.224	0.001	0.141	0.203	0.113
ECA	-0.206	-0.171	0.143	-0.091	0.008
TDA	-0.205	-0.163	0.208	-0.025	0.043
TSA	0.168	-0.282	-0.053	-0.068	0.200
BOA	0.003	0.375	0.046	-0.394	-0.058
NOA	0.143	-0.304	0.149	-0.191	-0.090
NHA	-0.214	-0.131	-0.165	0.080	-0.007
POA	-0.197	0.026	-0.399	-0.155	0.013
TC	0.223	0.119	-0.041	-0.019	0.393
pHC	0.214	-0.049	-0.106	0.346	-0.046
ECC	0.216	-0.080	-0.132	-0.269	0.352
TDC	0.183	-0.091	-0.194	-0.515	-0.256
TSC	0.210	-0.118	-0.246	-0.088	0.128
BOC	-0.203	0.041	-0.360	-0.150	0.025
NOC	0.217	-0.149	0.049	0.018	0.101
NHC	0.224	-0.101	0.103	0.000	0.037
POC	-0.226	0.044	-0.120	-0.141	-0.008
Variance %	68.2	21.9	5.9	3.8	0.0
Cum: Variance %	68.2	90.2	96.1	100.0	100.0

Table C. 2 Principal components of variables at HRT 12

Variable	PC1	PC2	PC3	PC4
TI	0.225	-0.136	-0.188	-0.087
pHI	0.245	-0.104	-0.120	0.069
ECI	-0.146	0.245	0.184	0.748
TDI	0.178	-0.068	0.439	-0.103
TSI	0.229	-0.127	0.184	-0.094
BOI	-0.072	-0.294	0.136	-0.024
NOI	0.112	0.159	0.465	-0.175
NHI	0.212	0.167	0.169	-0.068
POI	0.126	0.269	-0.124	0.033
TA	0.206	-0.162	-0.223	0.295
pHA	-0.240	-0.027	0.260	0.096
ECA	0.100	0.287	-0.088	0.007
TDA	0.060	0.303	-0.072	0.011
TSA	-0.235	-0.144	-0.035	0.013
BOA	-0.260	0.056	-0.044	-0.024
NOA	-0.218	0.140	0.217	-0.052
NHA	-0.024	-0.302	-0.156	0.060
POA	-0.214	-0.184	-0.035	0.026
TC	0.223	-0.135	-0.202	0.205
pHC	-0.152	0.210	-0.292	-0.466
ECC	-0.080	-0.292	0.131	-0.072
TDC	-0.074	-0.286	0.183	-0.037
TSC	-0.263	0.027	-0.050	-0.008
BOC	-0.259	0.065	-0.045	-0.014
NOC	-0.257	0.034	-0.140	-0.005
NHC	-0.148	-0.259	-0.039	0.031
POC	-0.257	0.073	-0.045	-0.025
Variance %	52.6	37.7	9.6	0.0
Cum: Variance %	52.6	90.3	100.0	100.0

Table C. 3 Principal components of variables at HRT 18

Variable	PC1	PC2	PC3	PC4
TI	0.211	-0.206	-0.061	-0.213
pHI	0.216	0.056	-0.259	0.170
ECI	0.029	-0.197	-0.385	-0.480
TDI	0.034	-0.271	-0.292	-0.065
TSI	-0.022	0.114	0.442	-0.155
BOI	-0.135	-0.173	-0.330	0.180
NOI	0.134	0.166	-0.337	0.299
NHI	-0.123	-0.288	0.154	0.164
POI	-0.215	-0.194	-0.081	0.018
TA	0.094	-0.325	-0.046	0.372
pHA	0.228	0.178	0.003	-0.233
ECA	-0.258	-0.022	-0.097	-0.108
TDA	-0.258	-0.077	-0.024	-0.031
TSA	-0.222	0.190	-0.022	0.012
BOA	-0.225	0.170	-0.089	0.103
NOA	0.131	0.133	-0.367	-0.287
NHA	-0.241	0.142	0.021	-0.123
POA	-0.206	-0.217	-0.047	0.108
TC	0.192	-0.232	0.087	0.235
pHC	0.224	0.182	-0.056	0.103
ECC	0.148	0.286	-0.061	0.305
TDC	0.033	0.327	-0.156	0.128
TSC	-0.262	0.020	-0.058	0.039
BOC	-0.224	0.182	-0.050	0.006
NOC	-0.235	0.081	-0.187	0.107
NHC	-0.210	0.204	-0.079	-0.013
POC	-0.262	-0.005	-0.059	0.064
Variance %	53.0	30.2	16.7	0.0
Cum: Variance %	52.6	83.2	100.0	100.0

APPENDIX D

Photograph of AS – FAMCW Pilot Scale Reactor

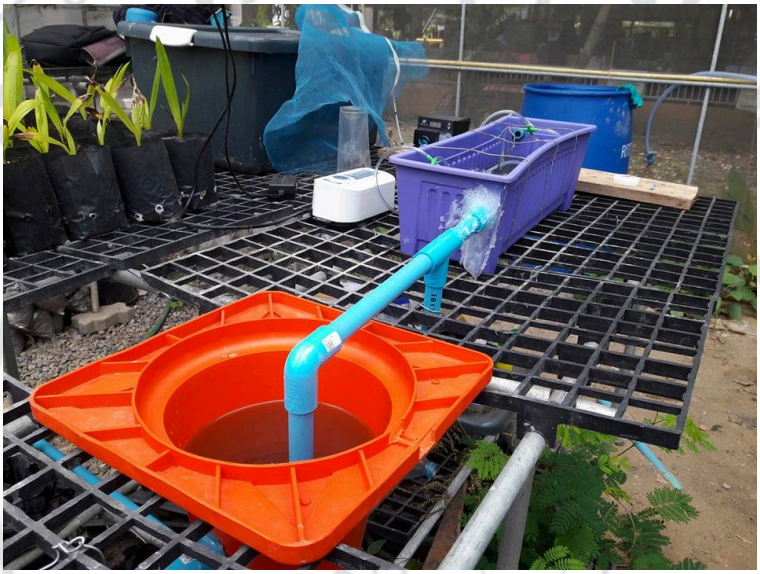

Figure. D1. AS - FAMCW pilot scale reactor

Figure. D2. AS aeration tank

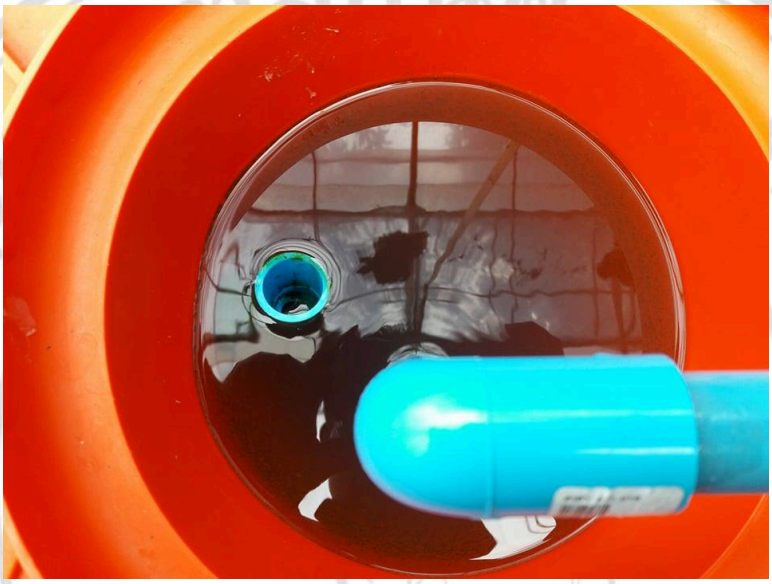

Figure. D3. AS Settling tank

Figure. D4. FAMCW system

Figure. D5. Activated sludge collected from CMU WWTP

Figure. D6 Cafeteria wastewater collection location

APPENDIX E

Building Effluents Standards in Thailand

Table E. 1 Building Effluents Standards in Thailand

Parameter	Unit	Range or Maximum Permitted Values for these Categories				
		A	B	C	D	E
pH	-	5-9	5-9	5-9	5-9	5-9
BOD	mg/l	20	30	40	50	200
Suspended Solids	mg/l	30	40	50	50	60
Settle able Solids	ml/l	0.5	0.5	0.5	0.5	-
Total Dissolved Solid (TDS)*	mg/l	500*	500*	500*	500*	-
Sulfide	mg/l	1	1	3.0 -	4	-
Nitrogen as TKN	mg/l	35	35	40	40	-
Fat, oil and grease (FOG)	mg/l	20	20	20	20	100

Table E. 2 Building categorization for building effluents standards in Thailand

Building Type	Size				
	A	B	C	D	E
1. Condominium	500 units or more	From 100 to not greater than 500 units	Less than 100 units	-	-
2. Hotels	200 rooms or more	From 60 to not greater than 200 rooms	Less than 60 rooms	-	-
3. Dormitories	-	250 rooms or more	From 50 to not greater than 250 rooms	From 10 to not greater than 50 rooms	-
4. Massage parlors (or equivalent)	-	5,000 m^2 or more	From 1,000 to not greater than 5,000 m^2	-	-
5. Hospitals	30 beds or more	From 10 to not greater than 30 beds	-	-	-
6. Schools, Colleges, Universities, or Institutes	25,000 m^2or more	From 5,000 to not greater than 25,000 m^2	-	-	-

7. Government offices, State enterprises, International agencies, Banks, and Office Buildings	55,000 m^2or more	From 10,000 to not greater than 55,000 m^2	From 5,000 to not greater than 10,000 m^2	-	-
8. Department stores	25,000 m^2or more	From 5,000 to not greater than 25,000 m^2	-	-	-
9. Fresh food markets	2,500 m^2 or more	From 1,500 to not greater than 2,500 m^2	From 1,000 to not greater than 1,500 m^2	From 500 to not greater than 1,000 m^2	-
10. Restaurants and food shops or food centers	2,500 m^2 or more	From 500 to not greater than 2,500 m^2	From 250 to not more than 500 m^2	From 100 to not more than 250 m^2	Less than 100 m^2

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