# CHAPTER III

# METHODOLOGY

This study was conducted at Sakol Nakorn Fisheries Station near Nong Han reservoir in Amphure Muang, Sakol Nakorn Province. The Sakol Nakorn municipality wastewater was collected from individual houses, markets, hospital, urban stromwater runoff and other non-point source in Sakol Nakorn Municipality. These municipal wastewaters were used to feed to the pilot-scale FWS units.

## Experimental Set-Up

Twelve pilot-scale of constructed wetland systems, made of concrete material, were built near nursing-plant area at Sakol Nakorn Fisheries Station (Figure 3.5). Six of them had working dimention of 9.75 x 1.15 x 1.00 m (length x width x depth) and other three units were 1.20 m depth to study efficiency of systems. The other one and two units had working dimention of 3.15 x 1.15 x 1.20 m and 3.20 x 1.15 x 1.20 m (length x width x depth), respectively for studying plant height growth in various depths (0.15, 0.30, and 0.45 m depth) (Figure 3.3 and 3.4).

Soil from the nearby area was put into each experimental unit up to 0.50 m level.

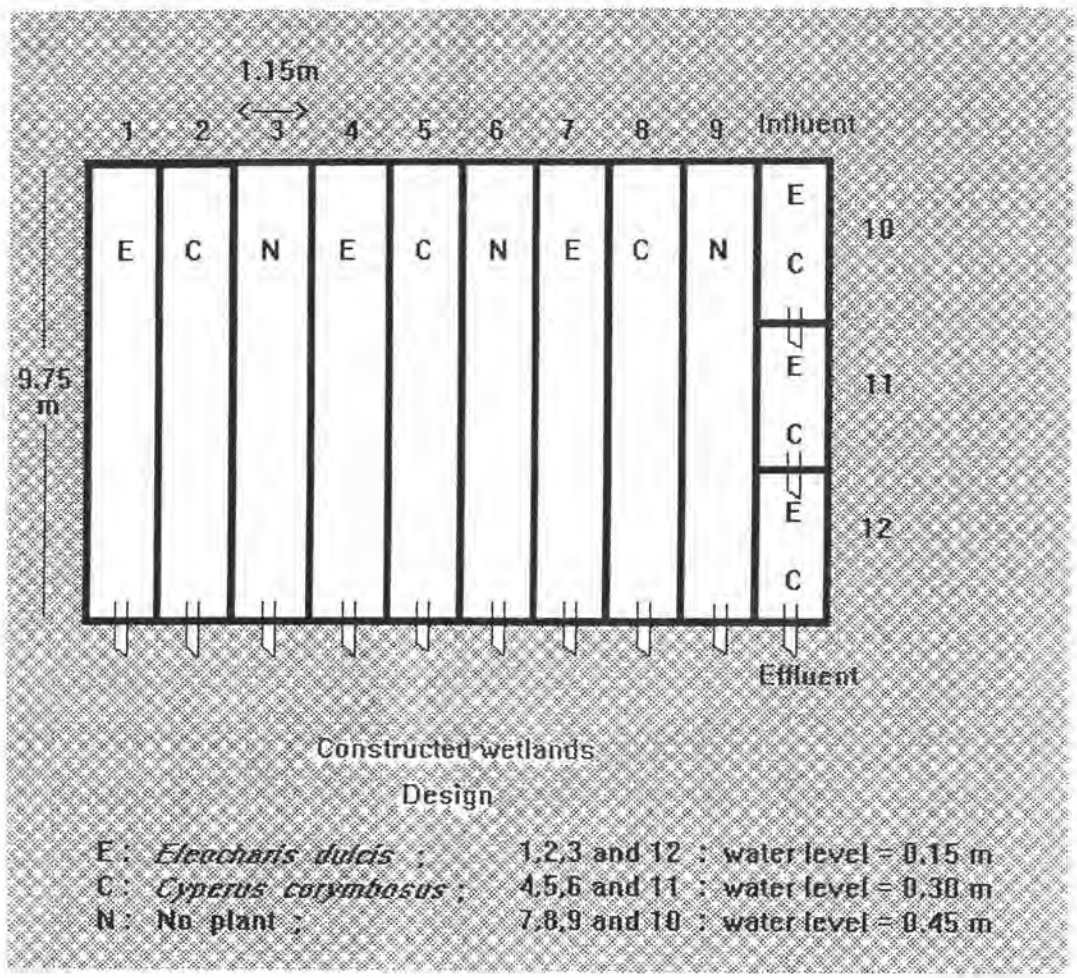



Figure 3.1 Illustration of the system design.

**Emergent Plants**

Plant Selection

The selected emergent plants in this study are Eleocharis dulcis (spikerush) and Cyperus corymbosus (chufa) which both are in Family Cyperaceae. They are annual or perennial herbs with narrow leaves and parallel veins. The reason for selection these plants due to their potentially high nutrient uptake and production rates (Guntenspergen, Stearns and Kadlec, 1989). These plants seem to be are suitable for planting in constructed wetland treatment in Thailand because they are native species that prefered wet conditions and are found in aquatic waste lands, swamp, paddy and distributes throughout Thailand.

Plant Collection

Emergent plants used in the experiments were collected from nearby area. The same age and size of spikerush and chufa were collected from nearshore of Nong Han reservoir, 350 stems of each species were used.

The collected spikerush were washed and seperated to 2-4 stems with stolen. The collected chufa were also washed and seperated to an individual stem with a stolen. All were cut down to 0.45 m height.

Plant Growing

Plants were grown on March 31 and April 1, 1995. They were planted on wetland beds at approximately 0.25 m intervals for every 0.75 m in three units (Figure 3.3). Each unit of interval contained 4 rows of plants and each row contained 4 plant stems. The other three units with no plant were control units. The three units for plant height study were divided into two parts. The first part was planted with spikerush and the other part was planted with chufa at approximately 0.25 m interval which contained of 4 rows of plants and each row contained 5 plant stems as shown in Figure 3.4 and 3.7.


a)

b)

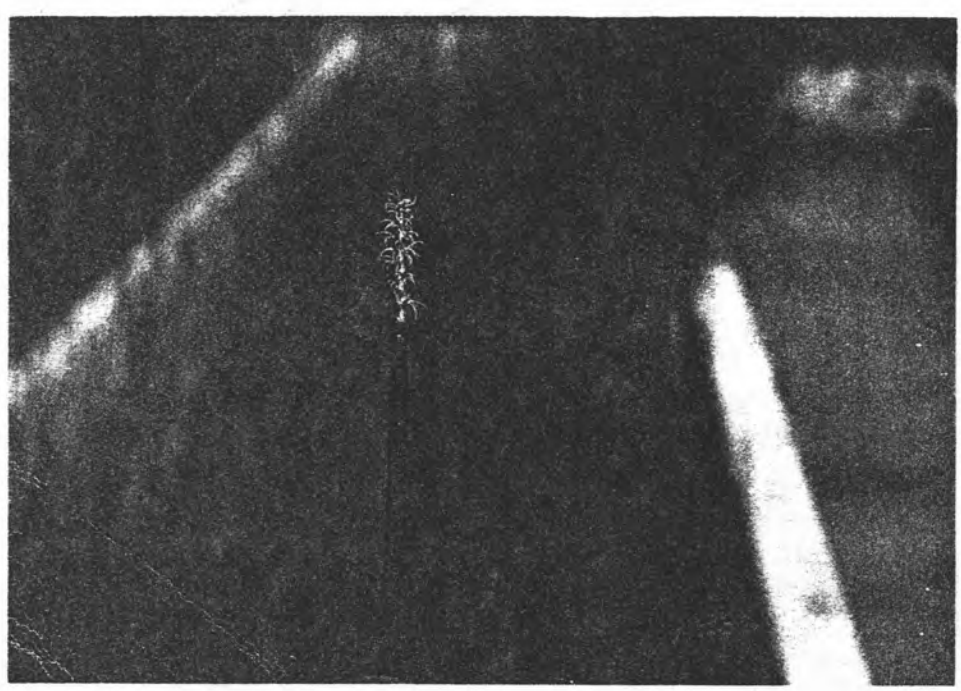


Figure 3.2 Selected emergent plants; a) Cyperus corymbosus b) Eleocharis dulcis.

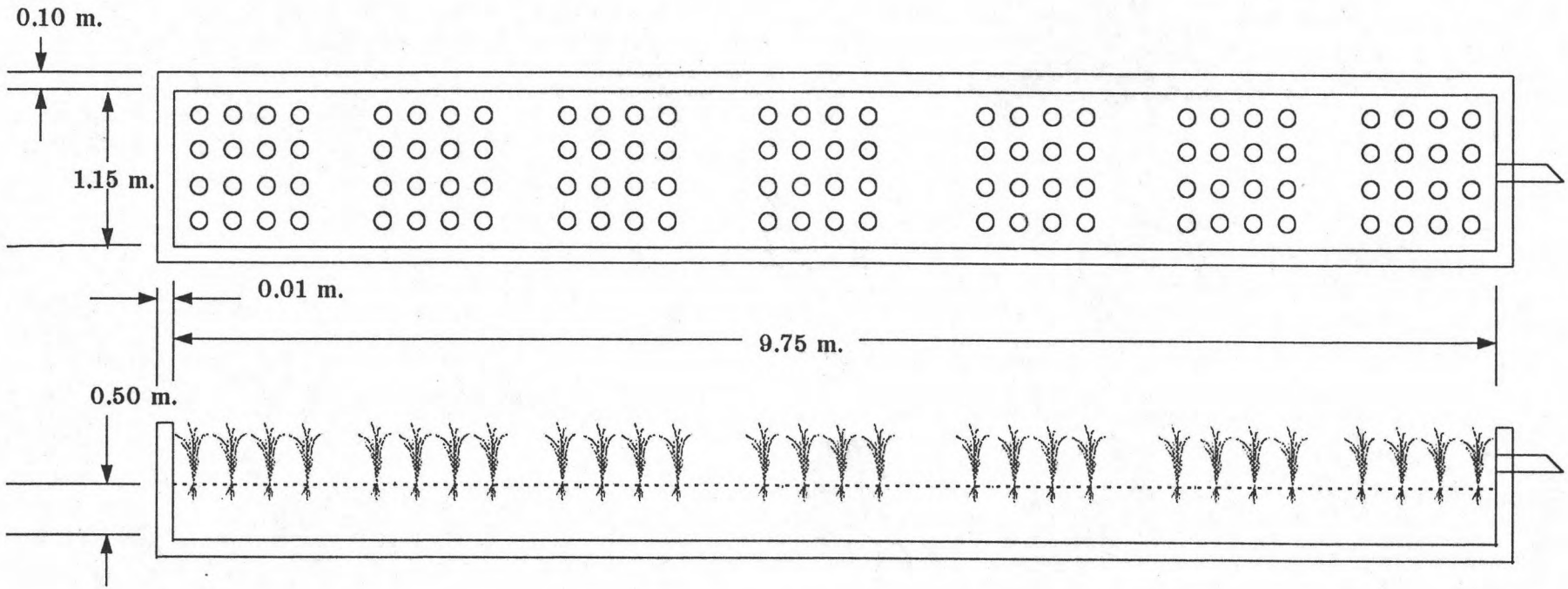



Figure 3.3 Schematic of plant growing on experimental wetland beds

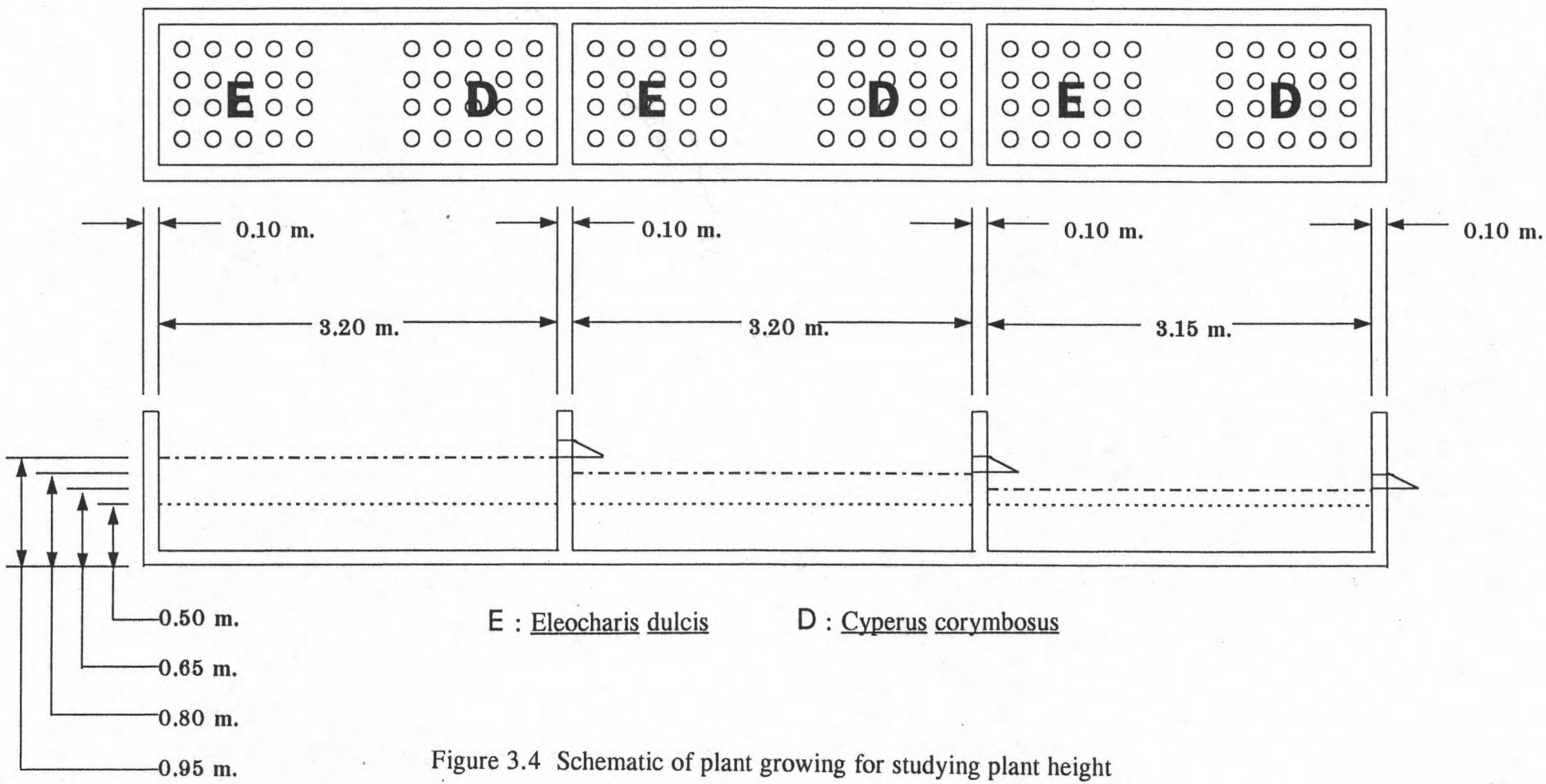
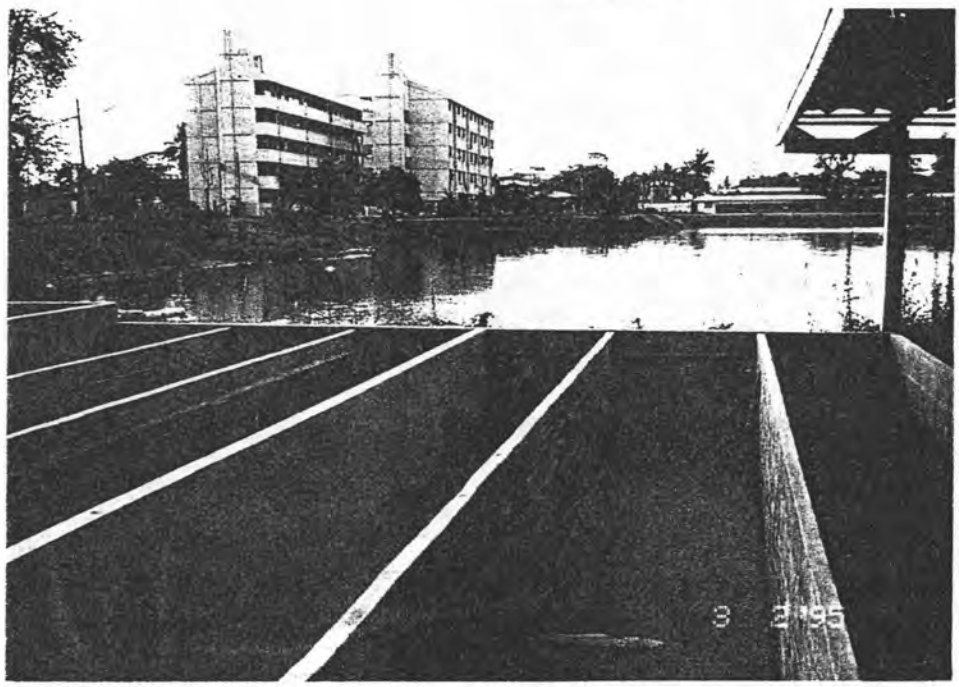



Figure 3.4 Schematic of plant growing for studying plant height



a) before putting wetland soil bed

b) effluent pipe

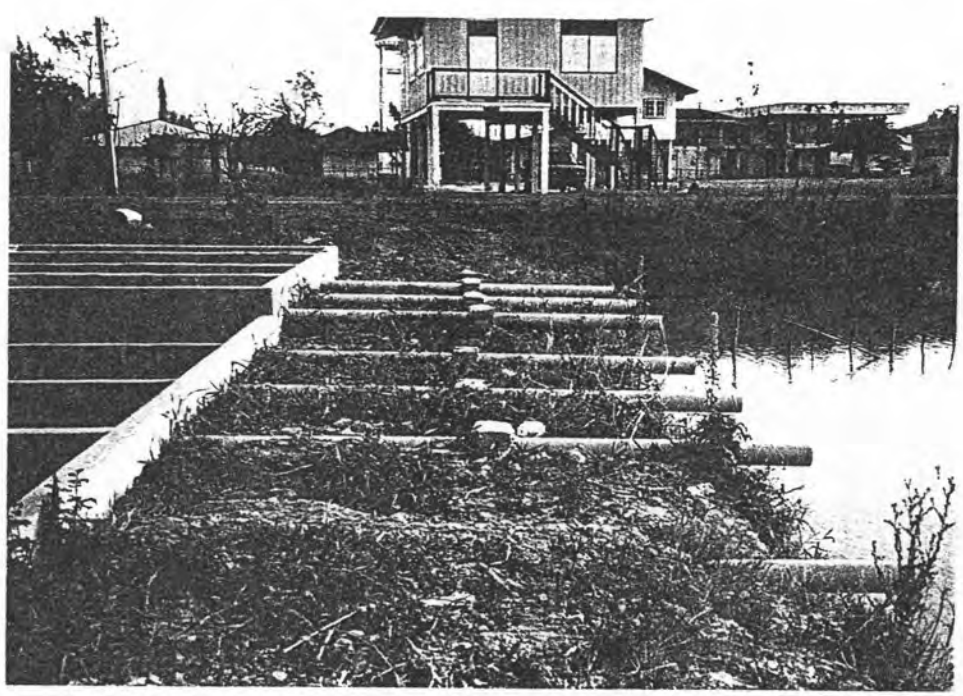


Figure 3.5 Experimental units.

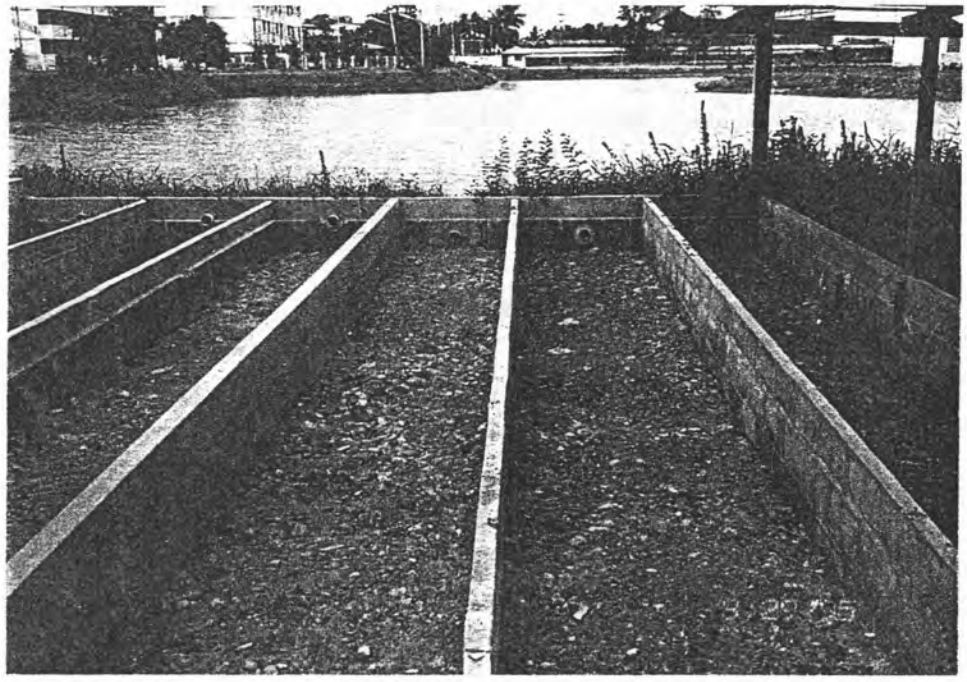
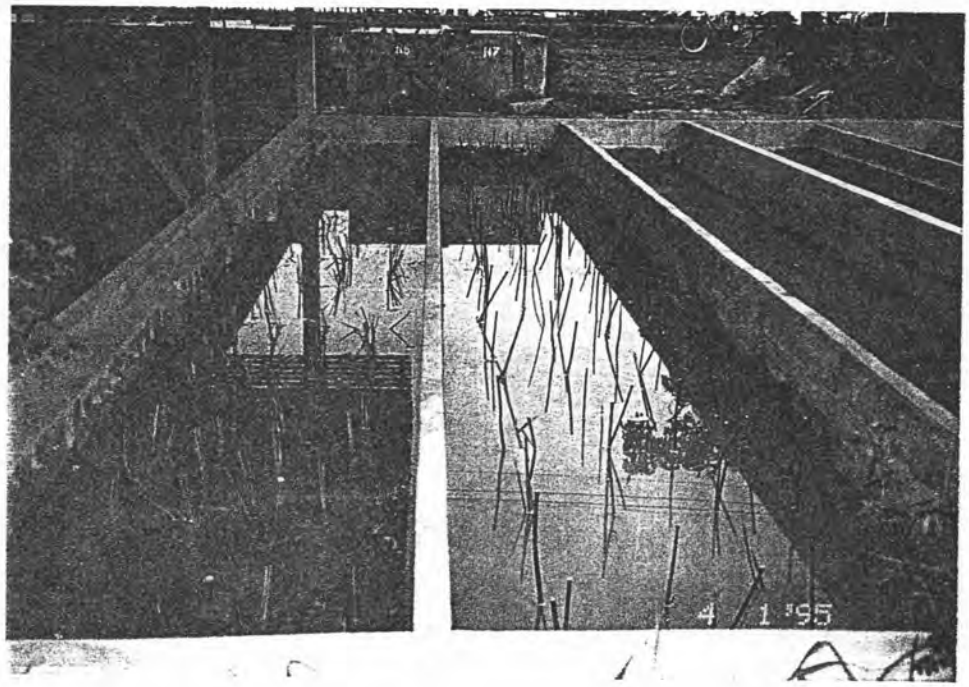


Figure 3.6 Putting some soil in constructed wetland systems.




a)

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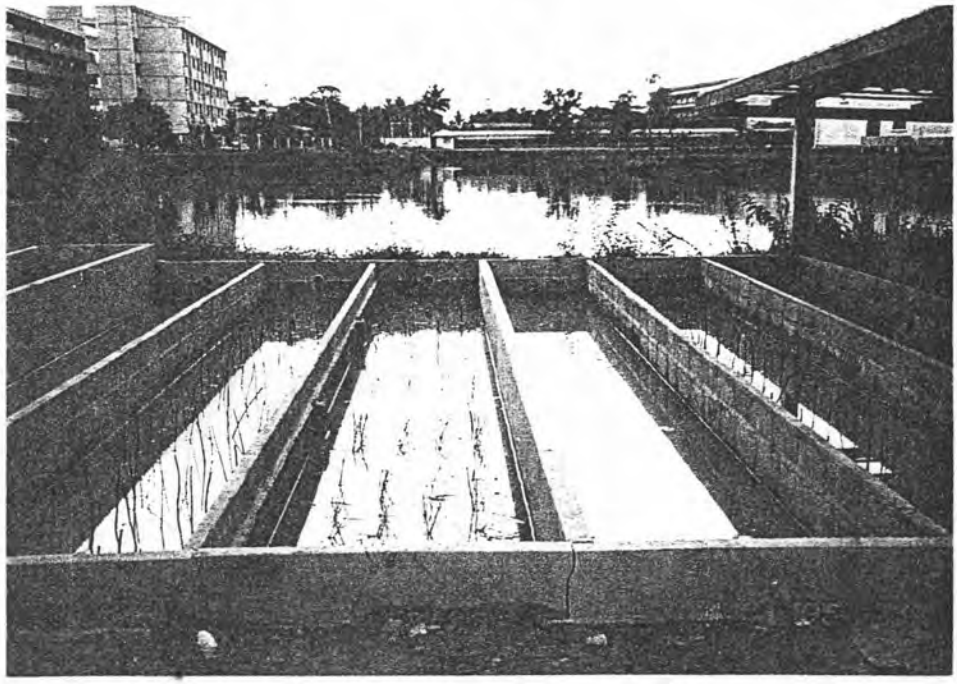
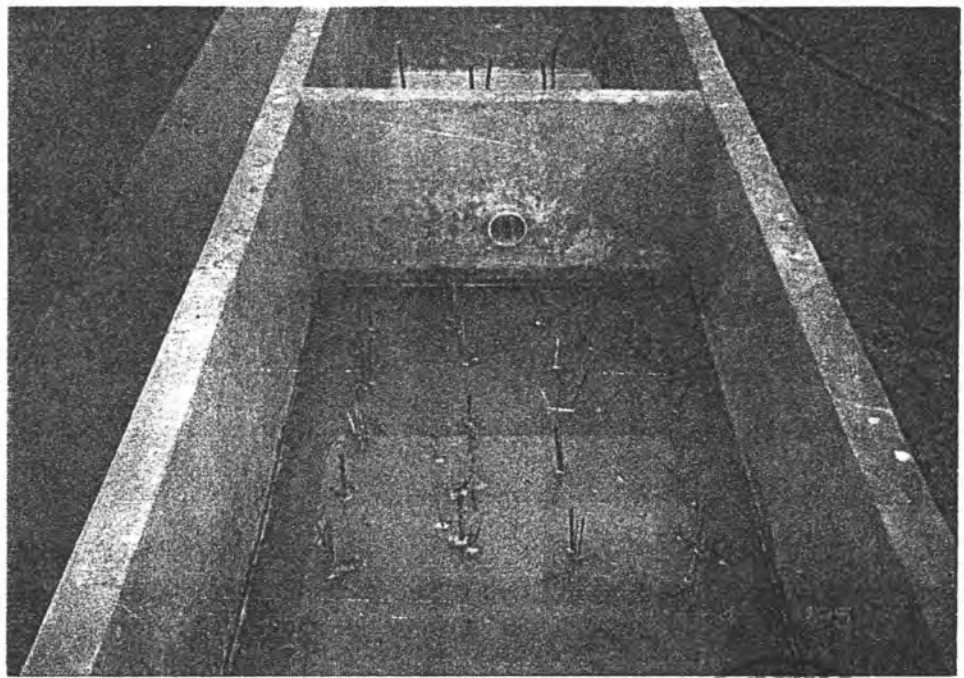


Figure 3.7 Constructed wetland systems after planting in experimental units.



a)

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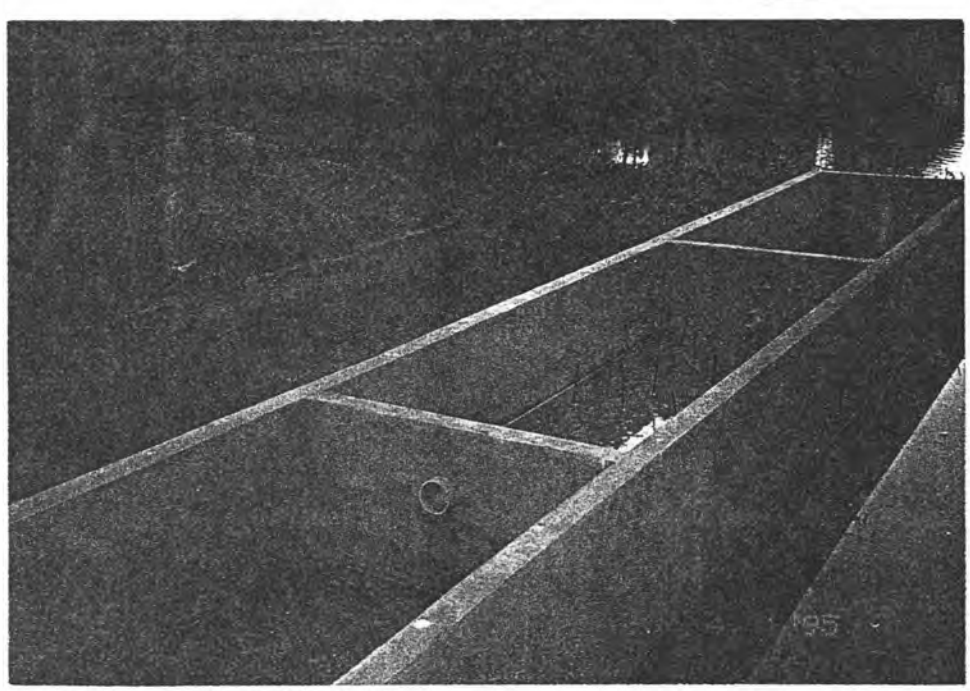
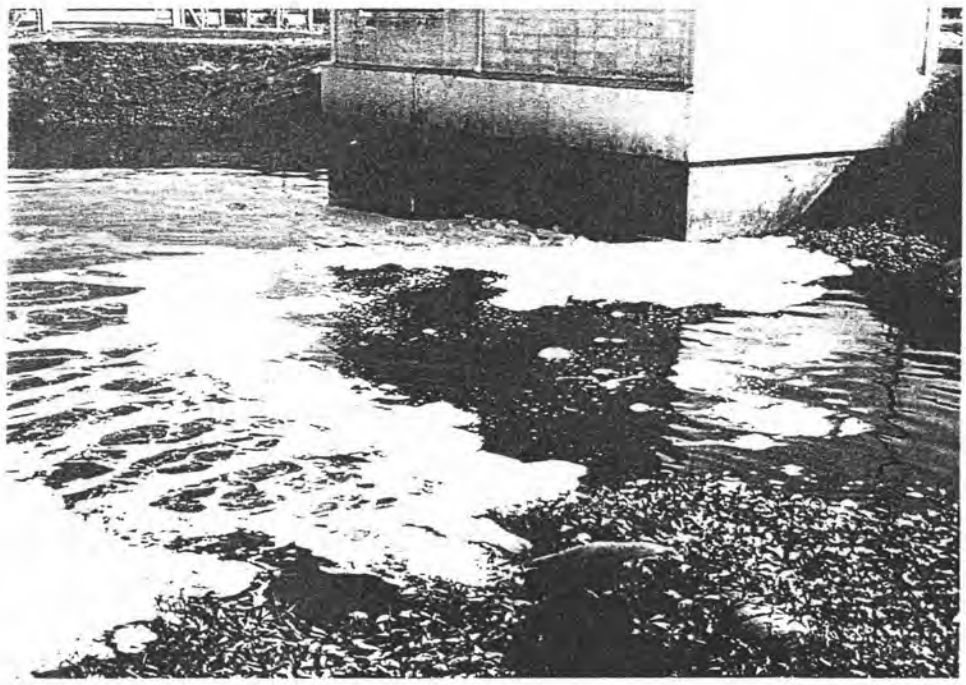


Figure 3.8 Experiment of plant height systems.



a)

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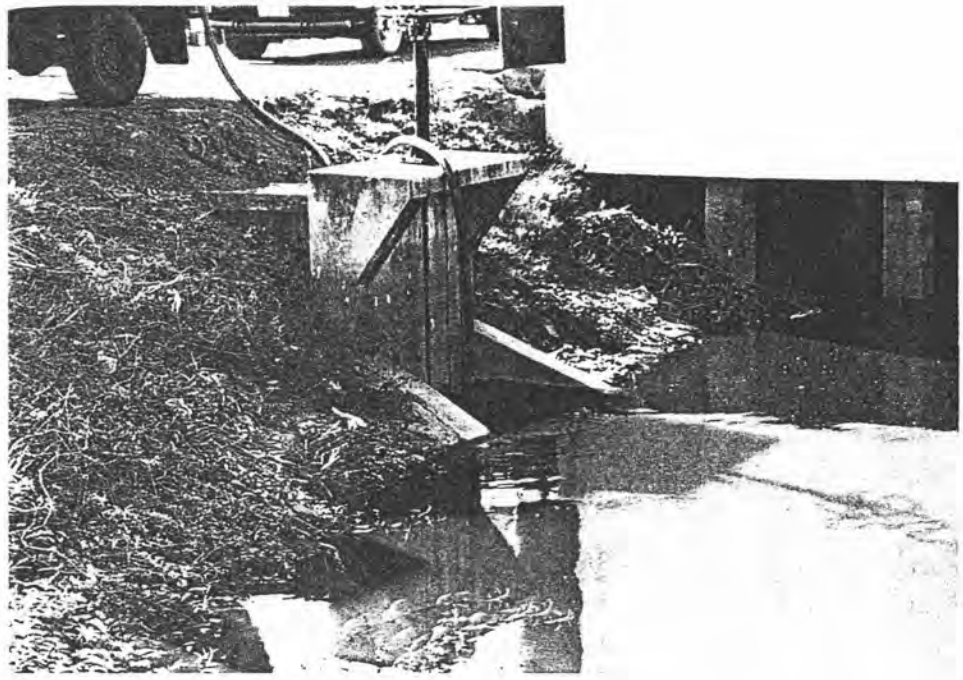
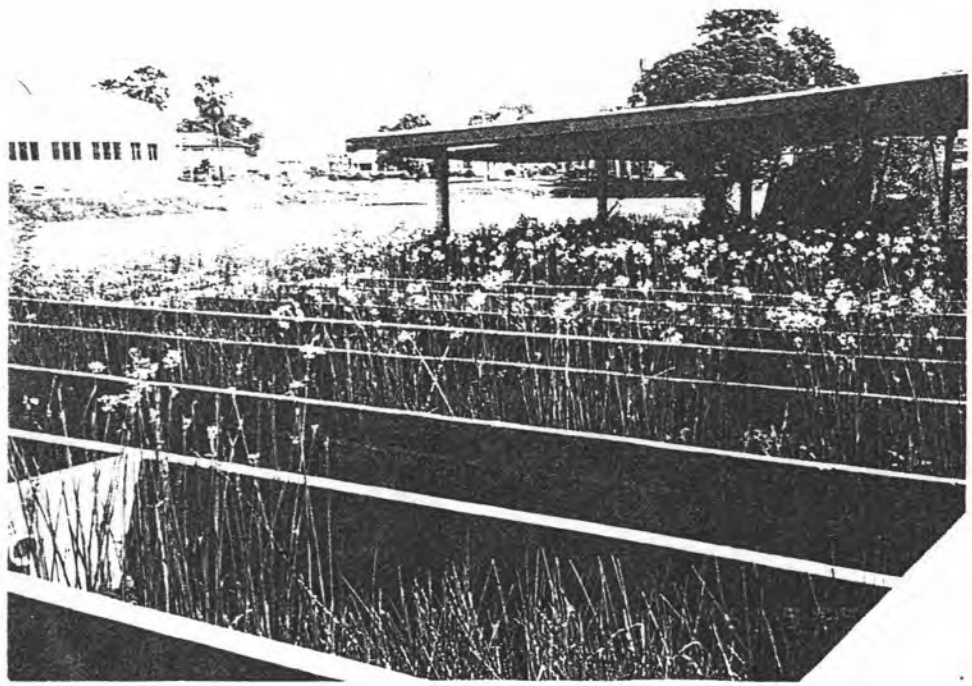


Figure 3.9 Municipal wastewater sump before pumping for experiments.



a)

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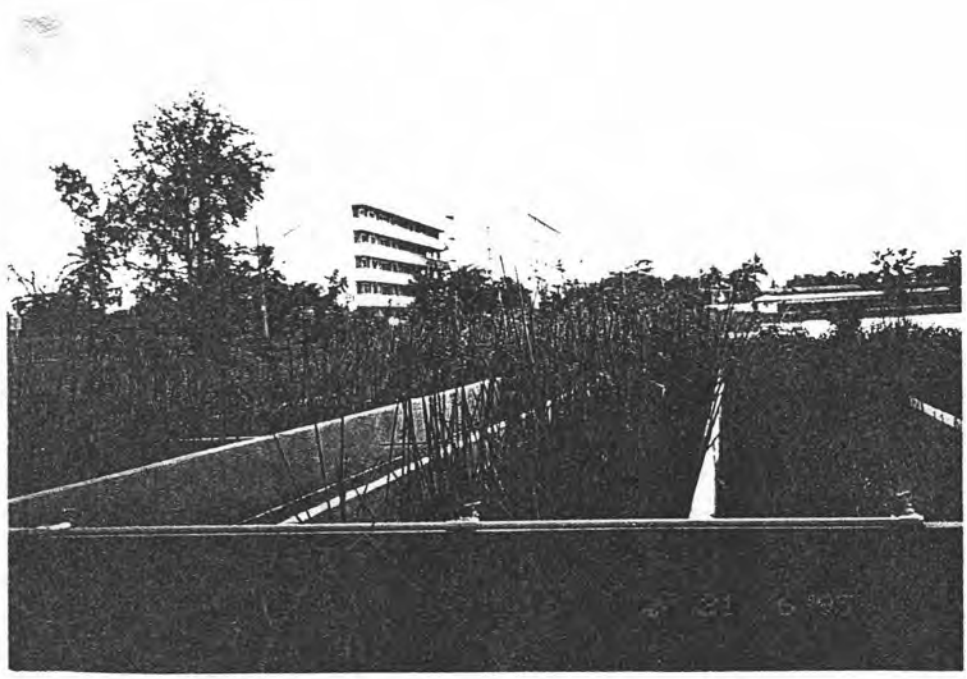

Figure 3.10 Plants'age, 45 days, before started up the experiment.

**Start-Up of Experiments**

After letting the plants grow for 3 month, municipal wastewaters were fed in all units. Wastewater levels in the constructed wetland system 1, 2, 3 (with spikerush, chufa and no plant) were 0.15 m depth from the soil beds. Wastewater level in constructed wetland system 4, 5 and 6 (with spikerush, chufa and no plant) were 0.30 m depth from wetland soil beds. Wastewater level in constructed wetland system 7, 8 and 9 (with spikerush, chufa and no plant) were 0.45 m depth from wetland soil beds.

Flow rate of wastewaters were controled at 0.25, 0.50, and 0.75 $m^3$ $day^{-1}$ in order to adjust the wastewater level at 0.15, 0.30, and 0.45 m, respectively. Wastewater level in the last three constructed wetland systems that were built for plant height study were 0.45, 0.30 and 0.15 m from wetland soil beds, respectively.

All units were acclimatized in wastewaters for 17 days befor the continuous wastewater was flowed according to the mentioned flow rate. The specification and data was following collected for 90 days or 18 trials.

**Water and Data Collection**

Wastewater Sample Collection

Influent and effluent samples from 9 constructed wetland units were collected every 5 days (retention time), on 19 consecutive occasions over a 90-day trial period. The reason for choosing 5 days retention time was in accordance with the defined retention time. All samples were taken between 1500-1600 hours and collected in 1 L plastic bottles.

The collected wastewater samples for BOD, TDS, TSS and orthophosphate phosphorus analysis were preserved by keeping them cool with ice or in a refrigerater set at 4 $^0$C during compositing. For ammonia nitrogen and total

kjeldahl nitrogen analysis, samples were preserved by adding $H_2SO_4$ to pH<2 and refrigerated at $4\ ^0C$.

Physical features of wastewaters such as odor and color were recorded in the same day of water sampling.

Wastewater Sample Analysis

Collected samples were analysed thouroughly. DO, temperature and pH were measured and recorded on site. BOD, TSS, TDS, ammonia nitrogen, and orthophosphate phosphorus were analysed at the Environmental Engineering Laboratory, Faculty of Engineering, Khon Kean University. All parameters were analysed according to the methods described in Standard Methods (APHA, AWWA,WPCF, 1992).

Table 3.1 Methods of parameters measured

| Parameters | Methods |
|---|---|
| pH | pH meter |
| Temperature | Thermometer |
| DO | DO meter |
| BOD | Azide modification of wrinkler method |
| TSS | Filtration / Evaporation |
| TDS | Filtration / Evaporation |
| $NH_3$ | Distillation |
| TKN | Digestion / Distillation |
| $PO_4^{3-}$ | Staneous chloride method |

Source : Standard Method for the Examination of Water and Wastewater, 1992

**Plants Harvesting for Plant Height Study**

Measurement of Plant Height

In constructed wetland systems 10, 11 and 12,the length of 20 stems of each species ,Eleocharis dulcis (spikerush) and Cyperus corymbosus (chufa), were measured on the first day of the experiment before planting. Then, they were replanted into the same place. Plant height was measured at every 10 days.

**Soil Sampling for Soil Texture Analysis**

Soil Sampling

In every constructed wetland system, the soil composite sample were random sampling in every eperimental unit. Total samples were 12 samples.

Soil Texture Analysis

The soil samples were air dried (room temperature) before being ground to a fine powder with a mortar and pestle. Soil sample was passed through a 2-mm sieve, then soil texture was analysed using hydrometer method to estimate percentages of sand, silt, and clay.

**Efficiency Analysis**

The pollutant removal efficiency of the constructed wetland systems were calculated by comparing the inflow and outflow concentrations. The parameters used were BOD, suspended solids and some species of nitrogen and phosphorus. This efficiency was calculated as follow ;

$$\text{System Efficiency (\%)} = \frac{\text{conc.influent - conc.effluent}}{\text{conc.influent}} \times 100$$

**Data Analysis**

The effects of two factors, plants' species and wastewater depths, on the efficiency of constructed wetland systems were analyzed by analysis of variance (ANOVA). Scheffe has proposed for composting any and all possible contrasts between factor means. This method could explain the difference between ;

1. efficiency of constructed wetland systems with different plant species or with out plant

2. effects of various wastewater depths on the efficiency of constructed wetland systems for pollutant removal

3. difference effects of plant species and wastewater depths in the constructed wetland system.