CHAPTER III

METHODOLOGY

This study was cooperated with Pala asset Co.,Ltd. That was located in The Tanning Industrial Zone at 34th kilometer on Sukhumvit Road., Bangpoomai Subdistrict, Muang District, Samut Prakarn Province. The pilot model was constructed on site in factory area.

3.1 Experimental set-up

3.1.1 Constructed wetland systems build-up

Twelve pilot-scales of constructed wetlands, made of concrete material, were built near the wastewater treatment system. Nine of them had working dimension of 1.00 x 6.00 x 0.75 m (width x length x height) and other three units were 2.00 m length for observing plant growth (see Figure 3-1 to 3-3).

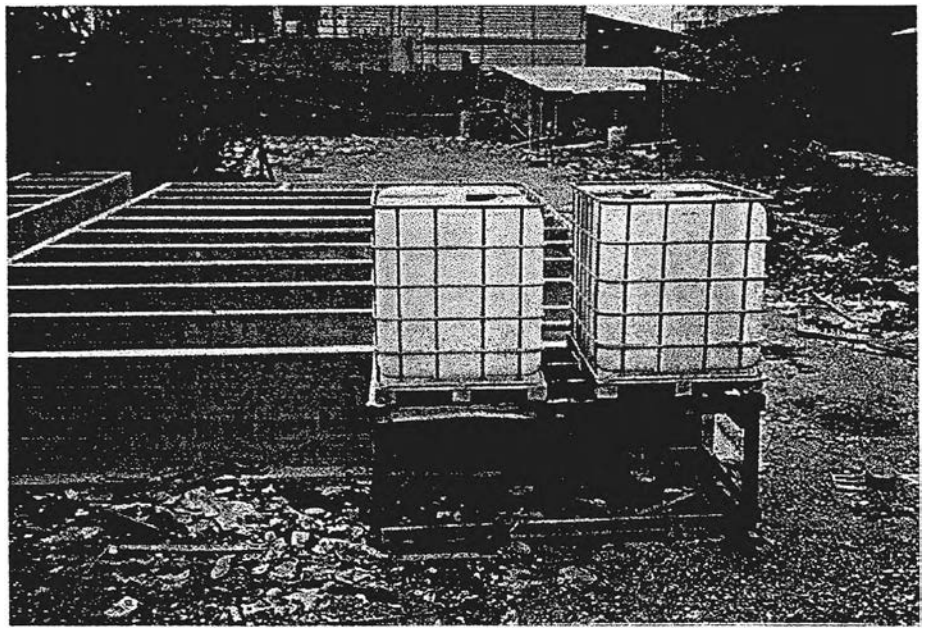


Figure 3-1 Pilot model of constructed wetlands

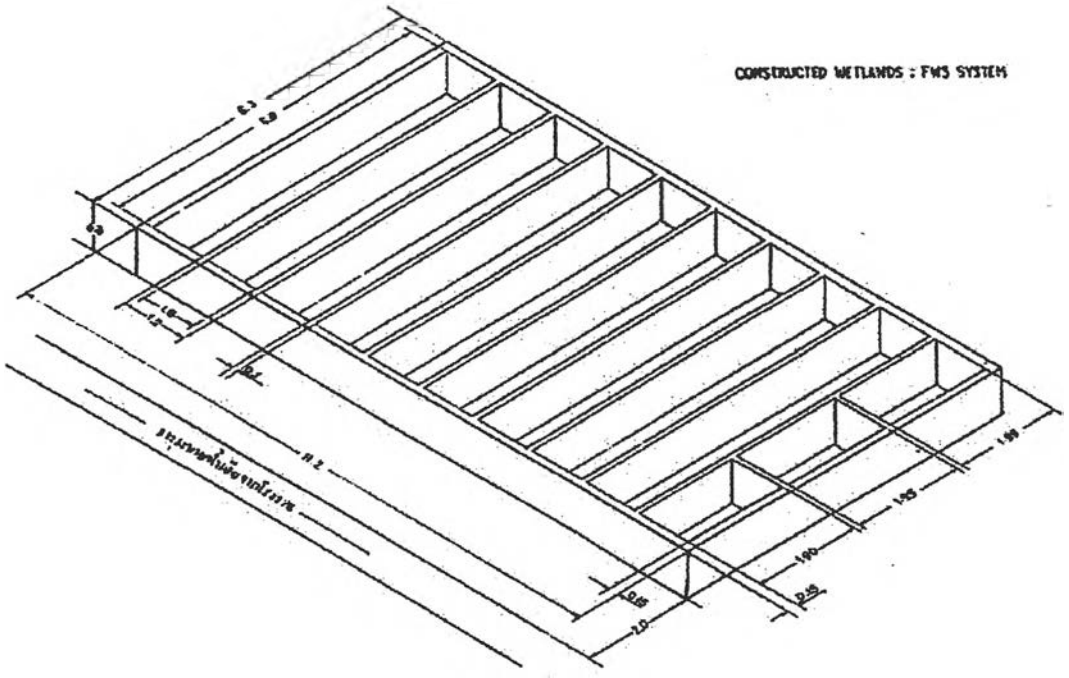
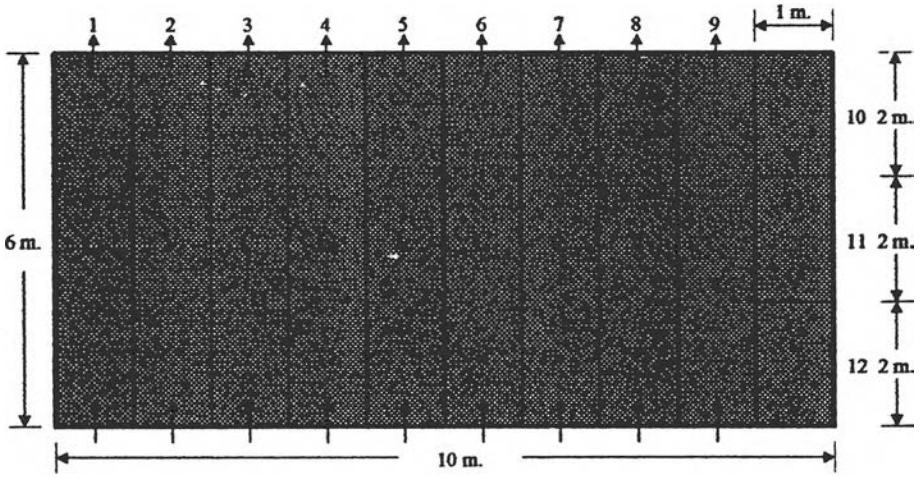


Figure 3-2 Perspective of pilot-scale units



G : *Colocasia esculenta* (L.) Schott (green) V : *Colocasia esculenta* (L.) Schott (violet)

C : Control

Unit No. 1, 2, 4, 5, 7, and 8	are	experimental units
Unit No. 3, 6, and 9	are	control units
Unit No. 10, 11, and 12	are	plant-observed units

Figure 3-3 Top view of constructed wetland system units

3.1.2 Soil bed containing

Topsoil from Ayuthaya Province was put into each unit up to 0.30 m level at slope 1%.

3.2 Plant cultivating and nourishment

3.2.1 Plant collection and selection

The same age and size of both *Colocasia esculenta* (L.) Schott (green and violet) were collected from Suphan Buri Province (Figure 3-4), 264 stems of each type were cultivated for using in this study.

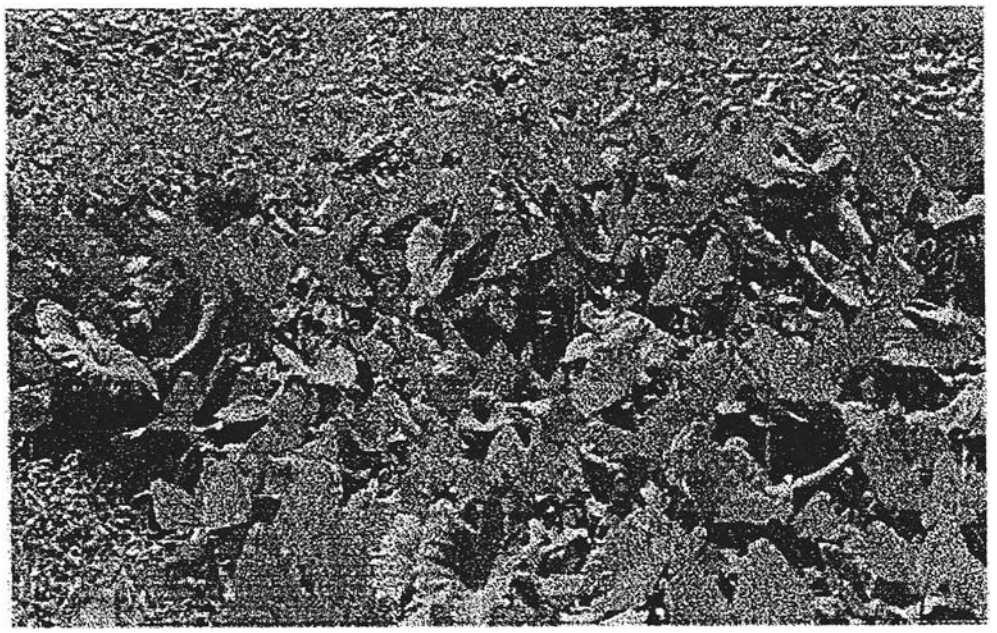


Figure 3-4 *Colocasia esculenta* (L.) schott in natural site at Suphan Buri Province

The selected stems were cleaned and cut down to 0.20 m length. As shown in Figure 3-5.

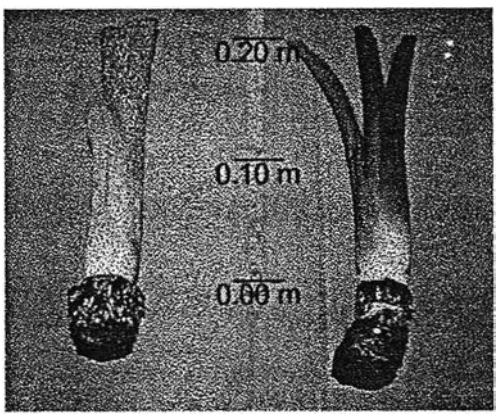


Figure 3-5 Cutting down to 0.20 m length of both *C. esculenta*

3.2.2 Plant growing

Plants were transplanted to constructed wetland beds in each experimental unit on December 20, 2000 about 0.25 m intervals in horizontal line and 0.3 m intervals in vertical line (see Figure 3-6). Each experimental unit contains 19 rows (horizontal line) and 4 columns (vertical line).

For each plant-observed unit, plants were grown at same intervals but there were only 4 rows of each type of plant.

3.2.3 Plant nourishment

Plants were nourished for 6 weeks to grow-up at 0.30 m height approximately and acclimatize in wastewater for 2 weeks before operating the system on February 23, 2001.

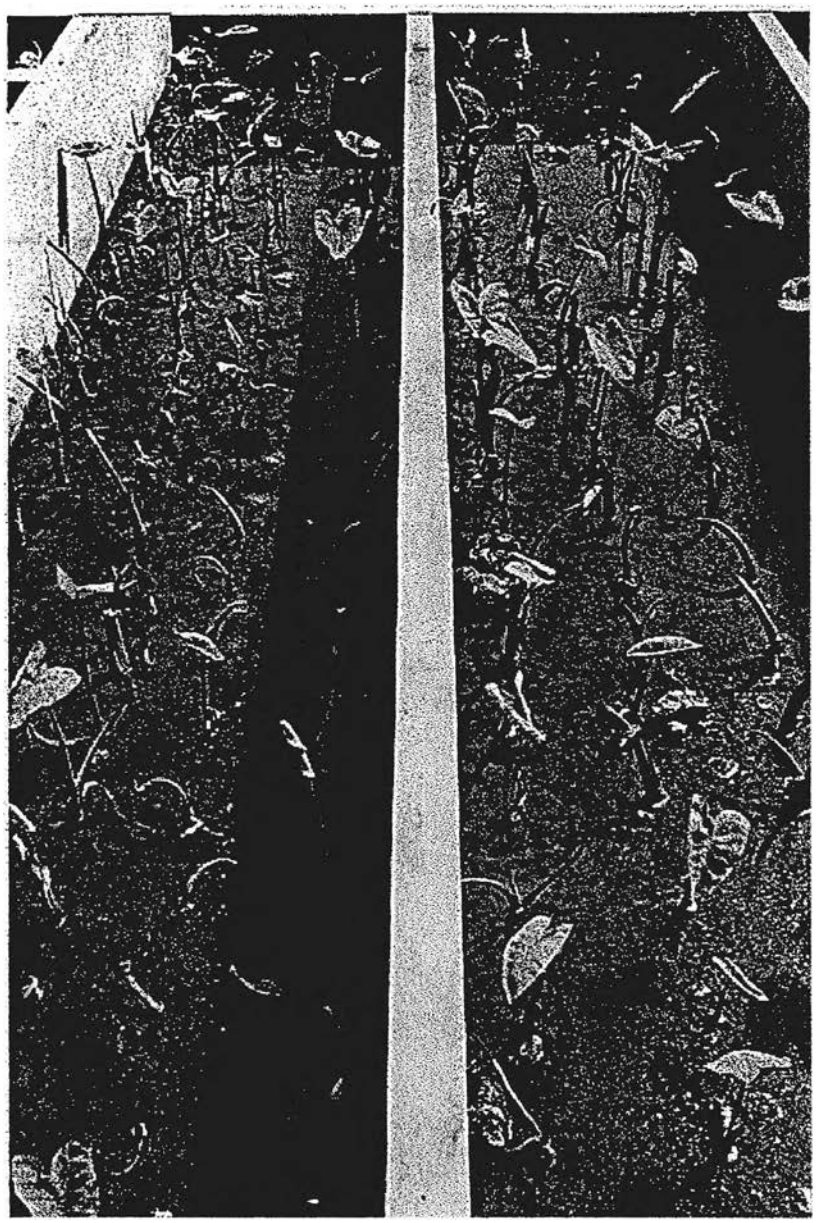


Figure 3-6 Transplanting of plants in each experimental unit bed

3.3 Experimental start-up

3.3.1 Experimental units running-up

Chrome-tanning post-treatment wastewaters were fed in experimental and control units (Figure 3-7).

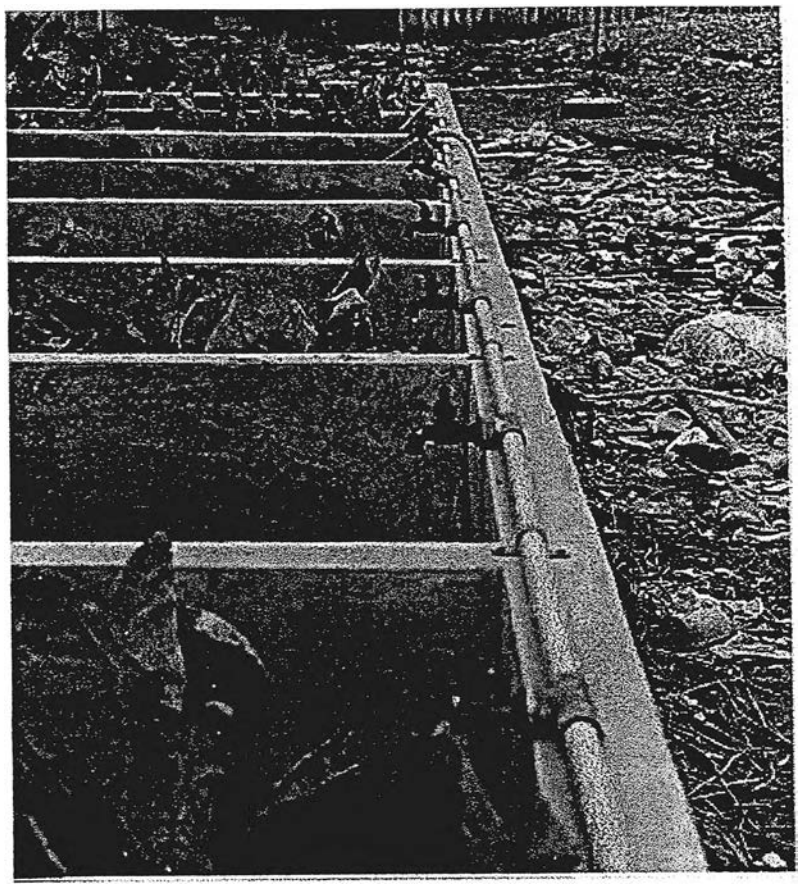


Figure 3-7 Wastewater inlets into Constructed wetland units

3.3.2 Control unit starting-up

Clean water was fed in all plant-observed units at 0.15, 0.25, and 0.35 m depth for unit No. 10, 11, and 12 respectively. Design descriptions for all units are shown in Table 3-1.

3.3.3 Running periods

This experiment was running-up for 110 days since February 23, 2001 until May 24, 2001.

Table 3-1 Design descriptions for FWS in this study

Design Parameters	Unit	FWS Unit No.	Value
Hydraulic Retention Time (HRT)	days	1 – 9	10
Water Depth	m	1 – 3 and 10	0.15
		4 – 6 and 11	0.25
		7 – 9 and 12	0.35
Aspect Ratio (L:W)	m : m	1 – 9	6 : 1
Flow Rate (Q)*	$m^3.d^{-1}$	1 – 3	0.0675
		4 – 6	0.1125
		7 – 9	0.1575

* Calculate by equation 2-5 in section 2.3.4 pp. 24

3.4 Sampling and field data collecting

3.4.1 Wastewater collecting

Wastewater samples were collected at inlet and outlet points of each experimental and control units.

3.4.2 Soil bed sampling

Soil composite samples were collected at the same point of plant harvesting in each experimental unit and same reference position in each control unit.

3.4.3 Plant harvesting

Plant samples were harvested one stem a time from each experimental and plant-observed unit by randomizes sampling method.

All of them were collected every 10 days during 100 experimental period times (described in Table 3-2 see below).

Table 3-2 Sampling timetable of this study

Treatment No.	Date to Sampling	Description of Studies		
		Influent Sampling	Effluent Sampling	Soil and Plant Sampling
1	23-Feb-2001	I	-	-
2	4-Mar-2001	II	I	I
3	13-Mar-2001	III	II	II
4	22-Mar-2001	IV	III	III
5	31-Mar-2001	V	IV	IV
6	9-Apr-2001	VI	V	V
7	18-Apr-2001	VII	VI	VI
8	27-Apr-2001	VIII	VII	VII
9	6-May-2001	IX	VIII	VIII
10	15-May-2001	X	IX	IX
11	24-May-2001	-	X	X

3.5 Sample analysis

3.5.1 Wastewater analysis

Wastewater samples were analyzed into two stages. First stage is in field study includes pH, temperature, conductivity, and salinity. Second stage is in laboratory include total suspended solid and chromium concentration in wastewater.

3.5.2 Soil bed analysis

Soil bed samples were analyzed into two steps. First step is soil property analysis before experimental start-up includes pH, cation exchange capacity, and soil texture. Second step is the determination of chromium amount in soil composite during experimental period time.

3.5.3 Plant analysis

Plants were harvested for two studying. First study is the growth rate study includes fresh weight, dry weight and length of petiole. Second study is Chromium concentration determination in each parts of plant; i.e. lamina (leaf), petiole (stem), corm (rhizome), and root (as shown in Figure 3-8).

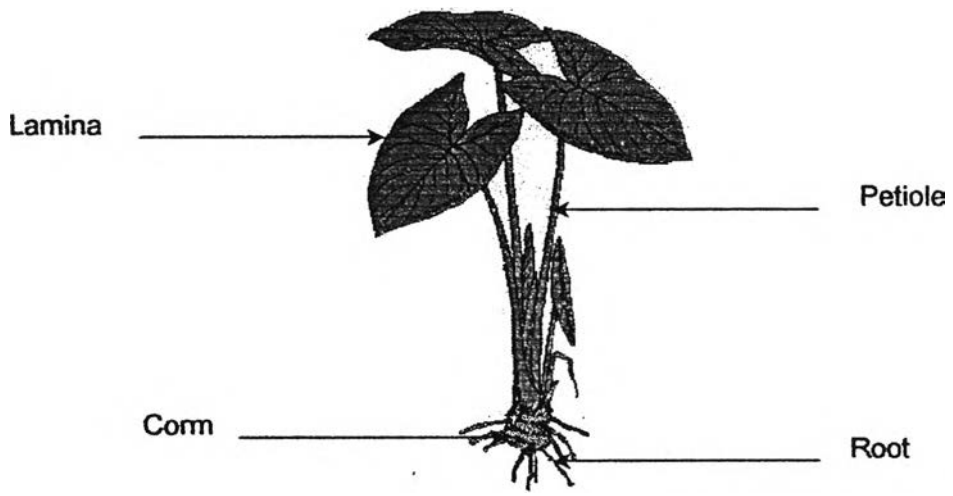


Figure 3-8 Parts of *Colocasia esculenta* (L.) Schott

All parameters of them were analyzed according to the methods described in Table 3-3.

Table 3-3 Methods of parameter measurements

Parameters	Methods
Wastewater Analysis	
1st stage: In field; on-site measurement	
- pH	pH Meter
- Temperature	Thermometer
- Conductivity	Conductivity Meter
- Salinity	Salinity Meter
2nd stage: In laboratory; preserved with conc.HNO_3 to pH < 2 and cooled at 4°C in 1L plastic bottle	
- TSS (Total Suspended Solid)	Filtration/Evaporation
- Cr in Wastewater	Nitric Acid-Sulfuric Acid Digestion and Atomic Absorption Spectrometry (Standard Method for the Examination of Water and Wastewater, 1998)

Table 3-3 Methods of parameter measurements (cont.)

Parameters	Methods
Soil Bed Analysis	
1st step: Before experimental start-up	
- pH	pH Meter
- CEC (Cation Exchange Capacity)	Ammonium saturation
- Soil Texture	Hydrometer Method
2nd step: During experimental period time	
- Cr in Soil	Mixed Acid Digestion (Soil Sampling and Method of Analysis (Soon&Abboud, 1993)) and Atomic Absorption Spectrometry
Plant Analysis	
1st study: Study on the plant growth rate	
- Length of petiole	Standard Method for Weights and Measures
- Fresh Weight	
- Dry Weight	
2nd study: Determine chromium amount in parts of plant	
- Cr in Plant	Mixed Acid Digestion (Chemical Analysis of Ecological Material (Allen, 1989)) and Atomic Absorption Spectrometry

3.6 Data analysis

3.6.1 Efficiency analysis

The chromium removal efficiency of the constructed wetland system was calculated by comparing the chromium in influent and effluent as follow:

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

3.6.2 Chromium accumulation in parts of plant

Chromium concentration accumulated in parts of plant was calculated from amount of chromium in tissue of plant per dry weight as follow:

$$\text{Cr accumulation in tissues of plant (mg/g(dry weight))} = \frac{\text{Amount of chromium in tissue (mg)}}{\text{Dry weight of tissue (g)}}$$

3.6.3 Statistical analysis

The effect of wastewater level and unit type on the chromium removal efficiency and the difference of chromium accumulation in parts of *C. esculenta* including the plant growth rate were analyzed by analysis of variance "one-ways type" (One-way ANOVA), while the difference of chromium accumulation in each phase of system was analyzed by mass balance. Scheffe has proposed for post hoc tests. These methods could accomplish the experimental goals includes:

1) The unit type which is the highest efficiency for chromium removing in same wastewater level; i.e. 0.15, 0.25, and 0.35 m wastewater level.

2) The wastewater level which is the highest efficiency for chromium removing by each plant type; i.e. green *C. esculenta* and violet *C. esculenta.*

3) The phase which has maximum chromium accumulation between soil phase and plant phase.

4) The part of plant which has maximum chromium accumulation between lamina, petiole, corm, and root.

5) The experimental unit which has the maximum plant growth rate into each plant type and each wastewater level.