



**APPENDICES**

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## Appendix A

### NITRATE, MR (0 to 4.5 mg/L NO<sub>3</sub><sup>-</sup>-N)

#### Method 8171, Cadmium Reduction Method, Using Powder Pillows:

1. Enter the stored program number for high rang nitrate nitrogen (NO<sub>3</sub><sup>-</sup>-N) .  
Press: 353 **ENTER** The display will show: **dial nm to 400**
2. Rotate the wavelength dial until the small display show: **400 nm**. When the correct wavelength is dialed in, the display will quickly show: **Zero sample** then: **mg/L NO<sub>3</sub><sup>-</sup>-N MR**
3. Fill a sample cell with 25 mL of sample. (the prepare sample)
4. Fill another cell with 25 mL of deionized water (the blank).
5. Add the contents of one Nitra Ver 5 Nitrate Reagent Poder Pillow to each cell. Stopper.
6. Press: **SHIFT TIMER** A one-minute reaction period will begin. Shake until the time beeps.
7. When the timer beeps, press: **SHIFT TIMER** A five-minute reaction period will begin.
8. When the timer beeps, the display will show: **mg/L NO<sub>3</sub><sup>-</sup>-N MR** Place the blank into the cell holder. Close the light shield.
9. Press: **ZERO** the display will show: **Zeroing.....then: 0.0 mg/L NO<sub>3</sub><sup>-</sup>-N MR**
10. Place the prepare sample into the cell holder. Close the light shield.
11. Press: **READ** the display will show: **Reading.....then** the result in mg/L nitrate expressed as nitrogen (NO<sub>3</sub><sup>-</sup>-N) will be displayed.

#### Sampling and storage:

Collect samples in clean plastic or glass bottles. Store at 4 °C (39°F) or lower if the sample is to be analyzed with 24 to 48 hours. Warm to room temperature before running the test.

**PHOSPHORUS, REACTIVE (0 to 2.5 mg/L PO<sub>4</sub><sup>3-</sup>)****(Also called Orthophosphate)****Method 8048, PhosVer 3 (Ascorbic Acid) Method, Using Powder Pillows:**

1. Enter the stored program number for reactive phosphorus, ascorbic acid method.  
Press: 490 **ENTER** The display will show: **dial nm to 890**
2. Rotate the wavelength dial until the small display show: **890 nm**. When the correct wavelength is dialed in, the display will quickly show: **Zero sample** then: **mg/L PO<sub>4</sub><sup>3-</sup>PV**
3. Insert a 10-mL Cell Riser into the cell compartment.
4. Fill a 10-mL sample cell with 10 mL of sample.
5. Add the contents of one Phosphate Powder Pillow for 10 mL sample to the cell (the prepare sample). Swirl immediately to mix.
6. Press: **SHIFT TIMER** A two-minute reaction period will begin.
7. Fill a second 10-mL sample cell with 10 mL of sample (this is the blank).
8. When the timer beeps, the display will show: **mg/L PO<sub>4</sub><sup>3-</sup>PV** Place the blank into the cell holder. Close the light shield.
9. Press: **ZERO** the display will show: **Zeroing.....then: 0.0 mg/L PO<sub>4</sub><sup>3-</sup>PV**
10. Place the prepare sample into the cell holder. Close the light shield.
11. Press: **READ** the display will show: **Reading....**then the result in mg/L PO<sub>4</sub><sup>3-</sup> will be displayed.

**Sampling and storage:**

Collect samples in clean plastic or glass bottles. Analyze samples immediately for best results. If prompt analysis is impossible, preserve samples by filtering immediately and storing at 4 °C (39°F) for up to 48 hours. Warm to room temperature before analysis.

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## Appendix B

### Standard Protein Assay

Preparing standard Bovine Serum Albumin with various concentrations

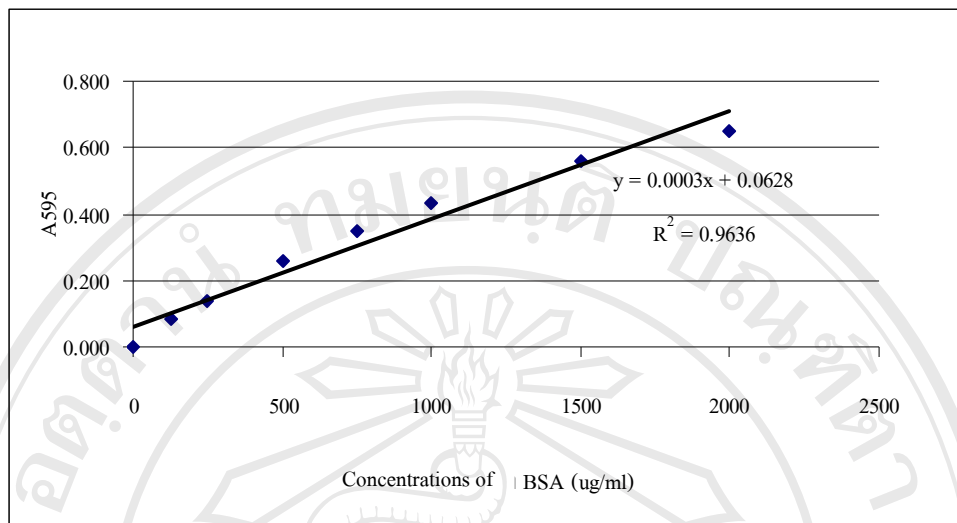
Vial #	Stock Standard BSA	ddH <sub>2</sub> O	Concentration
1	20 $\mu$ l 2 mg/ml stock	0 $\mu$ l	2000 $\mu$ g/ml
2	30 $\mu$ l 2 mg/ml stock	10 $\mu$ l	1500 $\mu$ g/ml
3	20 $\mu$ l 2 mg/ml stock	20 $\mu$ l	1000 $\mu$ g/ml
4	20 Tube 2	20 $\mu$ l	750 $\mu$ g/ml
5	20 Tube 3	20 $\mu$ l	500 $\mu$ g/ml
6	20 Tube 5	20 $\mu$ l	250 $\mu$ g/ml
7	20 Tube 6	20 $\mu$ l	125 $\mu$ g/ml
Blank	0	20 $\mu$ l	0 $\mu$ g/ml

BSA = Bovine Serum Albumin

ddH<sub>2</sub>O = double distilled water

Absorbance values at 595 nm at various standard concentration of BSA

Concentration ( $\mu$ g/ml)	Absorbance 595 nm			Average	Average standard- Average blank
	1	2	3		
0	0.299	0.303	0.301	0.301	0.000
125	0.374	0.382	0.397	0.384	0.083
250	0.434	0.445	0.447	0.442	0.141
500	0.561	0.566	0.558	0.562	0.261
750	0.649	0.656	0.651	0.652	0.351
1000	0.726	0.736	0.738	0.733	0.432
1500	0.859	0.853	0.865	0.859	0.558
2000	0.958	0.939	0.955	0.951	0.650



Standard graph of absorbance with various standard concentration of BSA

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## Appendix C

## Water Quality Standards for Industrial Effluent

Industrial Effluent Standards		
Parameters	Standard Values	Method for Examination
1. pH value	5.5-9.0	pH Meter
2. Total Dissolved Solids (TDS)	<ul style="list-style-type: none"> <li>not more than 3,000 mg/l depending on receiving water or type of industry under consideration of PCC but not exceed 5,000 mg/l</li> <li>not more than 5,000 mg/l exceed TDS of receiving water having salinity of more than 2,000 mg/l or TDS of sea if discharge to sea</li> </ul>	Dry Evaporation 103-105 °C, 1 hour
3. Suspended solids (SS)	not more than 50 mg/l depending on receiving water or type of industry or wastewater treatment system under consideration of PCC but not exceed 150 mg/l	Glass Fiber Filter Disc
4. Temperature	not more than 40°C	Termometer during the sampling
5. Color and Odor	not objectionable	Not specified
6. Sulphide as H <sub>2</sub> S	not more than 1.0 mg/l	Titrate
7. Cyanide as HCN	not more than 0.2 mg/l	Distillation and Pyridine Barbituric Acid Method
8. Fat, Oil & Grease (FOG)	not more than 5.0 mg/l depending of receiving water or type of industry under consideration of PCC but not exceed 15.0 mg/l	Solvent Extraction by Weight
9. Formaldehyde	not more than 1.0 mg/l	Spectrophotometry
10. Phenols	not more than 1.0 mg/l	Distillation and 4-Aminoantipyrine Method
11. Free Chlorine	not more than 1.0 mg/l	Iodometric Method
12. Pesticides	not detectable	Gas-Chromatography
13. Biochemical Oxygen Demand (BOD)	not more than 20 mg/l depending on receiving water or type of industry under consideration of PCC but not exceed 60 mg/l	-Azide Modification at 20 °C , 5 days
14. Total Kjeldahl Nitrogen (TKN)	not more than 100 mg/l depending on receiving water or type of industry under consideration of PCC but not exceed 200 mg/l	Kjeldahl
15. Chemical Oxygen Demand (COD)	not more than 120 mg/l depending on receiving water of type of industry under consideration of PCC but not exceed 400 mg/l	Potassium Dichromate Digestion
16. Heavy metals		
1. Zinc (Zn)	not more than 5.0 mg/l	Atomic Absorption Spectro Photometry; Direct Aspiration or Plasma Emission Spectroscopy ; Inductively Coupled Plasma : ICP
2. Chromium (Hexavalent)	not more than 0.25 mg/l	
3. Chromium (Trivalent)	not more than 0.75 mg/l	
4. Copper (Cu)	not more than 2.0 mg/l	
5. Cadmium (Cd)	not more than 0.03 mg/l	
6. Barium (Ba)	not more than 1.0 mg/l	
7. Lead (Pb)	not more than 0.2 mg/l	
8. Nickel (Ni)	not more than 1.0 mg/l	
9. Manganese (Mn)	not more than 5.0 mg/l	
10. Arsenic (As)	not more than 0.25 mg/l	
11. Selenium (Se)	not more than 0.02 mg/l	
12. Mercury (Hg)	not more than 0.005 mg/l	

**Remarks:** 1) PCC Pollution Control Committee

2) The standards were summarized from the Notification of the Ministry of Science, Technology and Environment, No. 3, B.E. 2539 (1996) and it specifies that pollution sources that the above standards are to be applied are factories group II and III issues under the Factory Act B.E.2535 (1992) and every kind of industrial estates.

3) Notification of the Pollution Control Committee, No. 3, B.E. 2539 (1996) dated August 20, B.E. 2539 (1996) has issued types of factories (category of factories issued under the Factory Act B.E.2535 (1992) that are allowed to discharge effluent having different standards from the Ministerial Notification No. 3 above as follows :

(1) BOD up to 60 mg/l

- animal furnishing factories (category 4 (1))
- starch factories (category 9 (2))
- food from starch factories (category 10)
- textile factories (category 15)
- tanning factories (category 22)
- pulp and paper factories (category 29)
- chemical factories (category 42)
- pharmaceutical factories(category 46)
- frozen food factories (category 92)

(2) COD up to 400 mg/l

- food furnishing factories (category 13 (2))
- animal food factories (category 15 (1))
- textile factories (category 22)
- pulp and paper factories (category 38)

(3) TKN

- 100 mg/l - effective after 1 year from the date published in the Royal Government Gazette of the Ministerial Notification No. 4
- 200 mg/l - effective after 2 year from the date published in the Royal Government Gazette of the Ministerial Notification No. 4 for the following factories:



(3.1) food furnishing factories (category 13 (2))

(3.2) animal food factories (category 15 (1))

**Sources:** Notification the Ministry of Science, Technology and Environment, No. 3, B.E.2539 (1996) issued under the Enhancement and Conservation of the National Environmental Quality Act B.E.2535 (1992), published in the Royal Government Gazette, Vol. 113 Part 13 D, dated February 13, B.E.2539 (1996)

### Surface Water Quality Standards

Surface Water Quality Standards								
Parameter <sup>1/</sup>	Units	Statistics	Standard Value for Class <sup>2/</sup>					Methods for Examination
			Class1	Class2	Class3	Class4	Class5	
1. Colour, Odour and Taste	-	-	n	n'	n'	n'	-	-
2. Temperature	C°	-	n	n'	n'	n'	-	Thermometer
3. pH	-	-	n	5-9	5-9	5-9	-	Electrometric pH Meter
4. Dissolved Oxygen (DO) <sup>2/</sup>	mg/l	P20	n	6.0	4.0	2.0	-	Azide Modification
5. BOD (5 days, 20°C)	mg/l	P80	n	1.5	2.0	4.0	-	Azide Modification at 20°C, 5 days
6. Total Coliform Bacteria	MPN/100 ml	P80	n	5,000	20,000	-	-	Multiple Tube Fermentation Technique
7. Fecal Coliform Bacteria	MPN/100 ml	P80	n	1,000	4,000	-	-	Multiple Tube Fermentation Technique
8. NO <sub>3</sub> -N	mg/l	-	n		5.0		-	Cadmium Reduction
9. NH <sub>3</sub> -N	mg/l	-	n		0.5		-	Distillation Nesslerization
10. Phenols	mg/l	-	n		0.005		-	Distillation, 4-Amino antipyrine
11. Copper (Cu)	mg/l	-	n		0.1		-	Atomic Absorption -Direct Aspiration
12. Nickel (Ni)	mg/l	-	n		0.1		-	Atomic Absorption -Direct Aspiration
13. Manganese (Mn)	mg/l	-	n		1.0		-	Atomic Absorption -Direct Aspiration
14. Zinc (Zn)	mg/l	-	n		1.0		-	Atomic Absorption -Direct Aspiration
15. Cadmium (Cd)	mg/l	-	n		0.005*		-	Atomic Absorption -Direct Aspiration
					0.05**			
16. Chromium Hexavalent	mg/l	-	n		0.05		-	Atomic Absorption -Direct Aspiration
17. Lead (Pb)	mg/l	-	n		0.05		-	Atomic Absorption -Direct Aspiration
18. Total Mercury (Total Hg)	mg/l	-	n		0.002		-	Atomic Absorption -Cold Vapour Technique
19. Arsenic (As)	mg/l	-	n		0.01		-	Atomic Absorption -Direct Aspiration
20. Cyanide (Cyanide)	mg/l	-	n		0.005		-	Pyridine-Barbituric Acid
21. Radioactivity								
- Alpha	Becquerel/l	-	n		0.1		-	Gas-Chromatography
- Beta					1.0			
22. Total Organochlorine Pesticides	mg/l	-	n		0.05		-	Gas-Chromatography
23. DDT	µg/l	-	n		1.0		-	Gas-Chromatography
24. Alpha-BHC	µg/l	-	n		0.02		-	Gas-Chromatography
25. Dieldrin	µg/l	-	n		0.1		-	Gas-Chromatography
26. Aldrin	µg/l	-	n		0.1		-	Gas-Chromatography
27. Heptachlor & Heptachlorepoxyde	µg/l	-	n		0.2		-	Gas-Chromatography
28. Endrin	µg/l	-	n		None		-	Gas-Chromatography



**Remark:** <sup>1/</sup> กำหนดค่ามาตรฐานเฉพาะในแหล่งน้ำประเภทที่ 2-4 สำหรับแหล่งน้ำประเภทที่ 1 ให้เป็นไปตามธรรมชาติ และแหล่งน้ำประเภทที่ 5 ไม่กำหนดค่า

<sup>2/</sup> ค่า DO เป็นเกณฑ์มาตรฐานต่ำสุด

P: Percentile value

n: naturally

n': naturally but changing not more than 3°C

\* : when water hardness not more than 100 mg/l as CaCO<sub>3</sub>

\*\* : when water hardness more than 100 mg/l as CaCO<sub>3</sub>

Based on Standard Methods for the Examination of Water and Wastewater recommended by APHA : American Public Health Association, AWWA : American Water Works Association and WPCF : Water Pollution Control Federation

**Source:** Notification of the National Environmental Board, No. 8, B.E. 2537 (1994), issued under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992) , published in the Royal Government Gazette, Vol. 111, Part 16, dated February 24, B.E.2537 (1994).

## Classification and Objectives

Classification	Objectives/Condition and Beneficial Usage
<b>Class 1</b>	Extra clean fresh surface water resources used for : (1) conservation not necessary pass through water treatment process require only ordinary process for pathogenic destruction (2) ecosystem conservation where basic organisms can breed naturally
<b>Class 2</b>	Very clean fresh surface water resources used for : (1) consumption which requires ordinary water treatment process before use (2) aquatic organism of conservation (3) fisheries (4) recreation
<b>Class 3</b>	Medium clean fresh surface water resources used for : (1) consumption, but passing through an ordinary treatment process before using (2) agriculture
<b>Class 4</b>	Fairly clean fresh surface water resources used for : (1) consumption, but requires special water treatment process before using (2) industry
<b>Class 5</b>	The sources which are not classification in class 1-4 and used for navigation.

**Source:** Notification of the National Environmental Board, No. 8, B.E. 2537 (1994), issued under the Enhancement and Conservation of National Environmental Quality Act B.E.2535 (1992) , published in the Royal Government Gazette, Vol. 111, Part 16, dated February 24, B.E.2537 (1994).

## Soil Quality Standard

### 1. Soil Quality Standards for Habitat and Agriculture

Soil Quality Standards for Habitat and Agriculture			
Parameter	Unit	Standard Value	Analytical Methods
<b>1. Volatile Organic Compound</b>			
1) Benzene	mg/kg	Not exceed 6.5	Gas Chromatography or Gas Chromatography/Mass Spectrometry (GC/MS) or other methods approved by PCD
2) Carbon Tetrachloride	"	Not exceed 2.5	"
3) 1,2-Dichloroethane	"	Not exceed 3.5	"
4) 1,1-Dichloroethylene	"	Not exceed 0.5	"
5) cis-1,2-Dichloroethylene	"	Not exceed 43	"
6) trans-1,2-Dichloroethylene	"	Not exceed 63	"
7) Dichloromethane	"	Not exceed 89	"
8) Ethylbenzene	"	Not exceed 230	"
9) Styrene	"	Not exceed 1,700	"
10) Tetrachloroethylene	"	Not exceed 57	"
11) Toluene	"	Not exceed 520	"
12) Trichloroethylene	"	Not exceed 28	"
13) 1,1,1-Trichloroethane	"	Not exceed 630	"
14) 1,1,2-Trichloroethane	"	Not exceed 8.4	"
15) Total Xylenes	"	Not exceed 210	"
<b>2. Heavy metals</b>			
1) Arsenic	mg/kg	Not exceed 3.9	Inductively Coupled Plasma-Atomic Emission Spectrometry or Inductively Coupled Plasma-Mass Spectrometry or Atomic Absorption, Furnace Technique or Atomic Absorption, Gaseous Hydride or Atomic Absorption, Borohydride Reduction or other Methods Approved by Pollution Control Department
2) Cadmium and compounds	"	Not exceed 37	Inductively Coupled Plasma-Atomic Emission Spectrometry or Inductively Coupled Plasma-Mass Spectrometry or Atomic Absorption, Direct Aspiration or Atomic Absorption, Furnace Technique or other Methods Approved by Pollution Control Department
3) Hexavalent Chromium	"	Not exceed 300	Coprecipitation or Colorimetric or Chelation/Extraction or other Methods Approved by Pollution Control Department
4) Lead	"	Not exceed 400	Inductively Coupled Plasma-Atomic Emission Spectrometry or Inductively Coupled Plasma-Mass Spectrometry or Atomic Absorption, Direct Aspiration or Atomic Absorption, Furnace Technique or other Methods Approved by Pollution Control Department
5) Manganese and compounds	"	Not exceed 1,800	"
6) Mercury and compounds	"	Not exceed 23	Cold-Vapor Technique or other Methods Approved by Pollution Control Department
7) Nickel, soluble salts	"	Not exceed 1,600	Inductively Coupled Plasma-Atomic Emission Spectrometry or Inductively Coupled Plasma-Mass Spectrometry or Atomic Absorption, Direct Aspiration or Atomic Absorption, Furnace Technique or other Methods Approved by Pollution Control Department
8) Selenium	"	Not exceed 390	Inductively Coupled Plasma-Atomic Emission Spectrometry or Atomic Absorption, Furnace Technique or Atomic Absorption, Gaseous Hydride or Atomic Absorption, Borohydride Reduction or other Methods Approved by Pollution Control Department
<b>3. Pesticides</b>			
1) Atrazine	mg/kg	Not exceed 22	Gas Chromatography or other Methods Approved by Pollution Control Department

2) Chlordane	"	Not exceed 16	Gas Chromatography/Mass Spectrometry (GC/MS) or other Methods Approved by Pollution Control Department
3) 2,4-D	"	Not exceed 690	Gas Chromatography or High Performance Liquid Chromatography/Thermal Extraction/Gas Chromatography/Mass Spectrometry (TE/GC/MS) or other Methods Approved by Pollution Control Department
4) DDT	"	Not exceed 17	Gas Chromatography or Gas Chromatography/Mass Spectrometry (GC/MS) or other Methods Approved by Pollution Control Department
5) Dieldrin	"	Not exceed 0.3	"
6) Heptachlor	"	Not exceed 1.1	"
7) Heptachlor Epoxide	"	Not exceed 0.5	"
8) Lindane	"	Not exceed 4.4	"
9) Pentachlorophenol	"	Not exceed 30	Gas Chromatography or Gas Chromatography/Mass Spectrometry (GC/MS) or Gas Chromatography/Fourier Transform Infrared (GC/FT-IR) Spectrometry or other Methods Approved by Pollution Control Department
<b>4. Other Chemicals</b>			
1) Benzo (a) pyrene	mg/Kg	Not exceed 0.6	Gas Chromatography/Mass Spectrometry (GC/MS), or Thermal Extraction/Gas Chromatography/Mass Spectrometry (TE/GC/MS), or Gas Chromatography/Fourier Transform Infrared (GC/FT-IR) Spectrometry, or other Methods Approved by Pollution Control Department
2) Cyanide and compounds	"	Not exceed 11	Total and Amenable Cyanide: Distillation, or Total Amenable Cyanide (Automated Colorimetric, with off-line Distillation), or Cyanide Extraction Procedure for Solids and Oils or other Methods Approved by Pollution Control Department
3) PCBs	"	Not exceed 2.2	Gas Chromatography or other methods approved by PCD
4) Vinyl Chloride	"	Not exceed 1.5	Gas Chromatography or Gas Chromatography/Mass Spectrometry (GC/MS) or other methods approved by PCD

**Remark:** 1. Test Methods of Evaluating Solid Waste, Physical/Chemical Methods

(SW-846) (United States Environmental Protection Agency)

2. Soil Sampling and Preservation Methods must be as specified

**Source:** Pollution Control Department, Bangkok, Thailand (PCD). 1996. Notification of the Ministry of Science, Technology and Environment, No. 3, B.E. 2539 (1996) : Specifying of the Control of Industrial Effluent Standard with the sources from Factories and Industrial Estates, published in the Royal Government Gazette, Vol. 113, Part 13 D, dated February 13, B.E.2539 (1996).

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## 2. Soil Quality Standard Soil Quality Standard for Other Purposes

Soil Quality Standard Soil Quality Standard for Other Purposes			
Parameter	Unit	Standard Value	Analytical Methods
<b>1. Volatile Organic Compounds</b>			
1) Benzene	mg/kg	Not exceed 15	Gas Chromatography or Gas Chromatography/Mass Spectrometry (GC/MS) or other methods approved by PCD
2) Carbon Tetrachloride	"	Not exceed 5.3	"
3) 1,2-Dichloroethane	"	Not exceed 7.6	"
4) 1,1-Dichloroethylene	"	Not exceed 1.2	"
5) cis-1,2-Dichloroethylene	"	Not exceed 150	"
6) trans-1,2-Dichloroethylene	"	Not exceed 210	"
7) Dichloromethane	"	Not exceed 210	"
8) Ethylbenzene	"	Not exceed 230	"
9) Styrene	"	Not exceed 1,700	"
10) Tetrachloroethylene	"	Not exceed 190	"
11) Toluene	"	Not exceed 520	"
12) Trichloroethylene	"	Not exceed 61	"
13) 1,1,1-Trichloroethane	"	Not exceed 1,400	"
14) 1,1,2-Trichloroethane	"	Not exceed 19	"
15) Total Xylenes	"	Not exceed 210	"
<b>2. Heavy metals</b>			
1) Arsenic	mg/kg	Not exceed 27	Inductively Coupled Plasma-Atomic Emission Spectrometry or Inductively Coupled Plasma-Mass Spectrometry or Atomic Absorption, Furnace Technique or Atomic Absorption, Gaseous Hydride or Atomic Absorption, Borohydride Reduction or other methods approved by PCD
2) Cadmium and compounds	"	Not exceed 810	Inductively Coupled Plasma-Atomic Emission Spectrometry or Inductively Coupled Plasma-Mass Spectrometry or Atomic Absorption, Direct Aspiration or Atomic Absorption, Furnace Technique or other methods approved by PCD
3) Hexavalent Chromium	"	Not exceed 640	Coprecipitation or Colorimetric or Chelation/Extraction or other methods approved by PCD
4) Lead	"	Not exceed 750	Inductively Coupled Plasma-Atomic Emission Spectrometry or Inductively Coupled Plasma-Mass Spectrometry or Atomic Absorption, Direct Aspiration or Atomic Absorption, Furnace Technique or other methods approved by PCD
5) Manganese and compounds	"	Not exceed 32,000	"
6) Mercury and compounds	"	Not exceed 610	Cold-Vapor Technique or other methods approved by PCD
7) Nickel, soluble salts	"	Not exceed 41,000	Inductively Coupled Plasma-Atomic Emission Spectrometry or Inductively Coupled Plasma-Mass Spectrometry or Atomic Absorption, Direct Aspiration or Atomic Absorption, Furnace Technique or other methods approved by PCD
8) Selenium	"	Not exceed 10,000	Inductively Coupled Plasma-Atomic Emission Spectrometry or Atomic Absorption, Furnace Technique or Atomic Absorption, Gaseous Hydride or Atomic Absorption, Borohydride Reduction or other methods approved by PCD
<b>3. Pesticides</b>			
1) Atrazine	mg/kg	Not exceed 110	Gas Chromatography or other methods approved by PCD
2) Chlordane	"	Not exceed 110	Gas Chromatography/Mass Spectrometry (GC/MS) or other methods approved by PCD
3) 2,4-D	"	Not exceed 12,000	Gas Chromatography or High Performance Liquid Chromatography/Thermal Extraction/Gas Chromatography/Mass Spectrometry (TE/GC/MS) or other methods approved by PCD
4) DDT	"	Not exceed 120	Gas Chromatography or Gas Chromatography/Mass Spectrometry (GC/MS) or other methods approved by PCD

5) Dieldrin	"	Not exceed 1.5	"
6) Heptachlor	"	Not exceed 5.5	"
7) Heptachlor Epoxide	"	Not exceed 2.7	"
8) Lindane	"	Not exceed 29	"
9) Pentachlorophenol	"	Not exceed 110	Gas Chromatography or Gas Chromatography/Mass Spectrometry (GC/MS) or Gas Chromatography/Fourier Transform Infrared (GC/FT-IR) Spectrometry or other methods approved by PCD
<b>4. Others</b>			
1) Benzo (a) pyrene	mg/kg	Not exceed 2.9	Gas Chromatography/Mass Spectrometry (GC/MS) or Thermal Extraction/Gas Chromatography/Mass Spectrometry (TE/GC/MS) or Gas Chromatography/Fourier Transform Infrared (GC/FT-IR) Spectrometry or other methods approved by PCD
2) Cyanide and compounds	"	Not exceed 35	Total and Amenable Cyanide: Distillation or Total Amenable Cyanide (Automated Colorimetric, with off-line Distillation) or Cyanide Extraction Procedure for Solids and Oils or other methods approved by PCD
3) PCBs	"	Not exceed 10	Gas Chromatography or other methods approved by PCD
4) Vinyl Chloride	"	Not exceed 8.3	Purge and Trap Gas Chromatography or Purge and Trap Gas Chromatography Mass Spectrometry or other methods approved by PCD

**Remark:** 1. Test Methods of Evaluating Solid Waste, Physical/Chemical Methods (SW-846) (United States Environmental Protection Agency)

2. Soil Sampling and Preservation Methods must be as specified

**Source:** Pollution Control Department, Bangkok, Thailand (PCD). 1996. Notification of the Ministry of Science, Technology and Environment, No. 3, B.E. 2539 (1996) : Specifying of the Control of Industrial Effluent Standard with the sources from Factories and Industrial Estates, published in the Royal Government Gazette, Vol. 113, Part 13 D, dated February 13, B.E.2539 (1996).

### Appendix D

#### Statistical analysis for the absorbance values of end-product released by esterase

Statistical analysis for the absorbance values of end-product released by esterase after a group of mollusk being treated with differing concentrations of Pb at 0.5, 1.0 and 1.5 mg/L and Zn at 2.5, 5.0 and 10.0 mg/L at day 10

Day10				
Duncan a,b				
sample	N	Subset for alpha = 0.05		
		1	2	3
Zn 10.0 mg/L	9	0.262		
Pb 1.5 mg/L	9	0.273		
Zn 2.5 mg/L	9	0.290		
Zn 5.0 mg/L	9	0.306	0.306	
Pb 1.0 mg/L	9		0.371	
Pb 0.5 mg/L	9			0.470
control	6			0.514
Sig.		0.240	0.054	0.181



Statistical analysis for the absorbance values of end-product released by esterase after a group of mollusk being treated with differing concentrations of Pb at 0.5, 1.0 and 1.5 mg/L and Zn at 2.5, 5.0 and 10.0 mg/L at day 20

<b>Day20</b>				
<b>Duncan a,b</b>				
sample	N	Subset for alpha = 0.05		
		1	2	3
Zn 10.0 mg/L	9	0.436		
Zn 5.0 mg/L	9	0.504	0.504	
Pb 1.5 mg/L	9	0.558	0.558	
Zn 2.5 mg/L	9		0.619	
Pb 1.0 mg/L	9		0.624	
control	6			0.908
Pb 0.5 mg/L	9			0.999
Sig.		0.127	0.145	0.219

Statistical analysis for the absorbance values of end-product released by esterase after a group of mollusk being treated with differing concentrations of Pb at 0.5, 1.0 and 1.5 mg/L and Zn at 2.5, 5.0 and 10.0 mg/L at day 30

<b>Day30</b>							
<b>Duncan a,b</b>							
sample	N	Subset for alpha = 0.05					
		1	2	3	4	5	6
Zn 5.0 mg/L	9	0.217					
Pb 1.5 mg/L	9	0.253	0.253				
Zn 10.0 mg/L	9		0.279	0.279			
Pb 1.0 mg/L	9			0.317	0.317		
Zn 2.5 mg/L	9				0.350	0.350	
control	6					0.379	0.379
Pb 0.5 mg/L	9						0.408



Sig.		0.169	0.305	0.142	0.210	0.261	0.256
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## CURRICULUM VITAE

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2000-2003 M. Sc. (Environmental Science), Kasetsart University,  
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### Fields of Specialization

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- Environment Impact Assessment (EIA)
  - Macrobenthic Fauna in the Mangrove Forest
  - Freshwater Mollusks

### Scholarships

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2005-2008	Ph.D. Program by the Commission on Higher Education(CHE). Thesis funded by the Graduate School of Chiang Mai University.
2000-2003	M. Sc. Program by the Commission on Higher Education (CHE). Thesis funded by the Laem Phak Bia Environmental Study and Development Project.
1995- 1998	B. Sc. Program by the Commission on Higher Education (CHE).

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### Attended Conferences

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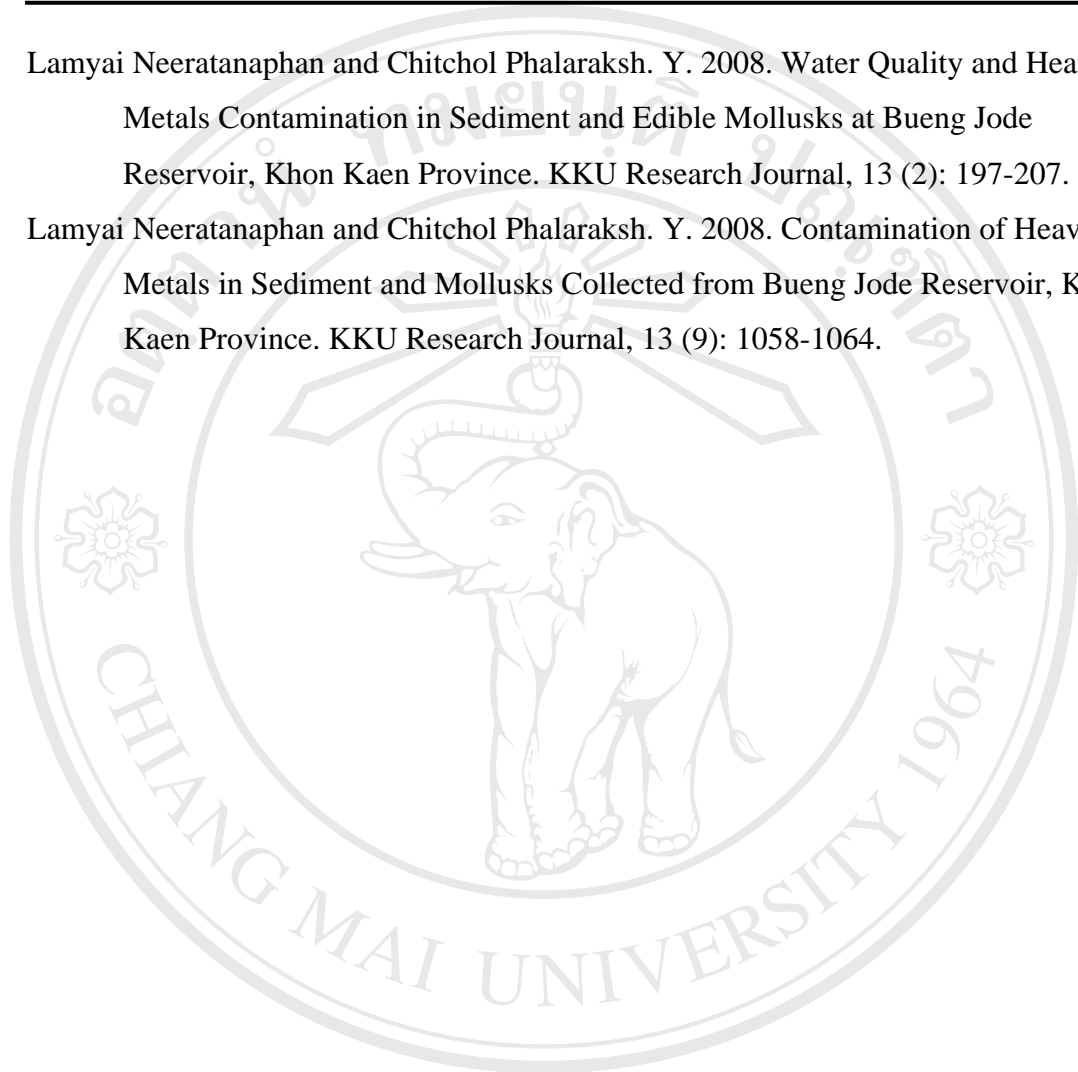
25-29 August 2008	Oral presentation on “Contamination of Heavy Metals in Sediment and Mollusks Collected from Bueng Jode Reservoir, Khon Kaen Province” at the 12 <sup>th</sup> International Conference on Integrated Diffuse Pollution Management (IWA DIPCON 2008) by Research Center for Environmental and Hazardous Substance Management (EHSM), Khon Kaen University, THAILAND
19 January 2007	Oral presentation on “Accumulation and Toxicity of Heavy Metals on Edible Mollusk from Bueng Jode Wetland, Khon Kaen Province” in Seminar Series IV at Department of Biology, Faculty of Science, Chaing Mai University, Chaing Mai, THAILAND
6 September 2006	Oral presentation on “Accumulation and Toxicity of Heavy Metals on Edible Mollusk from Nongjode Reservoir, Khon Kaen Province.” in Seminar Series III at Department of Biology, Faculty of Science, Chaing Mai University, Chaing Mai, THAILAND

**Publications**

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Lamyai Neeratanaphan and Chitchol Phalaraksh. Y. 2008. Water Quality and Heavy Metals Contamination in Sediment and Edible Mollusks at Bueng Jode Reservoir, Khon Kaen Province. *KKU Research Journal*, 13 (2): 197-207.

Lamyai Neeratanaphan and Chitchol Phalaraksh. Y. 2008. Contamination of Heavy Metals in Sediment and Mollusks Collected from Bueng Jode Reservoir, Khon Kaen Province. *KKU Research Journal*, 13 (9): 1058-1064.



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