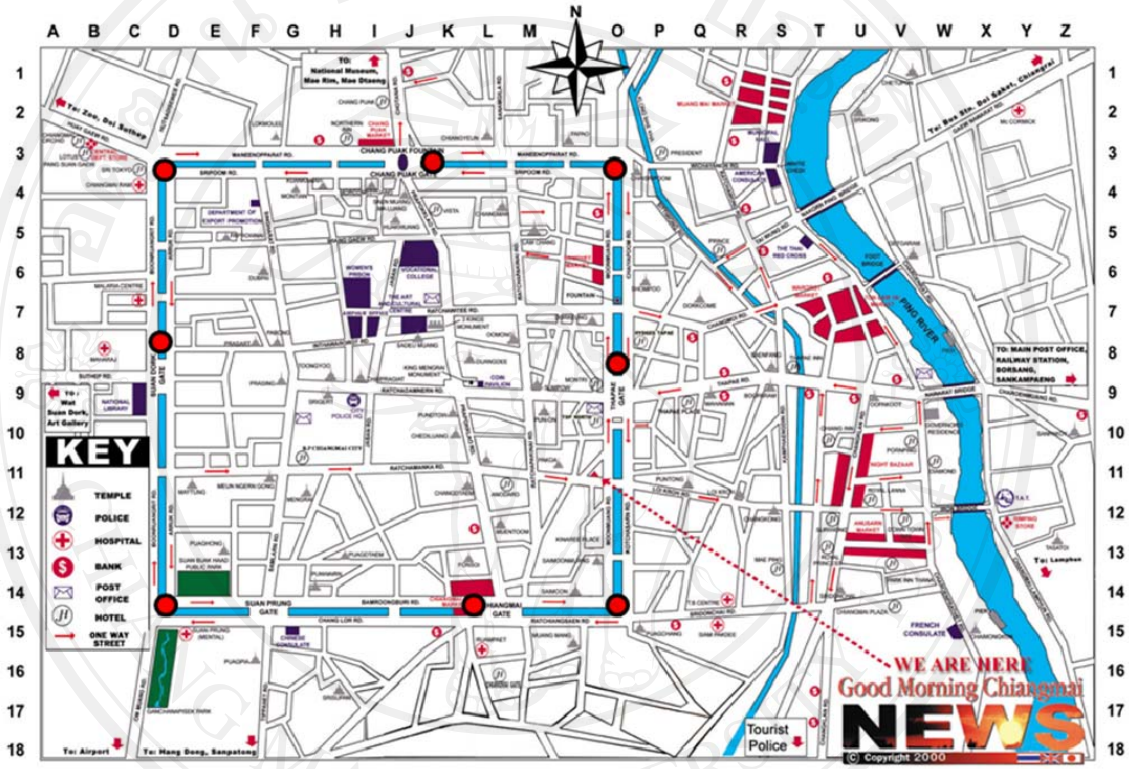
APPENDIX A

Water sampling site ( )



Chiang Mai Canal

Chiang Mai University reservoir

Table A.1 Standard quality of surface water defined by Pollution Control Department (PCD) Ministry of Natural Resources and Environment [65]

Parameters	**Units**	**PCD (Guideline Value)**
1. Bacteriological Quality		
Bacteria E. coli	Found-no found/100 ml	No found/100 ml
2. Physical and Chemical Quality		
Apperance colour	True colour unit	15
Turbidity	NTU	5
Taste and odour	-	-
pH	-	5.5 – 9.0
DO	mg/l	1.5
BOD	mg/l	20
COD	mg/l	40
Arsenic	mg/l	0.01
Cadmium	mg/l	0.05
Chromium	mg/l	0.05
Cyanide	mg/l	0.005
Lead	mg/l	0.05
Mercury	mg/l	0.002

Note 1 mg = 1,000 µg

Table A.1 (Continued)

Parameters	Units	PCD (Guideline Value)
Selenium	mg/l	0.01
Barium	mg/l	0.03
Chloride	mg/l	250
Copper	mg/l	0.1
Iron	mg/l	0.3
Manganese	mg/l	1.0
Mercury	mg/l	0.002
Nickel	mg/l	0.1
Sulfate	mg/l	250
Zinc	mg/l	1.0
Hydrogen sulfide	mg/l	1.0
Total dissolved solids	mg/l	1,300
Nitrate as NO_3^-	mg/l	5.0
Nitrite as NO_2^-	mg/l	3
Free residual chlorine	mg/l	1.0
Dichloroethylene	mg/l	0.005
Tetrachloroethene	mg/l	0.005
Trichloroethene	mg/l	0.005
3. Pesticides		
Aldrin/Dieldrin	µg/l	0.03
Chlordane	µg/l	0.2
DDT	µg/l	1.0

Note 1 mg = 1,000 µg

Table A.1 (Continued)

Parameters	Units	PCD (Guideline Value)
2,4-D	µg/l	30
Heptachlor	µg/l	0.4
Heptachlor and Heptachlor epoxide	µg/l	0.2
Lindane	µg/l	0.2
Pentachlorophenol	µg/l	1.0
Temperature	^{o}C	<40
4. Radioactive		
Gross alpha activity	Bq/l	0.1
Gross beta activity	Bq/l	1.0

Note 1 mg = 1,000 µg

Table A.2 Recommended minimum sample numbers for faecal indicator testing in distribution systems *

Population	**Total number of samples per year**
Point sources	Progressive sampling of all sources over 3 to 5 year cycles (maximum)
Piped supplies	
< 5000	12
5000 - 100000	12 per 5,000 head of population
> 100000 - 500000	12 per 10,000 head of population plus an additional 120 samples
> 500000	12 per 100,000 head of population plus an additional 180 samples

* Parameters such as chlorine, turbidity and pH should be tested more frequently as part of operational and verification monitoring.

APPENDIX B

The student t-Test [62]

$$t = \frac{\bar{x}_d \sqrt{n}}{S_d}$$

$$S_d = \sqrt{\frac{\sum (x_d - \bar{x}_d)^2}{n-1}}$$

$$\bar{x}_d = \frac{\sum x_d}{n}$$

Where; x_d the difference between two method

$\bar{x}_d$ the mean difference

S_d the standard deviation

n number of sample

n-1 number of degree of freedom

The Table B.1 gives the concentration of selenium (mg L^{-1}) determined by two difference methods for each four test portions.

Table B.1 Calculation of t-test for selenium determination of FIA

Water samples	Concentrations (mg L^{-1})		x_d	$x_d - \bar{x}_d$	$(x_d - \bar{x}_d)^2$
	FIA*	ICP-MS*			
Hua Lin Corner.	0.017	0.016	0.001	0.0003	0.000009
Sri Poom Corner.	0.051	0.050	0.001	0.0003	0.000009
Khatum Corner.	0.024	0.024	0.000	-0.0008	0.000000
Chiang mai Gate.	0.029	0.028	0.001	0.0003	0.000000
Σ			0.003	-	0.00002
S_d			0.00258		
T			0.581		

* average of five replicate results

$$\bar{x} = \frac{\sum x_i}{n}$$

$$= \frac{0.003}{4}$$

$$= 0.00075$$

$$S_d = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{0.00002}{4-1}}$$

$$= \quad 0.00258$$

$$t \quad = \quad \frac{\bar{x}_d \sqrt{n}}{S_d}$$

$$= \quad \frac{0.00075\sqrt{4}}{0.00258}$$

$$= \quad 0.581$$

The calculated value of t (0.581) is less than the t value from Table B.3 (3.18) for three degrees of freedom indicating that results obtained by both methods show no significant difference at 95% confidence intervals.

Table B.2 Calculation of t-test for selenium determination of SIA

Water samples	**Concentrations (mg L^{-1})**		x_d	$x_d - \bar{x}_d$	$(x_d - \bar{x}_d)^2$
	SIA*	**ICP-MS****			
Hua Lin Corner.	0.016	0.016	0.000	0.0003	0.000000
Sri Poom Corner.	0.052	0.050	0.002	0.0018	0.000003
Khatum Corner.	0.023	0.024	-0.001	-0.0013	0.000002
Chiang mai Gate.	0.028	0.028	0.000	-0.0003	0.000000
Σ			0.001	-	0.000005
S_d			0.00129		
t			0.387		

* average of five replicate results

$$\bar{x} = \frac{\sum x_i}{n}$$

$$= \frac{0.001}{4}$$

$$= 0.00025$$

$$S_d = \sqrt{\frac{\sum (x_i - \bar{x})^2}{n-1}}$$

$$= \sqrt{\frac{0.000005}{4-1}}$$

$$= 0.00129$$

$$t = \frac{\bar{x}_d \sqrt{n}}{S_d}$$

$$= \frac{0.00025\sqrt{4}}{0.00129}$$

$$= 0.387$$

The calculated value of t (0.387) is less than the t value from Table B.3 (3.18) for three degrees of freedom indicating that results obtained by both methods show no significant difference at 95% confidence intervals.

Table B.3 Values of t for various levels of confidence interval

Degrees of freedom	Confidence interval			
	80%	90%	95%	99%
1	3.08	6.31	12.70	63.7
2	1.89	2.92	4.30	9.92
3	1.64	2.35	3.18	5.84
4	1.53	2.13	2.78	4.60
5	1.48	2.02	2.57	4.03
6	1.44	1.94	2.45	3.71
7	1.42	1.90	2.36	3.50
8	1.40	1.86	2.31	3.36
9	1.38	1.83	2.26	3.25
10	1.37	1.81	2.23	3.17
15	1.34	1.75	2.13	2.95
20	1.32	1.72	2.09	2.84
30	1.31	1.70	2.04	2.75
60	1.30	1.67	2.00	2.66
α	1.29	1.64	1.96	2.58

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List of publications:

National conferences

1. Y. Thepchuay, S. Liawruangrath, **"Development of flow injection spectrophotometric method for the determination of selenium",** *34th Congress on Science and Technology of Thailand, Bangkok,* 2008.

2. Y. Thepchuay, S. Liawruangrath, **"Development of flow injection spectrophotometric method for the determination of selenium",** *The sixth PERCH Annual Scientific Congress, Chonburi*, 2009.