Project Ref. No.: CDD/320/05/005

Final Report on the Measurement of Thermal Plume for the Operation of GT57 Combined Cycle Unit at Lamma Power Station

(Revision No. 1)

Prepared for

The Hongkong Electric Co., Ltd.

by

Environmental Management Division

Hong Kong Productivity Council

13 August 2010

香港電燈有限公司
The Hongkong Electric Co., Ltd.

港燈
HK Electric

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) ORDINANCE, CAP. 499

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LAMMA POWER STATION
CONVERSION OF TWO EXISTING GAS TURBINES (GT5 & GT7) INTO A COMBINED CYCLE UNIT
ENVIRONMENTAL MONITORING & AUDIT PROGRAMME AT OPERATIONAL PHASE

Report Title	Final Report on the Measurement of Thermal Plume for the Operation of GT57 Combined Cycled Unit
Date	26 August 2010
Certified by	(Mr. Chan Kwok-Fai, Environmental Team Leader)
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Amendment Record

Revision No.	Date	Section Amended	Remarks
0	20 July 2010	Nil	Issued for comment
1	13 August 2010	1. Table 3.1 2. Table 4.1 3. Annex A 4. Annex B 5. Annex E3	Sections amended in response to IEC's comments

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EXECUTIVE SUMMARY

This is the Final Report on the Measurement of Thermal Plume for the Operation of GT57 Combined Cycle Unit at Lamma Power Station.

To inspect the thermal impacts on the sensitive receivers during the operation of GT57 combined cycle unit and the existing coal-fired generating units, two surveys to determine the seawater quality at the sensitive receivers were carried out at both flood and ebb tides during the spring tide on 17th May 2010 and the neap tide on 21st June 2010.

A total of 7 inspection locations consisting of 4 sensitive receiver (SR) stations, 2 ambient (AM) stations, and 1 station close to the cooling water outfall (CW) were designated for the surveys.

The seawater quality consisting of temperature, dissolved oxygen (DO), salinity, conductivity, and pH was determined during the surveys.

Survey Findings

During the surveys, the temperature elevation at all sensitive receivers were maintained no more than 2^{o}C. The impact of the thermal plume from the spent cooling water was localized and confined close to the cooling water outfall. No unacceptable impact was identified and no additional survey for the project is considered necessary. Continuous monitoring of the temperature and flow rate of the spent cooling water discharged from the project is deemed adequate for the future EM&A programme.

1. INTRODUCTION

1.1 Scope of Report

This is the Final Report on the Measurement of Thermal Plume for the Operation of GT57 Combined Cycle Unit at Lamma Power Station. This report has been prepared by the Environmental Management Division of Hong Kong Productivity Council (HKPC) for submission to The Hongkong Electric Company Limited (HK Electric).

1.2 Structure of the Report

The structure of the report is as follows:

Section 1: **INTRODUCTION** – details the scope and structure of report.

Section 2: **PROJECT INFORMATION** – summarizes the background of the report.

Section 3: **MONITORING METHODOLOGY** – describes the survey locations, schedule, monitoring equipment to be used for the in-situ measurement

Section 4: **PRESENTATION AND ANALYSIS OF SURVEY RESULTS** – presents the survey results and the key findings.

Section 5: **DISCUSSIONS**

Section 6: **CONCLUSION AND RECOMMENDATIONS**

2. PROJECT BACKGROUND

Pursuant to the Environmental Monitoring and Audit (EM&A) Manual for the operation of GT57 Combined Cycle Unit, HK Electric shall carry out two thermal surveys to demonstrate that with the heat discharge from the GT57 and all the 8 existing coal-fired generating units for at least 3 hours the seawater temperatures at the sensitive receivers would not be raised by more than $2^{o}C$. With the operating of GT57 as a base-load unit since January 2010, the operating conditions suitable for the surveys could be available during L9 outages scheduled in May/June 2010.

On behalf of HK Electric, HKPC carried out two thermal surveys at both flood and ebb tides during the spring and neap on 17th May 2010 and 21st June 2010 respectively. The result of the surveys would determine if more thermal surveys for the project is required in future.

3. SURVEY METHODOLOGY

3.1 Survey Locations

A total of 7 inspection locations consisting of 4 sensitive receiver (SR) stations, 2 ambient (AM) stations, and 1 station close to the cooling water outfall (CW) were designated for the survey. The nature of these inspection stations is:-

- AM (AM1 & AM2) representing the locations undisturbed by the operation of GT57 combined cycle unit or other works
- SR (SR1, SR2, SR5, & SR6) representing the sensitive location required to be protected
- CW representing the location of initial mix up with the cooling water

Locations of the 7 stations are listed in Table 3.1, and are also depicted in Annex A.

Table 3.1 Co-ordinate of Monitoring Locations

Type	Station	Description	HK Metric Grid E	HK Metric Grid N
Sensitive Receiver Stations	SR1	Pak Kok	830 224	811 528
	SR2	Shek Kok Tsui	829 004	810 903
	*SR5	South Lamma Marine Park 1	829 977	805 758
	*SR6	South Lamma Marine Park 2	829 566	804 545
Ambient Stations	AM1	Ambient water quality conditions during the ebb tide	828 500	814 500
	AM2	Ambient water quality conditions during the flood tide	830 500	803 000
Station Close to the Cooling Water Outfalls 1&2	CW	Cooling water outfalls 1&2 serving Units L1-L8 & GT57	828 600	808 900

Note:

***SR5 and SR6 are "Potential Marine Park".**

3.2 Survey Schedule and Monitoring Parameters

Temperature measurement was conducted at 2 m below the water surface at all of the designated locations. Other additional parameters viz. salinity, conductivity, pH, dissolved oxygen (DO), current direction/speed, and water depth were also measured and recorded during the survey. The measurement schedule is summarized in Table 3.2.

Table 3.2 Schedule and Parameters of Water Quality Monitoring

Monitoring Station	Parameters Measured	Survey Schedule	No. of Depth
Sensitive Receivers SR1, SR2, SR5 & SR6 **Ambient Stations** AM1 & AM2 **Cooling Water Outfall** CW	Seawater temperature, in ^{o}C Salinity, in ppt Conductivity, in µS/cm pH Dissolved oxygen, in mg/L Current direction, in degree Current speed, in cm/s Water depth, in m	Two separate tidal cycles embracing spring tide on 17th May 2010 and neap tide on 21st June 2010	1 (2m below the water surface)

3.3 Monitoring Periods

The survey was carried out from 9:00 to 18:00 covering both flood and ebb tides on 17th May 2010 (spring tide) and 21st June 2010 (neap tide) as indicated in Table 3.3.

Table 3.3 Monitoring Period of the Survey

Monitoring Date	Monitoring Time	Tide Condition	Weather
17/05/2010 (Monday) – Spring Tide	9:00-10:52 10:52-18:00	Flood Ebb	Sunny Sunny
21/06/2010 (Monday) – Neap Tide	9:00-11:31 11:31-18:00	Ebb Flood	Cloudy Cloudy

3.4 Field Records and Meteorological Conditions

Field logs were maintained for all survey works, noting the date of the survey, equipment used, survey personnel and a record of all activities and observations.

Site observations found that there was no abnormality of the sea condition and no other works underway within the survey area throughout the course of the survey.

Meteorological observations for the two days of the survey were extracted from Cheung Chau Automatic Weather Station of Hong Kong Observatory as presented in Table 3.4.

Table 3.4 Meteorological Observations Extracted from Hong Kong Observatory

Date		17/05/2010	21/06/2010
Mean Pressure (hPa)		1011.5	1007.7
Air Temperature (^{o}C)	Max	28.1	32.9
	Mean	25.1	28.4
	Min	23.6	26.3
Mean Dew Point Temperature (^{o}C)		23.1	26.9
Relative Humidity (%)	Max	96	99
	Mean	89	92
	Min	75	75
Total Rainfall (mm)		0	0
Prevailing Wind Direction (Degrees)		100	200
Mean Wind Speed (km/h)		19.4	15.2

3.5 Monitoring Methodology

In order to achieve measurement at 1-hour interval for all stations, 2 vessels were employed at the same time for the survey, i.e. one for AM1, SR1, SR2 & CW, and the other for SR5, SR6 & AM2. The survey boats were guided by their own Global Positioning System (GPS) to the target location for measurement.

At every location, the depth of seawater was measured by using a depth meter. Afterwards, the seawater quality at 2 m below the water surface at that location was determined and these in-situ measurements were carried out in duplicates. In case the difference in the duplicate results was larger than 25%, a third set of measurement would be carried out for confirmation purpose. If the precision still exceeded the limit, the operator should report to and consult with the supervisor immediately. In addition, field information such as general meteorological conditions and observation regarding any significant activities at each monitoring location was also recorded.

3.6 Monitoring Equipment

The equipment deployed for the on-site measurement of marine water quality is summarized in Table 3.5.

Table 3.5 Equipment Used for Maine Water Monitoring

Equipment	Model No.
Water Depth	Eagle Fish ID 123 Depth Meter / Navman Fish 4100sh
GPS Natvigator	Furuno GP-32 GPS Navigator / Simrad MX 421B
Dissolved Oxygen Measuring Meter	YSI 6820 / YSI 556 Multiparameter System
pH meter	YSI 6820 / YSI 556 Multiparameter System
Salinity Meter	YSI 6820 / YSI 556 Multiparameter System
Water Temperature	YSI 6820 / YSI 556 Multiparameter System
Current Direction and Speed	Aanderaa Doppler Current Sensor

3.7 Equipment Calibration

The equipment deployed for field measurement of marine water quality was calibrated before use. The methodologies for the calibration are referred to the instruction manual provided by the manufacturers respectively. The calibration records are shown in Annex B. The results of calibration indicated that the equipment deployed for the in-situ measurement of marine water during the survey period were properly calibrated and operated in line with the required accuracy.

4. SURVEY RESULTS

4.1 General

The field records are provided in Annex C, Water Quality Monitoring Field Log. The data of monitoring parameters at each monitoring location in terms of arithmetic mean and ranges are summarized in Table 4.1. On the other hand, the results of Seawater Temperature, Dissolved Oxygen, Salinity, Conductivity and pH are presented graphically in Annex E.

Table 4.1 Water Quality Monitoring Results

Monitoring Parameter	Tide	Monitoring Station						
		AM1	AM2	SR1	SR2	SR5	SR6	CW
Survey Conducted on 17 May 2010 (Spring Tide)								
Seawater Temperature, ^{o}C	Ebb	24.7 (24.5-25.0)	24.7 (24.3-24.9)	24.8 (24.7-24.9)	25.0 (24.6-25.2)	24.7 (24.1-25.0)	24.7 (24.1-25.0)	26.5 (24.8-29.6)
	Flood	24.3 (24.2-24.4)	24.1 (23.9-24.2)	24.4 (24.3-24.4)	24.5 (24.5-24.6)	24.0 (23.9-24.1)	24.0 (24.0-24.1)	26.5 (26.5-26.5)
Dissolved Oxygen, mg/L	Ebb	6.3 (5.3-8.8)	7.0 (5.6-8.3)	6.2 (5.4-6.9)	6.4 (5.3-6.9)	6.5 (5.9-7.5)	6.4 (5.9-7.2)	6.5 (5.5-8.9)
	Flood	5.7 (5.6-5.9)	7.5 (7.3-7.6)	5.7 (5.4-6.0)	6.4 (6.3-6.5)	6.5 (6.4-6.6)	6.2 (5.8-6.6)	5.9 (5.9-5.9)
Salinity, ppt	Ebb	32.3 (29.8-34.4)	33.1 (31.5-34.6)	32.1 (30.6-34.5)	32.0 (31.2-32.9)	33.9 (32.6-34.7)	33.4 (32.3-34.9)	33.3 (30.6-34.6)
	Flood	32.5 (32.4-32.5)	32.7 (30.9-34.4)	32.7 (32.2-33.0)	32.8 (32.6-33.1)	34.0 (33.5-34.4)	33.3 (32.4-34.2)	34.6 (34.6-34.6)
Conductivity, mS/cm	Ebb	49.2 (45.8-51.3)	50.1 (48.0-51.6)	48.4 (46.7-51.3)	48.6 (47.7-49.4)	51.0 (49.8-51.9)	50.6 (49.0-53.0)	52.4 (46.7-57.4)
	Flood	48.9 (48.8-49.0)	48.6 (45.9-51.3)	49.4 (48.8-50.0)	49.6 (49.1-50.1)	50.8 (50.4-51.3)	50.2 (49.3-51.0)	54.1 (54.1-54.1)
pH (note 2)	Ebb	8.3 (8.2-8.6)	8.3 (8.2-8.6)	8.4 (8.2-8.5)	8.2 (8.1-8.4)	8.4 (8.2-8.4)	8.3 (8.2-8.5)	8.4 (8.1-8.5)
	Flood	8.2 (8.2-8.2)	8.2 (8.0-8.4)	8.2 (8.2-8.2)	8.2 (8.2-8.3)	8.3 (8.2-8.4)	8.2 (8.2-8.3)	8.4 (8.3-8.4)
Survey Conducted on 21 June 2010 (Neap Tide)								
Seawater Temperature, ^{o}C	Ebb	27.8 (27.6-27.9)	28.1 (28.0-28.2)	28.2 (28.0-28.4)	28.3 (28.2-28.3)	28.2 (28.0-28.4)	28.1 (27.9-28.5)	31.7 (30.5-33.0)
	Flood	28.3 (27.4-28.9)	28.8 (28.4-29.3)	28.5 (28.0-28.9)	28.6 (27.7-29.4)	29.1 (28.5-29.8)	28.9 (28.5-29.2)	30.5 (29.7-32.0)
Dissolved Oxygen, mg/L	Ebb	5.8 (5.1-6.3)	7.3 (7.1-7.6)	6.9 (6.2-7.9)	7.6 (7.1-7.9)	7.2 (6.7-7.7)	6.9 (6.6-7.1)	6.6 (6.1-7.1)
	Flood	6.3 (5.2-8.6)	8.3 (7.1-9.4)	6.6 (5.9-7.4)	6.6 (5.2-7.6)	8.7 (7.7-10.7)	8.3 (7.7-8.9)	8.0 (6.0-9.3)
Salinity, ppt	Ebb	23.8 (22.0-25.5)	21.2 (21.1-21.4)	23.3 (23.0-23.7)	23.1 (23.0-23.1)	22.9 (22.1-23.5)	23.2 (22.5-23.8)	23.2 (23.1-23.4)
	Flood	22.9 (21.6-24.6)	22.1 (19.1-24.0)	21.8 (20.9-24.4)	22.3 (20.8-24.9)	23.6 (23.3-23.9)	23.7 (22.4-24.9)	22.0 (20.4-24.5)
Conductivity, mS/cm	Ebb	37.6 (35.1-40.0)	33.6 (33.4-33.8)	36.9 (36.6-37.4)	36.6 (36.5-36.7)	36.4 (35.0-37.4)	36.7 (35.9-37.7)	37.0 (36.8-37.2)
	Flood	36.4 (34.5-38.7)	35.3 (30.3-38.3)	34.7 (33.4-38.2)	35.5 (33.3-39.2)	38.0 (37.4-38.5)	38.0 (36.0-40.0)	35.2 (32.8-38.8)
pH (note 2)	Ebb	8.0 (7.9-8.1)	8.1 (8.1-8.1)	8.2 (8.1-8.2)	8.2 (8.2-8.3)	8.1 (8.1-8.2)	8.1 (8.1-8.1)	8.2 (8.2-8.3)
	Flood	8.0 (7.9-8.3)	8.3 (8.0-8.5)	8.1 (8.0-8.3)	8.1 (8.0-8.3)	8.5 (8.4-8.7)	8.4 (8.3-8.6)	8.4 (8.2-8.5)

Notes:

1. Data in brackets indicate the ranges.
2. The figures in pH are presented in arithmetical mean for easy reference only. The individual figures please refer to Annex D, Water Quality Monitoring Field Log.

4.2 Temperature Results

The seawater temperatures measured at AM (AM1 & AM2) at the tidal conditions are presented in Annex D. The temperature of AM could serve as the background levels to check if temperature rise taking place at the inspection stations SR & CW. Table 4.2 summarizes the temperature differences between the inspection stations (SR & CW) and the ambient stations (AM). Besides, the temperature differences are also presented graphically in section E1 of Annex E.

Obviously, the seawater temperature at CW was higher than that at AM in the range from 0.2 ^{o}C to 5.1 ^{o}C. However, the heat from the cooling water could only raise the temperature of SR no more than 0.8 ^{o}C as comparison with the seawater temperature at AM.

Table 4.2 Temperature Rise at the Sensitive Receivers and Cooling Water Outfall

Monitoring Station	Measurement Time	Tidal Condition	Seawater Temp. (S), ^{o}C	Ambient Temp. (A), ^{o}C	Temperature Rise, ^{o}C (S – A)
Monitoring on 17 May 2010 (Spring Tide)					
CW	9:51	Flood	26.5	24.2	2.3
	10:57	Ebb	26.4	24.0	2.4
	11:52	Ebb	25.4	24.5	0.9
	12:53	Ebb	26.0	24.7	1.3
	13:49	Ebb	24.8	24.6	0.2
	14:51	Ebb	26.5	24.6	1.9
	15:52	Ebb	25.4	24.8	0.6
	16:52	Ebb	29.6	24.8	4.8
	17:52	Ebb	28.3	24.9	3.4
SR1	9:25	Flood	24.3	24.2	0.1
	10:23	Flood	24.4	24.0	0.4
	11:28	Ebb	24.7	24.5	0.2
	12:30	Ebb	24.8	24.7	0.1
	13:29	Ebb	24.9	24.6	0.3
	14:29	Ebb	24.9	24.6	0.3
	15:32	Ebb	24.9	24.8	0.1
	16:31	Ebb	24.8	24.8	0
	17:28	Ebb	24.9	24.9	0
SR2	9:38	Flood	24.6	24.2	0.4
	10:42	Flood	24.5	24.0	0.5
	11:39	Ebb	24.6	24.5	0.1
	12:39	Ebb	24.8	24.7	0.1
	13:37	Ebb	25.1	24.6	0.5
	14:39	Ebb	25.1	24.6	0.5
	15:41	Ebb	25.2	24.8	0.4
	16:40	Ebb	25.0	24.8	0.2
	17:38	Ebb	25.0	24.9	0.1
SR5	9:20	Flood	24.0	24.2	0
	10:20	Flood	24.0	24.0	0
	11:20	Ebb	24.2	24.5	0
	12:20	Ebb	24.7	24.7	0
	13:20	Ebb	25.0	24.6	0.4
	14:20	Ebb	24.6	24.6	0
	15:18	Ebb	24.8	24.8	0
	16:20	Ebb	24.9	24.8	0.1
	17:20	Ebb	24.8	24.9	0
SR6	9:30	Flood	24.1	24.2	0
	10:31	Flood	24.0	24.0	0
	11:30	Ebb	24.1	24.5	0
	12:30	Ebb	24.6	24.7	0
	13:32	Ebb	24.8	24.6	0.2
	14:29	Ebb	24.8	24.6	0.2
	15:30	Ebb	24.9	24.8	0.1
	16:30	Ebb	24.7	24.8	0
	17:33	Ebb	25.0	24.9	0.1

Table 4.2 (Cont'd) Temperature Rise at the Sensitive Receivers and Cooling Water Outfall

Monitoring Station	Measurement Time	Tidal Condition	Seawater Temp. (S), ^{o}C	Ambient Temp. (A), ^{o}C	Temperature Rise, ^{o}C (S – A)
Monitoring on 21 June 2010 (Neap Tide)					
CW	9:43	Ebb	30.5	27.6	2.9
	10:41	Ebb	33.0	27.9	**5.1**
	11:44	Flood	32.0	28.5	3.5
	12:39	Flood	30.3	28.4	1.9
	13:39	Flood	29.7	28.6	1.1
	14:41	Flood	30.2	29.0	1.2
	15:38	Flood	31.4	29.3	2.1
	16:41	Flood	29.8	29.0	0.8
	17:50	Flood	29.8	29.1	0.7
SR1	9:23	Ebb	28.4	27.6	**0.8**
	10:23	Ebb	28.2	27.9	0.3
	11:23	Ebb	28.0	27.9	0.1
	12:20	Flood	28.0	28.4	0
	13:18	Flood	28.6	28.6	0
	14:16	Flood	28.6	29.0	0
	15:19	Flood	28.4	29.3	0
	16:16	Flood	28.9	29.0	0
	17:19	Flood	28.6	29.1	0
SR2	9:31	Ebb	28.3	27.6	0.7
	10:01	Ebb	28.2	27.9	0.3
	11:32	Flood	27.7	28.5	0
	12:27	Flood	28.1	28.4	0
	13:28	Flood	28.5	28.6	0
	14:25	Flood	28.6	29.0	0
	15:27	Flood	29.4	29.3	0.1
	16:24	Flood	29.3	29.0	0.3
	17:29	Flood	28.4	29.1	0
SR5	9:10	Ebb	28.0	27.6	0.4
	10:10	Ebb	28.4	27.9	0.5
	11:11	Ebb	28.1	27.9	0.2
	12:15	Flood	28.5	28.4	0.1
	13:20	Flood	29.0	28.6	0.4
	14:18	Flood	29.8	29.0	**0.8**
	15:15	Flood	28.7	29.3	0
	16:14	Flood	29.3	29.0	0.3
	17:15	Flood	29.2	29.1	0.1
SR6	9:25	Ebb	28.1	27.6	0.5
	10:26	Ebb	28.5	27.9	0.6
	11:28	Ebb	27.9	27.9	0
	12:30	Flood	28.5	28.4	0.1
	13:38	Flood	28.7	28.6	0.1
	14:35	Flood	28.9	29.0	0
	15:33	Flood	29.2	29.3	0
	16:30	Flood	29.1	29.0	0.1
	17:33	Flood	29.0	29.1	0

Table 4.3 Flow Rate, Inlet and Outlet Temperature of Cooling Water at C.W. System No.1 Serving Units L1-L6 & GT57 Condensers from HK Electric's Plant Computer

Hour	17 May 2010 (Spring Tide)			21 June 2010 (Neap Tide)		
	Flow Rate (m^3/s)	Inlet Temp (^oC)	Outlet Temp (^oC)	Flow Rate (m^3/s)	Inlet Temp (^oC)	Outlet Temp (^oC)
0	35.4	24.0	27.8	53.0	27.5	32.0
1	34.7	24.0	27.8	49.9	27.2	31.3
2	48.3	24.0	27.5	41.0	27.3	31.4
3	48.1	24.0	27.4	41.1	27.2	31.3
4	47.7	23.9	27.4	53.5	27.4	31.4
5	47.9	23.9	27.5	55.7	27.4	31.2
6	48.9	23.9	27.7	58.6	27.4	31.3
7	53.6	24.0	28.0	59.4	27.7	32.3
8	58.6	24.0	28.7	63.4	27.9	33.6
9	58.6	24.0	29.5	63.7	28.3	35.2
10	58.5	24.2	30.0	63.3	28.5	35.9
11	58.5	24.3	30.5	62.7	28.4	36.0
12	58.3	24.4	30.6	63.5	28.0	35.7
13	57.8	24.4	30.6	63.9	27.4	35.0
14	57.3	24.6	30.8	63.8	27.5	35.1
15	56.7	24.7	30.9	63.9	27.6	35.1
16	56.1	24.8	31.0	64.0	27.4	34.8
17	55.8	24.7	31.0	64.1	27.2	34.5
18	55.7	24.7	30.7	64.2	27.4	34.4
19	56.0	24.7	30.0	62.7	27.5	34.2
20	56.3	24.4	29.4	55.7	27.9	34.2
21	56.6	24.4	29.1	62.1	28.0	33.7
22	56.9	24.3	28.6	63.4	28.1	33.3
23	50.0	24.2	28.3	63.5	28.1	32.7

Table 4.4 Flow Rate, Inlet and Outlet Temperature of Cooling Water at C.W. System No.2 Serving Units L7 and L8 Condensers from HK Electric's Plant Computer

Hour	17 May 2010 (Spring Tide)			21 June 2010 (Neap Tide)		
	Flow Rate (m^3/s)	Inlet Temp (^oC)	Outlet Temp (^oC)	Flow Rate (m^3/s)	Inlet Temp (^oC)	Outlet Temp (^oC)
0	26.2	24.0	27.4	25.7	27.5	32.9
1	16.7	24.0	27.0	13.2	27.2	31.6
2	15.3	24.0	26.9	25.1	27.3	31.5
3	19.5	24.0	26.9	25.9	27.4	31.2
4	25.9	24.0	27.0	25.8	27.5	31.1
5	26.1	24.0	27.0	25.9	27.5	31.2
6	26.2	24.0	27.2	25.7	27.7	32.3
7	26.4	24.0	28.8	25.6	27.9	33.8
8	26.4	24.0	30.2	25.5	28.1	35.0
9	26.4	24.0	30.8	25.4	28.4	35.4
10	26.4	24.1	31.4	25.3	28.6	35.6
11	26.4	24.2	31.2	25.3	28.5	35.5
12	26.3	24.3	31.3	25.3	28.2	35.2
13	26.2	24.4	31.5	25.4	27.5	34.5
14	25.9	24.5	31.6	25.5	27.6	34.6
15	25.7	24.8	32.0	25.5	27.7	34.8
16	25.5	24.9	32.1	25.5	27.5	34.6
17	25.4	24.8	32.0	25.5	27.3	34.4
18	25.4	24.7	31.9	25.6	27.6	34.6
19	25.5	24.6	31.8	25.5	27.7	34.7
20	25.6	24.5	30.8	25.5	28.1	35.1
21	25.7	24.4	30.2	25.4	28.2	35.2
22	25.8	24.4	29.6	25.4	28.3	34.9
23	25.8	24.2	29.1	25.4	28.2	34.2

Note: Unit L9 served by CW System No.3 was not on load during the surveys on 17 May 2010 and 21 June 2010.

Table 4.5 Total Heat Rejection from Lamma Power Station

Hour	17 May 2010 (Spring Tide)	21 June 2010 (Neap Tide)
	(Gcal/hr)	(Gcal/hr)
0	771	1296
1	627	901
2	740	931
3	767	917
4	835	1056
5	859	1074
6	932	1197
7	1178	1465
8	1513	1850
9	1729	2114
10	1831	2228
11	1874	2250
12	1878	2288
13	1863	2297
14	1866	2303
15	1857	2271
16	1844	2250
17	1823	2226
18	1773	2168
19	1663	2045
20	1533	1823
21	1438	1818
22	1315	1702
23	1143	1535

5 DISCUSSIONS

The Water Quality Objectives (WQO) for the Southern Water Control Zone stipulates that the temperature rise in the water column due to human activity should not exceed 2^{o}C. In other words, the temperature difference between SR and AM should be no more than 2^{o}C.

Based on the survey results, all the temperature elevations at the sensitive receiver stations (SR) were in the range of 0.0 ^{o}C – 0.8 ^{o}C, which was lower than the requirement of 2 ^{o}C.

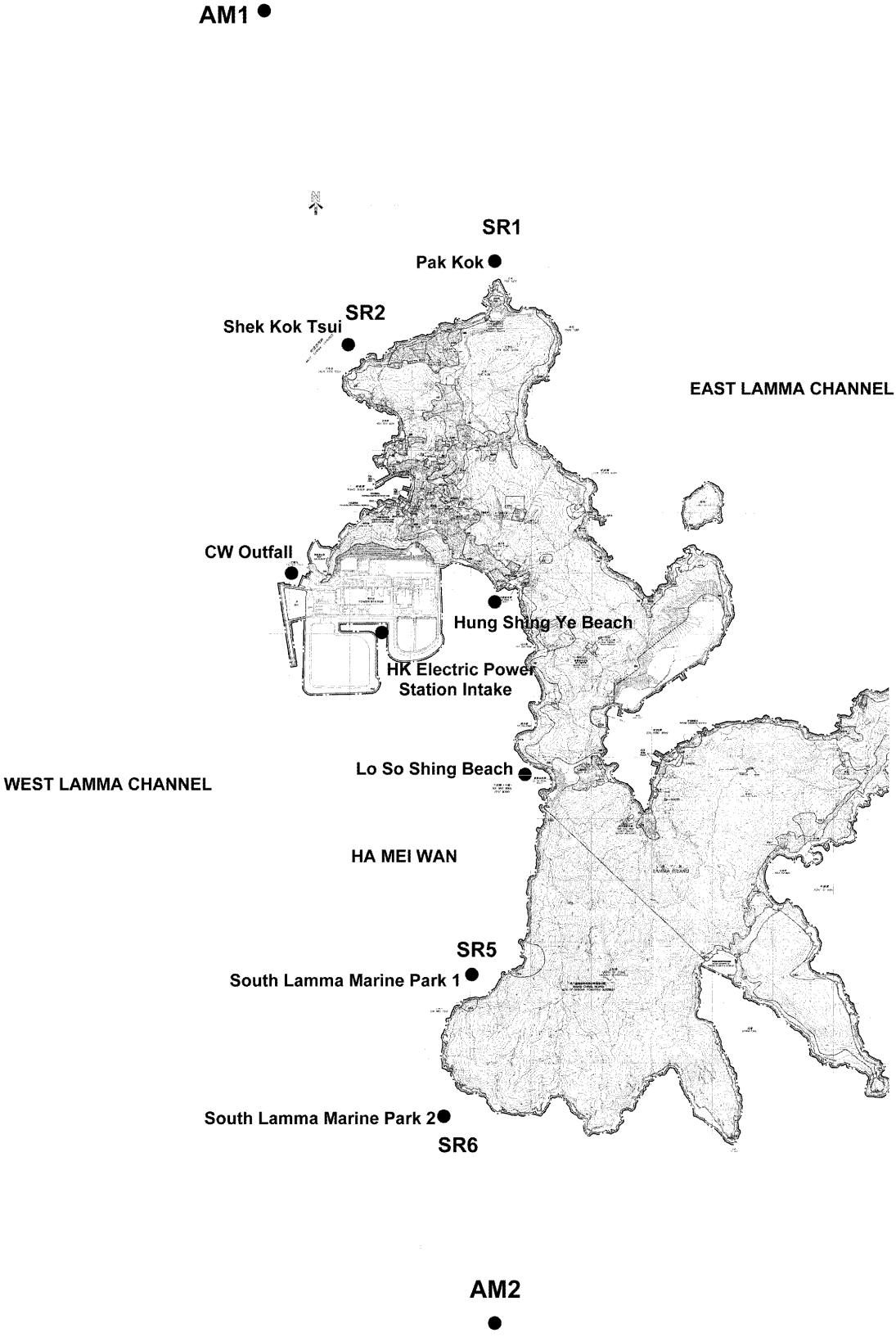
6 CONCLUSION AND RECOMMENDATIONS

Two thermal surveys were carried out at both flood and ebb tides during spring tide on 17 May 2010 and neap tide on 21 June 2010 to demonstrate that the heat discharge from the combined cycle unit GT57 and the existing coal-fired generating units did not cause any impact on the seawater temperatures at the sensitive receivers (SR) in comparison with the background seawater temperature. In fact, the temperature at the SR only increased by 0.0 ^{o}C to 0.8 ^{o}C against the ambient seawater temperature during the survey, which complied with the requirement of less than 2 ^{o}C. No unacceptable impact was identified and no additional survey for the project is considered necessary. Continuous monitoring of the temperature and flow rate of the spent cooling water discharged from the project is deemed adequate for the future EM&A programme.

- END -

ANNEX A

Figure Showing Marine Water Monitoring Locations


AM1
SR1
Pak Kok
SR2
Shek Kok Tsui
EAST LAMMA CHANNEL
CW Outfall
Hung Shing Ye Beach
HK Electric Power
Station Intake
WEST LAMMA CHANNEL
Lo So Shing Beach
HA MEI WAN
SR5
South Lamma Marine Park 1
South Lamma Marine Park 2
SR6
AM2

ANNEX B

Calibration Records of Water Quality Monitoring Equipment

Hong Kong Productivity Council
香港生產力促進局

Environmental Management Division

CALIBRATION REPORT

Client : Hong Kong Productivity Council
Address : Environment and Product Innovation Laboratory
3/F HKPC Building
78 Tat Chee Avenue
Kowloon Tong, Kowloon.

Report No. : CR 000094R
Page No. : 1 of 4
Issue Date : 22/04/2010

Received Date : 19/04/2010
Completion Date : 20/04/2010
Approved Signatory : Fung Kam Wing
Remarks :

Calibration Results:

Item : YSI Model 6820

Serial No. : 02M0667AA

Calibration Method : APHA 18e 2520 A & B

Date of Calibration : 20/04/2010

Results :

Salinity

Expected Reading (ppt)	Recorded Reading (ppt)	% Difference from Expected
0	0	0
7.4	7.36	-0.54
15	14.90	-0.67
35	34.20	-2.3
39.3	39.90	1.5

Remarks : Permissible tolerance of calibration is ± 5% difference from the expected value.

Approval Signatory:

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Hong Kong Productivity Council
香港生產力促進局

Environmental Management Division

CALIBRATION REPORT

Client : Hong Kong Productivity Council
Address : Environment and Product Innovation Laboratory
3/F HKPC Building
78 Tat Chee Avenue
Kowloon Tong, Kowloon.

Report No. : CR 000094R
Page No. : 2 of 4
Issue Date : 22/04/2010

Received Date : 19/04/2010
Completion Date : 20/04/2010
Approved Signatory : Fung Kam Wing
Remarks :

Calibration Results:

Item : YSI Model 6820

Serial No. : 02M0667AA

Calibration Method : In house method

Date of Calibration : 20/04/2010

Results: :

Temperature

Expected Reading (°C)	Recorded Reading (°C)	% Difference from Expected
10.0	10.21	2.1
20.0	20.85	4.3
30.0	30.96	3.2
40.0	40.74	1.9

Remarks : Permissible tolerance of calibration is ± 5% difference from the expected value.

Approval Signatory:

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CALIBRATION REPORT

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Report No. : CR 000094R
Page No. : 3 of 4
Issue Date : 22/04/2010

Received Date : 19/04/2010
Completion Date : 20/04/2010
Approved Signatory : Fung Kam Wing
Remarks :

Calibration Results:

Item : YSI Model 6820

Serial No. : 02M0667AA

Calibration Method : APHA 18e 4500-O A, B, C & D

Date of Calibration : 20/04/2010

Results :

Dissolved Oxygen

Expected Reading (mg/L)	Recorded Reading (mg/L)	% Difference from Expected
3.00	3.12	4.0
4.85	4.96	2.3
6.40	6.44	0.63
7.55	7.53	-0.26
8.60	8.67	0.81

Remarks : Permissible tolerance of calibration is ± 5% difference from the expected value.

Approval Signatory:

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Hong Kong Productivity Council
香港生產力促進局

Environmental Management Division

CALIBRATION REPORT

Client : Hong Kong Productivity Council
Address : Environment and Product Innovation Laboratory
3/F HKPC Building
78 Tat Chee Avenue
Kowloon Tong, Kowloon.

Report No. : CR 000094R
Page No. : 4 of 4
Issue Date : 22/04/2010

Received Date : 19/04/2010
Completion Date : 20/04/2010
Approved Signatory : Fung Kam Wing
Remarks :

Calibration Results:

Item : YSI Model 6820

Serial No. : 02M0667AA

Calibration Method : In house method

Date of Calibration : 20/04/2010

Results :

pH

Expected Reading (pH unit)	Recorded Reading (pH unit)	Difference from Expected
4.00	4.08	+0.08 pH unit
7.00	7.05	+0.05 pH unit
10.0	10.08	+0.08 pH unit

Remarks : Permissible tolerance of calibration is ± 0.2 units from the expected value.

Approval Signatory:

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Environmental Management Division

CALIBRATION REPORT

Client : Hong Kong Productivity Council
Address : Environment and Product Innovation Laboratory
3/F HKPC Building
78 Tat Chee Avenue
Kowloon Tong, Kowloon.

Report No. : CR 000096
Page No. : 1 of 1
Issue Date : 13/05/2010

Received Date : 10/05/2010
Completion Date : 10/05/2010
Approved Signatory : Fung Kam Wing
Remarks :

Calibration Results:

Item : YSI Model 6820

Serial No. : 02M0667AA

Calibration Method : APHA 18e 2510B

Date of Calibration : 10/05/2010

Results :

Salinity

Expected Reading (mS/cm)	Recorded Reading (mS/cm)	% Difference from Expected
0	0	0
12.89	12.62	-2.1
24.80	25.31	2.1
58.67	59.62	1.6

Remarks : Permissible tolerance of calibration is ± 5% difference from the expected value.

Approval Signatory:

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Environmental Management Division

CALIBRATION REPORT

Client : Hong Kong Productivity Council
Address : Environment and Product Innovation Laboratory
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78 Tat Chee Avenue
Kowloon Tong, Kowloon.

Report No. : CR 000095R
Page No. : 1 of 4
Issue Date : 22/04/2010

Received Date : 19/04/2010
Completion Date : 20/04/2010
Approved Signatory : Fung Kam Wing
Remarks :

Calibration Results:

Item : YSI Model 556MPS

Serial No. : 07L100507

Calibration Method : APHA 18e 2520 A & B

Date of Calibration : 20/04/2010

Results :

Salinity

Expected Reading (ppt)	Recorded Reading (ppt)	% Difference from Expected
0	0	0
7.4	7.32	-1.1
15	14.88	-0.80
35	34.00	-2.9
39.3	39.40	0.25

Remarks : Permissible tolerance of calibration is ± 5% difference from the expected value.

Approval Signatory:

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Hong Kong Productivity Council
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Environmental Management Division

CALIBRATION REPORT

Client : Hong Kong Productivity Council
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Report No. : CR 000095R
Page No. : 2 of 4
Issue Date : 22/04/2010

Received Date : 19/04/2010
Completion Date : 20/04/2010
Approved Signatory : Fung Kam Wing
Remarks :

Calibration Results:

Item : YSI Model 556MPS

Serial No. : 07L100507

Calibration Method : In house method

Date of Calibration : 20/04/2010

Results :

Temperature

Expected Reading (℃)	Recorded Reading (℃)	% Difference from Expected
10.0	9.87	-1.3
20.0	20.56	2.8
30.0	30.69	2.3
40.0	40.84	2.1

Remarks : Permissible tolerance of calibration is ± 5% difference from the expected value.

Approval Signatory:

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Report No. : CR 000095R
Page No. : 3 of 4
Issue Date : 22/04/2010

Received Date : 19/04/2010
Completion Date : 20/04/2010
Approved Signatory : Fung Kam Wing
Remarks :

Calibration Results:

Item : YSI Model 556MPS

Serial No. : 07L100507

Calibration Method : APHA 18e 4500-O A, B, C & D

Date of Calibration : 20/04/2010

Results :

Dissolved Oxygen

Expected Reading (mg/L)	Recorded Reading (mg/L)	% Difference from Expected
3.00	3.08	2.7
4.85	4.94	1.9
6.40	6.63	3.6
7.55	7.63	1.1
8.60	8.37	-2.7

Remarks : Permissible tolerance of calibration is ± 5% difference from the expected value.

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Report No. : CR 000095R
Page No. : 4 of 4
Issue Date : 22/04/2010

Received Date : 19/04/2010
Completion Date : 20/04/2010
Approved Signatory : Fung Kam Wing
Remarks :

Calibration Results:

Item : YSI Model 556MPS

Serial No. : 07L100507

Calibration Method : In house method

Date of Calibration : 20/04/2010

Results :

pH

Expected Reading (pH unit)	Recorded Reading (pH unit)	Difference from Expected
4.00	3.95	-0.05 pH unit
7.00	6.98	-0.02 pH unit
10.0	10.01	+0.01 pH unit

Remarks : Permissible tolerance of calibration is ± 0.2 units from the expected value.

Approval Signatory:

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Environmental Management Division

CALIBRATION REPORT

Client : Hong Kong Productivity Council
Address : Environment and Product Innovation Laboratory
3/F HKPC Building
78 Tat Chee Avenue
Kowloon Tong, Kowloon.

Report No. : CR 000097
Page No. : 1 of 1
Issue Date : 13/05/2010

Received Date : 10/05/2010
Completion Date : 10/05/2010
Approved Signatory : Fung Kam Wing
Remarks :

Calibration Results:

Item : YSI Model 556MPS

Serial No. : 07L100507

Calibration Method : APHA 18e 2510 B

Date of Calibration : 10/05/2010

Results :

Salinity

Expected Reading (mS/cm)	Recorded Reading (mS/cm)	% Difference from Expected
0	0	0
12.89	13.01	0.93
24.80	24.39	-1.7
58.67	57.39	-2.2

Remarks : Permissible tolerance of calibration is ± 5% difference from the expected value.

Approval Signatory:

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ANNEX C

Water Quality Monitoring Field Logs

Hong Kong Productivity Council 香港生產力促進局

Environmental Management Division

Measurement of Thermal Plume for The Operation of GT57 Combined Cycle Unit at Lamma Power Station

Team No.: 1 (North of Lamma Island) Client : The Hong Kong Electric Co., Ltd. Monitoring Site : Lamma Island Page No. : 1 of 2

Monitoring Date : 17/05/10 Tide : Spring Weather Condition: *Sunny / ~~Cloudy~~ / ~~Overcast~~ / ~~Rainy~~

Equipment : (*~~Furuno GP-32~~/Simrad MX 421B) GPS Natvigator, YSI 6820 / ~~YSI 556~~ Water Quality Monitor, (*Eagle Fish ID 128/~~Navman Fish 4100sh~~) Depth Meter Sea Condition: *~~Calm~~ / Moderate / ~~Rough~~

Monitoring Location	Measurement Time	Water Depth(m)	Current Speed (cm/s)		Current Direction (in deg.)		DO (mg/L)		Sea Water Temp (°C)		Salinity (ppt)		Conductivity (mS/cm)		pH		Other Observation
			1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	
AM1	9:00	13.8	31.38	35.89	54	59	5.57	5.60	24.23	24.25	32.40	32.39	48.81	48.81	8.23	8.24	Nil
SR1	9:25	24.3	29.92	27.57	4	11	5.43	5.60	24.33	24.32	32.33	32.24	48.82	48.83	8.16	8.15	Nil
SR2	9:38	10.5	28.16	27.81	111	104	6.33	6.30	24.58	24.60	33.09	33.07	50.07	50.07	8.31	8.30	Nil
CW	9:51	9.7	4.11	5.57	231	327	5.90	5.88	26.47	26.49	34.57	34.55	54.08	54.09	8.36	8.34	Nil
AM1	10:08	14.2	10.27	12.48	34	38	5.83	5.92	24.35	24.39	32.54	32.54	49.03	49.02	8.22	8.23	Nil
SR1	10:23	25.6	26.45	28.54	21	26	6.02	5.78	24.42	24.40	33.02	33.02	49.94	49.95	8.23	8.21	Nil
SR2	10:42	11.2	11.15	12.31	150	126	6.54	6.25	24.48	24.49	32.58	32.59	49.10	49.12	8.17	8.15	Nil
CW	10:57	9.0	17.01	18.82	51	47	6.13	6.10	26.36	26.38	34.57	34.59	54.33	54.44	8.36	8.34	Nil
AM1	11:18	15.0	25.22	24.58	45	40	6.83	6.92	24.45	24.47	33.28	33.29	51.24	51.24	8.25	8.26	Nil
SR1	11:28	25.4	21.41	18.58	120	110	5.90	6.02	24.69	24.67	32.29	32.29	48.90	48.92	8.38	8.38	Nil
SR2	11:39	10.9	22.58	21.83	230	215	6.90	6.58	24.63	24.64	32.33	32.33	48.83	48.83	8.16	8.18	Nil
CW	11:52	9.2	13.49	15.28	321	310	7.28	7.14	25.34	25.39	30.60	30.60	46.69	46.69	8.23	8.24	Nil
AM1	12:17	14.3	28.45	32.32	90	80	5.48	5.83	24.67	24.65	34.42	34.42	51.26	51.25	8.22	8.20	Nil
SR1	12:30	24.3	17.60	20.49	101	95	6.28	5.99	24.79	24.77	34.44	34.45	51.27	51.26	8.43	8.41	Nil
SR2	12:39	10.8	30.00	33.43	47	59	5.85	6.02	24.73	24.76	31.93	31.94	47.98	47.98	8.25	8.23	Nil
CW	12:53	9.0	16.13	18.84	53	59	6.98	6.78	25.98	25.95	31.43	31.44	47.08	47.09	8.15	8.14	Nil
AM1	13:15	14.2	42.82	43.99	125	139	6.22	6.19	24.58	24.59	33.35	33.34	51.29	51.23	8.28	8.29	Nil
SR1	13:29	23.5	16.13	13.20	282	275	6.38	6.43	24.88	24.85	32.38	32.37	49.02	49.03	8.32	8.35	Nil
SR2	13:37	11.1	11.10	7.33	20	20	6.33	6.30	25.11	25.10	31.49	31.46	48.37	48.47	8.38	8.37	Nil
CW	13:49	9	16.16	14.48	163	200	8.86	8.71	24.84	24.83	34.56	34.57	51.67	51.59	8.48	8.46	Nil
AM1	14:14	13.8	20.82	25.52	152	167	8.83	8.67	24.61	24.63	32.39	32.38	49.14	49.14	8.59	8.60	Nil
SR1	14:29	23.0	27.55	27.57	71	74	6.28	6.30	24.87	24.89	31.89	31.91	48.63	48.67	8.49	8.50	Nil
SR2	14:39	10.5	14.66	16.48	122	125	6.74	6.59	25.05	25.07	31.58	31.58	48.49	48.47	8.28	8.27	Nil
CW	14:51	8.5	29.92	29.33	67	59	5.94	5.97	26.49	26.51	34.61	34.60	55.96	55.97	8.51	8.50	Nil
AM1	15:17	13.6	10.56	12.21	246	265	5.56	5.54	24.77	24.80	29.77	29.79	45.78	45.81	8.32	8.34	Nil
SR1	15:32	23.2	16.42	16.72	191	201	6.92	6.89	24.88	24.86	30.60	30.59	46.69	46.70	8.49	8.50	Nil
SR2	15:41	10.0	18.77	17.30	144	128	6.93	6.90	25.24	25.22	31.17	31.18	47.72	47.71	8.31	8.30	Nil
CW	15:52	8.0	19.27	22.26	151	165	5.77	5.75	25.35	25.37	32.38	32.34	49.83	49.84	8.39	8.38	Nil

Prepared by : Joe Wong Date: 17/5/2010 Checked by K W Fung Date: 30/5/2010

Hong Kong Productivity Council 香港生產力促進局

Environmental Management Division

Measurement of Thermal Plume for The Operation of GT57 Combined Cycle Unit at Lamma Power Station

Team No.: 1 (North of Lamma Island) Client : The Hong Kong Electric Co., Ltd. Monitoring Site : Lamma Island Page No. : 2 of 2

Monitoring Date : 17/05/10 Tide : Spring Weather Condition: *Sunny / ~~Cloudy~~ / ~~Overcast~~ / ~~Rainy~~

Equipment : (*~~Furuno GP-32~~/Simrad MX 421B) GPS Natvigator, YSI 6820 / ~~YSI 556~~ Water Quality Monitor, (*Eagle Fish ID 128/~~Navman Fish 4100sh~~) Depth Meter Sea Condition: *~~Calm~~ / Moderate / ~~Rough~~

Monitoring Location	Measurement Time	Water Depth(m)	Current Speed (cm/s)		Current Direction (in deg.)		DO (mg/L)		Sea Water Temp (°C)		Salinity (ppt)		Conductivity (mS/cm)		pH		Other Observation
			1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	
AM1	16:16	13.7	39.60	35.84	271	280	5.78	5.39	24.82	24.81	30.22	30.23	46.59	46.58	8.24	8.23	Nil
SR1	16:31	22.8	26.08	29.83	217	245	6.03	6.23	24.78	24.76	31.43	31.43	47.03	47.05	8.29	8.27	Nil
SR2	16:40	10.3	16.13	14.89	207	204	6.48	6.43	24.98	24.96	32.84	32.85	49.35	49.32	8.14	8.11	Nil
CW	16:52	8.0	10.58	12.10	151	165	5.77	5.75	29.57	29.60	34.09	34.08	57.41	57.40	8.38	8.40	Nil
AM1	17:14	13.2	23.76	21.84	101	129	5.34	5.93	24.93	24.95	32.48	32.48	49.02	49.05	8.34	8.33	Nil
SR1	17:28	23.4	40.77	36.48	192	184	5.38	5.49	24.89	24.86	31.58	31.60	47.59	47.53	8.24	8.21	Nil
SR2	17:38	10.2	27.04	23.39	183	181	5.97	5.34	25.03	25.05	32.58	32.59	49.10	49.12	8.19	8.22	Nil
CW	17:52	8.2	21.41	24.98	158	161	5.54	5.57	28.31	28.30	33.83	33.84	55.90	55.90	8.32	8.34	Nil

Prepared by : Joe Wong Date: 17/5/2010 Checked by K W Fung Date: 30/5/2010

Hong Kong Productivity Council 香港生產力促進局

Environmental Management Division

Measurement of Thermal Plume for The Operation of GT57 Combined Cycle Unit at Lamma Power Station

Team No.: 2 (South of Lamma Island) Client : The Hong Kong Electric Co., Ltd. Monitoring Site : Lamma Island Page No. : 1 of 1

Monitoring Date : 17/05/10 Tide : Spring Weather Condition: *Sunny / ~~Cloudy~~ / ~~Overcast~~ / ~~Rainy~~

Equipment : (*Furuno GP-32/~~Simrad MX 421B~~) GPS Natvigator, ~~YSI 6820 /~~ YSI 556 Water Quality Monitor, (*~~Eagle Fish ID 128~~/Navman Fish 4100sh) Depth Meter Sea Condition: *~~Calm~~ / ~~Moderate~~ / ~~Rough~~

Monitoring Location	Measurement Time	Water Depth(m)	Current Speed (cm/s)		Current Direction (in deg.)		DO (mg/L)		Sea Water Temp (°C)		Salinity (ppt)		Conductivity (mS/cm)		pH		Other Observation
			1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2rd trial	
SR5	9:20	9.8	22.88	25.53	129	158	6.47	6.43	23.97	23.94	34.44	34.42	51.26	51.26	8.34	8.36	Nil
SR6	9:30	21.4	12.03	13.50	140	125	6.20	6.58	24.02	24.08	34.22	34.23	51.02	51.03	8.28	8.25	Nil
AM2	9:45	22.3	29.97	28.38	100	104	7.32	7.59	24.24	24.21	30.88	30.87	45.98	45.92	8.04	8.07	Nil
SR5	10:20	10.2	19.97	18.48	100	125	6.58	6.41	24.05	24.02	33.51	33.52	50.38	50.40	8.22	8.23	Nil
SR6	10:31	21.6	31.38	28.74	89	92	5.82	6.24	23.99	23.98	32.38	32.39	49.28	49.29	8.15	8.17	Nil
AM2	10:45	22.8	22.88	23.58	129	139	7.47	7.43	23.97	23.94	34.44	34.42	51.26	51.26	8.34	8.36	Nil
SR5	11:20	10.4	20.44	23.95	143	145	6.43	6.05	24.14	24.18	32.58	32.59	49.84	49.83	8.28	8.24	Nil
SR6	11:30	20.8	20.82	22.00	76	85	6.00	5.97	24.06	24.07	33.21	33.23	49.61	49.60	8.28	8.27	Nil
AM2	11:44	22.9	15.25	17.83	45	52	5.98	5.55	24.28	24.26	34.01	34.02	51.54	51.49	8.38	8.35	Nil
SR5	12:20	9.9	40.77	39.60	49	51	6.56	6.53	24.68	24.66	34.61	34.60	51.58	51.57	8.35	8.34	Nil
SR6	12:30	21.3	12.91	11.44	113	123	7.17	7.18	24.53	24.58	33.76	33.74	51.15	51.15	8.42	8.41	Nil
AM2	12:45	22.4	19.96	24.13	50	60	6.78	6.77	24.77	24.74	34.61	34.62	51.58	51.58	8.35	8.34	Nil
SR5	13:20	10.0	29.92	33.73	139	123	6.25	6.48	24.98	24.92	33.54	33.55	50.83	50.82	8.42	8.41	Nil
SR6	13:32	21.6	14.89	15.58	206	236	6.45	6.69	24.78	24.76	32.38	32.39	49.38	49.39	8.25	8.27	Nil
AM2	13:46	22.0	28.74	29.48	139	159	8.29	8.01	24.88	24.86	31.85	31.84	48.59	48.55	8.17	8.15	Nil
SR5	14:20	9.9	15.93	18.44	81	84	7.48	7.31	24.63	24.62	34.72	34.71	51.89	51.90	8.33	8.31	Nil
SR6	14:29	21.1	33.42	40.09	146	124	6.28	6.01	24.80	24.83	34.89	34.88	52.98	52.99	8.53	8.52	Nil
AM2	14:45	22.2	43.70	40.48	192	185	6.48	6.89	24.82	24.81	32.38	32.37	49.31	49.35	8.34	8.35	Nil
SR5	15:18	10.0	15.25	17.43	59	53	7.20	6.89	24.76	24.74	34.52	34.53	51.23	51.22	8.43	8.43	Nil
SR6	15:30	20.9	20.53	22.21	145	135	6.49	6.31	24.89	24.83	34.88	34.86	52.58	52.58	8.24	8.23	Nil
AM2	15:45	22.0	25.28	29.32	197	206	7.28	7.24	24.73	24.72	31.45	31.46	47.98	47.99	8.59	8.55	Nil
SR5	16:20	9.7	23.17	25.39	78	84	6.03	6.34	24.86	24.83	33.82	33.81	51.03	51.02	8.33	8.35	Nil
SR6	16:30	20.6	29.92	30.29	89	84	6.48	6.25	24.72	24.75	32.58	32.56	49.18	49.15	8.25	8.25	Nil
AM2	16:43	21.8	34.66	30.33	145	139	7.84	7.34	24.67	24.69	32.98	32.97	50.84	50.82	8.28	8.26	Nil
SR5	17:20	9.9	30.50	26.53	95	104	5.91	5.90	24.82	24.81	33.56	33.53	50.57	50.58	8.37	8.39	Nil
SR6	17:33	20.5	20.50	23.28	76	82	5.93	5.95	24.95	24.98	32.32	32.34	49.02	49.03	8.30	8.28	Nil
AM2	17:45	22.0	24.66	28.24	135	125	6.39	6.49	24.86	24.85	34.38	34.39	50.98	50.96	8.28	8.26	Nil

Prepared by : Yeung Date: 17/5/2010 Checked by : K W Fung Date: 30/5/2010

Hong Kong Productivity Council 香港生產力促進局

Environmental Management Division

Measurement of Thermal Plume for The Operation of GT57 Combined Cycle Unit at Lamma Power Station

Team No.: 1 (North of Lamma Island) Client : The Hong Kong Electric Co., Ltd. Monitoring Site : Lamma Island Page No. : 1 of 2

Monitoring Date : 21/06/10 Tide : Neap Weather Condition: *~~Sunny~~ / Cloudy / ~~Overcast~~ / ~~Rainy~~

Equipment : (*~~Furuno GP-32~~/Simrad MX 421B) GPS Natvigator, YSI 6820 / ~~YSI 556~~ Water Quality Monitor, (*Eagle Fish ID 128/~~Navman Fish 4100sh~~) Depth Meter Sea Condition: *~~Calm~~ / Moderate / ~~Rough~~

Monitoring Location	Measurement Time	Water Depth(m)	Current Speed (cm/s)		Current Direction (in deg.)		DO (mg/L)		Sea Water Temp (°C)		Salinity (ppt)		Conductivity (mS/cm)		pH		Other Observation
			1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	
AM1	9:07	13.1	7.63	7.33	151	161	5.97	5.96	27.56	27.55	25.48	25.48	39.99	39.97	8.05	8.05	Nil
SR1	9:23	24.9	12.61	12.03	287	308	7.86	7.89	28.43	28.40	23.04	23.04	36.58	36.58	8.24	8.24	Nil
SR2	9:31	10.9	21.41	22.58	308	309	7.94	7.90	28.29	28.26	23.08	23.12	36.63	36.70	8.26	8.25	Nil
CW	9:43	8.2	18.48	22.88	227	218	7.11	6.71	30.45	30.46	23.12	23.15	36.80	36.81	8.22	8.24	Nil
AM1	10:05	13.1	22.24	25.22	190	203	6.26	6.18	27.87	27.85	23.77	23.79	37.62	37.63	7.97	8.01	Nil
SR1	10:23	25.1	7.92	7.33	237	241	6.54	6.62	28.15	28.19	23.29	23.17	36.94	36.72	8.17	8.19	Nil
SR2	10:01	10.1	23.14	20.53	297	277	7.14	7.25	28.24	28.21	23.05	23.02	36.58	36.53	8.21	8.22	Nil
CW	10:41	7.9	20.24	18.48	142	146	6.10	6.51	33.04	32.92	23.31	23.39	37.24	37.24	8.26	8.27	Nil
AM1	11:06	13.2	10.85	11.44	227	222	5.40	5.08	27.90	27.93	22.01	22.02	35.09	35.10	7.92	7.93	Nil
SR1	11:23	23.1	30.80	29.60	238	249	6.52	6.19	27.95	27.98	23.65	23.64	37.44	37.42	8.11	8.13	Nil
SR2	11:32	10.2	31.68	30.21	212	214	5.18	5.25	27.67	27.72	24.87	24.86	39.16	39.14	8.04	8.02	Nil
CW	11:44	8.2	10.85	11.44	169	160	6.51	5.95	32.04	32.00	23.23	23.22	37.07	36.98	8.21	8.22	Nil
AM1	12:07	13.7	45.75	40.18	204	200	5.32	5.68	27.40	27.38	24.56	24.56	38.70	38.72	7.92	7.93	Nil
SR1	12:20	23.3	16.72	16.42	293	296	6.47	6.20	28.05	28.02	24.20	24.41	38.22	38.24	8.09	8.10	Nil
SR2	12:27	10.2	29.33	32.85	202	214	6.62	6.63	28.14	28.13	24.01	24.02	37.97	37.97	8.10	8.13	Nil
CW	12:39	8.0	27.28	25.22	163	151	6.64	6.23	30.35	30.30	24.48	24.52	38.73	38.77	8.16	8.17	Nil
AM1	13:00	13.7	33.44	30.50	315	306	5.53	5.23	28.44	28.46	21.61	21.60	34.54	34.50	7.97	7.97	Nil
SR1	13:18	24.6	40.77	36.08	301	299	6.01	5.94	28.65	28.61	20.85	20.85	33.43	33.43	7.99	8.01	Nil
SR2	13:28	10.9	14.08	15.54	207	215	6.08	6.48	28.45	28.46	20.79	20.78	33.36	33.33	7.97	8.01	Nil
CW	13:39	7.8	10.56	11.15	218	228	8.66	8.62	29.72	29.70	21.05	21.07	33.76	33.80	8.43	8.43	Nil
AM1	14:01	13.2	43.70	41.66	233	227	5.93	5.75	28.87	28.82	21.91	21.91	34.97	34.87	7.96	8.01	Nil
SR1	14:16	24.5	15.25	14.66	315	315	6.30	6.35	28.60	28.62	21.24	21.24	34.00	33.99	8.09	8.10	Nil
SR2	14:25	10.8	20.82	19.36	225	212	6.36	6.09	28.60	28.58	21.14	21.15	33.85	33.86	8.12	8.08	Nil
CW	14:41	8.6	10.56	12.32	141	139	8.83	8.91	30.17	30.20	21.37	21.37	34.24	34.24	8.44	8.41	Nil
AM1	15:04	14.2	32.26	29.04	272	265	5.92	6.35	28.49	28.44	23.24	23.24	36.89	36.87	8.01	8.02	Nil
SR1	15:19	26.2	14.08	13.49	275	280	6.67	6.76	28.33	28.39	21.99	22.03	35.08	35.11	8.13	8.09	Nil
SR2	15:27	10.8	16.71	17.01	224	243	7.57	7.60	29.42	29.40	20.96	20.99	33.62	33.66	8.24	8.25	Nil
CW	15:38	8.0	15.20	14.32	309	306	7.76	8.13	31.39	31.35	22.93	22.91	36.55	36.53	8.36	8.38	Nil

Prepared by : Joe Wong Date: 21/6/2010 Checked by K W Fung Date: 30/6/2010

Hong Kong Productivity Council 香港生產力促進局

Environmental Management Division

Measurement of Thermal Plume for The Operation of GT57 Combined Cycle Unit at Lamma Power Station

Team No.: 1 (North of Lamma Island) Client : The Hong Kong Electric Co., Ltd. Monitoring Site : Lamma Island Page No. : 2 of 2

Monitoring Date : 21/06/10 Tide : Neap Weather Condition: *~~Sunny~~ / Cloudy / ~~Overcast~~ / ~~Rainy~~

Equipment : (*~~Furuno GP-32~~/Simrad MX 421B) GPS Natvigator, YSI 6820 / ~~YSI 556~~ Water Quality Monitor, (*Eagle Fish ID 128/~~Navman Fish 4100sh~~) Depth Meter Sea Condition: *~~Calm~~ / Moderate / ~~Rough~~

Monitoring Location	Measurement Time	Water Depth(m)	Current Speed (cm/s)		Current Direction (in deg.)		DO (mg/L)		Sea Water Temp (°C)		Salinity (ppt)		Conductivity (mS/cm)		pH		Other Observation
			1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	
AM1	16:02	14.6	22.29	24.64	260	272	6.53	6.49	28.26	28.28	23.34	23.33	37.00	37.00	8.06	8.07	Nil
SR1	16:16	26.2	31.68	27.86	336	336	7.23	7.05	28.89	28.85	21.12	21.12	33.82	33.83	8.11	8.16	Nil
SR2	16:24	10.8	17.89	21.12	231	229	7.36	7.26	29.27	29.26	21.29	21.30	34.08	34.10	8.30	8.32	Nil
CW	16:41	7.9	17.60	17.01	257	252	8.81	9.31	29.81	29.84	20.39	20.42	32.82	32.85	8.54	8.54	Nil
AM1	17:04	13.4	43.41	41.94	197	192	8.56	8.45	28.68	28.60	22.87	22.88	36.35	36.34	8.26	8.27	Nil
SR1	17:19	26.4	36.37	32.26	349	353	7.35	7.43	28.55	28.59	20.97	20.99	33.65	33.70	8.27	8.25	Nil
SR2	17:29	10.5	22.29	24.05	251	242	7.20	6.99	28.39	28.38	23.19	23.19	36.78	36.79	8.20	8.19	Nil
CW	17:50	7.9	15.54	14.37	214	230	8.82	8.86	29.81	29.85	20.53	20.50	33.04	32.95	8.50	8.49	Nil

Prepared by : Joe Wong Date: 21/6/2010 Checked by K W Fung Date: 30/6/2010

Hong Kong Productivity Council 香港生產力促進局

Environmental Management Division

Measurement of Thermal Plume for The Operation of GT57 Combined Cycle Unit at Lamma Power Station

Team No.: 2 (South of Lamma Island) Client : The Hong Kong Electric Co., Ltd. Monitoring Site : Lamma Island Page No. : 1 of 1

Monitoring Date : 21/06/10 Tide : Neap Weather Condition: *~~Sunny~~ / Cloudy / Overcast / Rainy

Equipment : (*Furuno GP-32/~~Simrad MX 421B~~) GPS Natvigator, ~~YSI 6820~~ / YSI 556 Water Quality Monitor, (*~~Eagle Fish ID 128~~/Navman Fish 4100sh) Depth Meter Sea Condition: *~~Calm~~ / Moderate / ~~Rough~~

Monitoring Location	Measurement Time	Water Depth(m)	Current Speed (cm/s)		Current Direction (in deg.)		DO (mg/L)		Sea Water Temp (°C)		Salinity (ppt)		Conductivity (mS/cm)		pH		Other Observation
			1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	1st trial	2nd trial	
SR5	9:10	9.7	16.54	18.38	198	185	7.71	7.62	28.03	28.01	23.18	23.19	36.66	36.58	8.11	8.10	Nil
SR6	9:25	21.0	25.58	23.50	295	300	7.07	7.02	28.06	28.07	23.84	23.83	37.71	37.70	8.10	8.11	Nil
AM2	9:35	22.3	16.45	15.35	209	216	7.11	7.07	28.17	28.18	21.09	21.08	33.38	33.38	8.09	8.08	Nil
SR5	10:10	9.6	20.43	24.23	200	211	7.20	7.10	28.43	28.44	23.49	23.50	37.42	37.44	8.14	8.13	Nil
SR6	10:26	21.3	19.36	18.77	258	239	7.05	6.99	28.47	28.46	22.54	22.55	35.93	35.92	8.13	8.12	Nil
AM2	10:34	22.9	28.45	34.28	238	264	7.55	7.48	28.05	28.03	21.39	21.40	33.84	33.82	8.13	8.14	Nil
SR5	11:11	10.1	17.53	18.35	184	198	6.73	6.66	28.13	28.14	22.11	22.12	35.05	35.04	8.17	8.16	Nil
SR6	11:28	20.8	23.46	27.93	212	225	6.57	6.55	27.90	27.87	23.11	23.12	36.49	36.42	8.12	8.11	Nil
AM2	11:35	22.0	38.54	34.90	225	223	7.18	7.14	28.50	28.51	19.05	19.06	30.28	30.29	8.03	8.04	Nil
SR5	12:15	9.9	32.01	28.32	160	166	7.80	7.96	28.51	28.50	23.54	23.53	37.54	37.57	8.62	8.61	Nil
SR6	12:30	21.4	16.72	14.58	112	104	8.92	8.88	28.50	28.51	24.35	24.34	38.79	38.87	8.56	8.55	Nil
AM2	12:39	22.0	36.08	33.14	292	303	8.73	8.63	28.44	28.40	23.87	23.86	38.03	38.07	8.46	8.45	Nil
SR5	13:20	10.3	28.89	32.53	209	215	7.80	7.70	28.95	28.96	23.26	23.27	37.37	37.37	8.44	8.43	Nil
SR6	13:38	21.0	29.62	25.48	178	158	8.11	8.03	28.70	28.72	24.52	24.51	39.23	39.24	8.40	8.41	Nil
AM2	13:48	21.4	30.50	29.04	287	279	7.45	7.47	28.57	28.58	23.96	23.97	38.26	38.24	8.45	8.46	Nil
SR5	14:18	10.5	34.53	28.54	129	148	8.96	8.94	29.81	29.79	23.41	23.42	38.12	38.13	8.67	8.66	Nil
SR6	14:35	21.3	19.59	18.34	205	216	8.41	8.30	28.85	28.86	24.94	24.93	39.99	40.01	8.54	8.55	Nil
AM2	14:45	22.2	29.04	27.09	284	259	8.85	8.76	29.03	29.02	23.52	23.51	37.83	37.82	8.51	8.52	Nil
SR5	15:15	10.5	28.53	34.93	174	185	9.14	9.02	28.66	28.67	23.85	23.86	38.14	38.13	8.53	8.54	Nil
SR6	15:33	21.3	32.84	34.55	159	166	7.91	7.83	29.23	29.22	23.04	23.03	37.17	37.13	8.27	8.26	Nil
AM2	15:42	22.3	48.38	52.24	214	249	9.27	9.19	29.24	29.25	21.74	21.73	35.06	35.08	8.28	8.26	Nil
SR5	16:14	10.4	22.38	24.59	259	273	10.73	10.64	29.27	29.26	23.87	23.86	38.54	38.53	8.39	8.38	Nil
SR6	16:30	21.2	25.83	28.01	157	185	8.73	8.60	29.06	29.05	22.39	22.40	36.03	36.01	8.35	8.34	Nil
AM2	16:42	22.4	37.53	33.79	206	229	9.38	9.27	28.97	28.95	21.69	21.70	34.83	34.82	8.32	8.30	Nil
SR5	17:15	9.7	20.34	24.59	232	258	7.91	7.87	29.18	29.16	23.73	23.71	38.26	38.28	8.47	8.48	Nil
SR6	17:33	21.6	34.33	29.95	195	228	7.85	7.73	29.02	29.01	22.87	22.86	36.78	36.77	8.44	8.43	Nil
AM2	17:45	22.0	38.82	40.31	173	185	7.68	7.59	29.08	29.07	20.53	20.52	32.99	32.98	8.33	8.32	Nil

Prepared by : Yeung Date: 21/6/2010 Checked by K W Fung Date: 30/6/2010

ANNEX D
Ambient Seawater Temperature

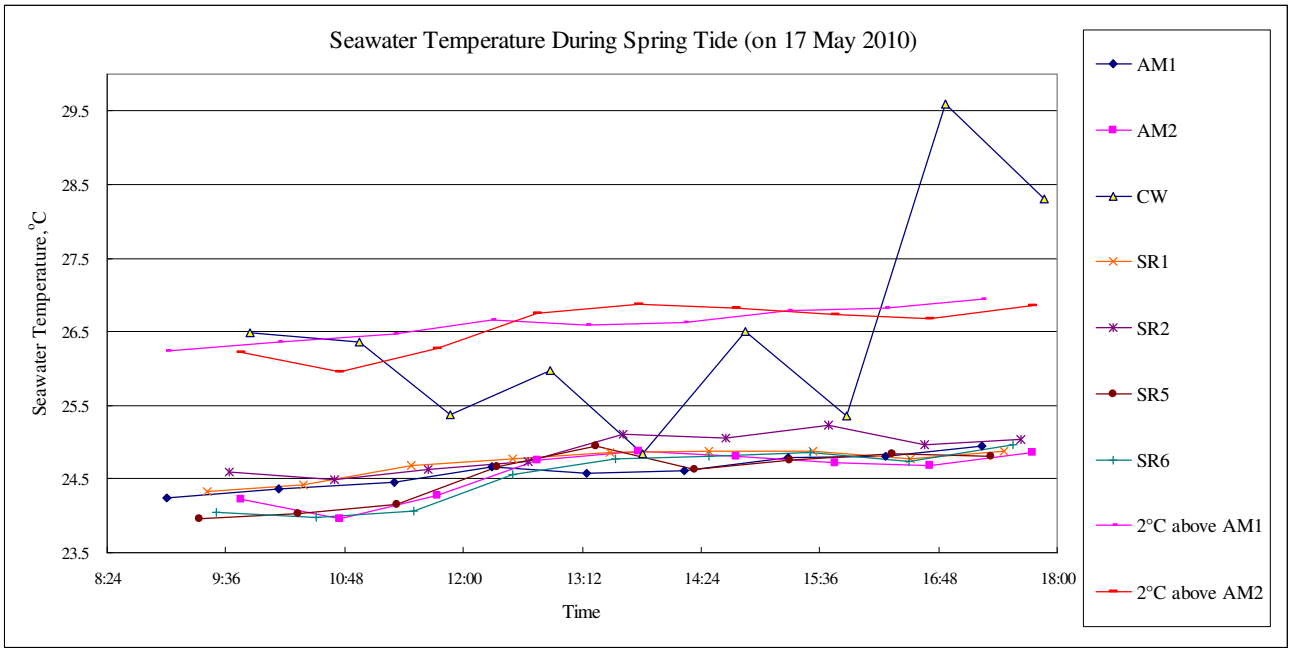
Ambient Seawater Temperature Defined for Different Measurement Periods

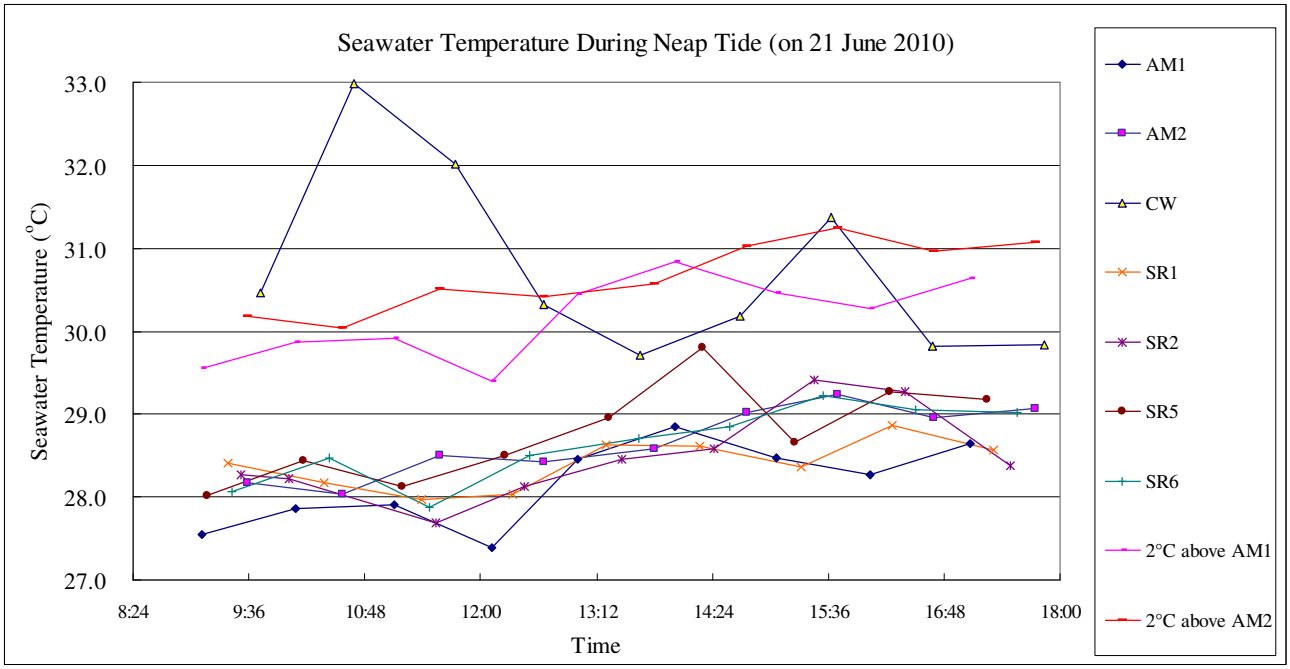
Measurement Period	Tidal Condition	Ambient station selected (upstream to the SR and CW)	AM's seawater temperature measured (assigned as the ambient condition for the measurement period), ^{o}C
Monitoring on 17 May 2010 (Spring)			
9:00 – 10:00	Flood	AM2 (measured at 9:45)	24.2
10:01 – 11:00	Flood	AM2 (measured at 10:45)	24.0
11:01 – 12:00	Ebb	AM1 (measured at 11:18)	24.5
12:01 – 13:00	Ebb	AM1 (measured at 12:17)	24.7
13:01 – 14:00	Ebb	AM1 (measured at 13:15)	24.6
14:01 – 15:00	Ebb	AM1 (measured at 14:14)	24.6
15:01 – 16:00	Ebb	AM1 (measured at 15:17)	24.8
16:01 – 17:00	Ebb	AM1 (measured at 16:16)	24.8
17:01 – 18:00	Ebb	AM1 (measured at 17:14)	24.9
Monitoring on 21 June 2010 (Neap)			
9:00 – 10:00	Ebb	AM1 (measured at 9:07)	27.6
10:01 – 11:00	Ebb	AM1 (measured at 10:05)	27.9
11:01 – 11:30	Ebb	AM1 (measured at 11:06)	27.9
11:31 – 12:00	Flood	AM2 (measured at 11:35)	28.5
12:01 – 13:00	Flood	AM2 (measured at 12:39)	28.4
13:01 – 14:00	Flood	AM2 (measured at 13:48)	28.6
14:01 – 15:00	Flood	AM2 (measured at 14:45)	29.0
15:01 – 16:00	Flood	AM2 (measured at 15:42)	29.3
16:01 – 17:00	Flood	AM2 (measured at 16:42)	29.0
17:01 – 18:00	Flood	AM2 (measured at 17:45)	29.1

ANNEX E

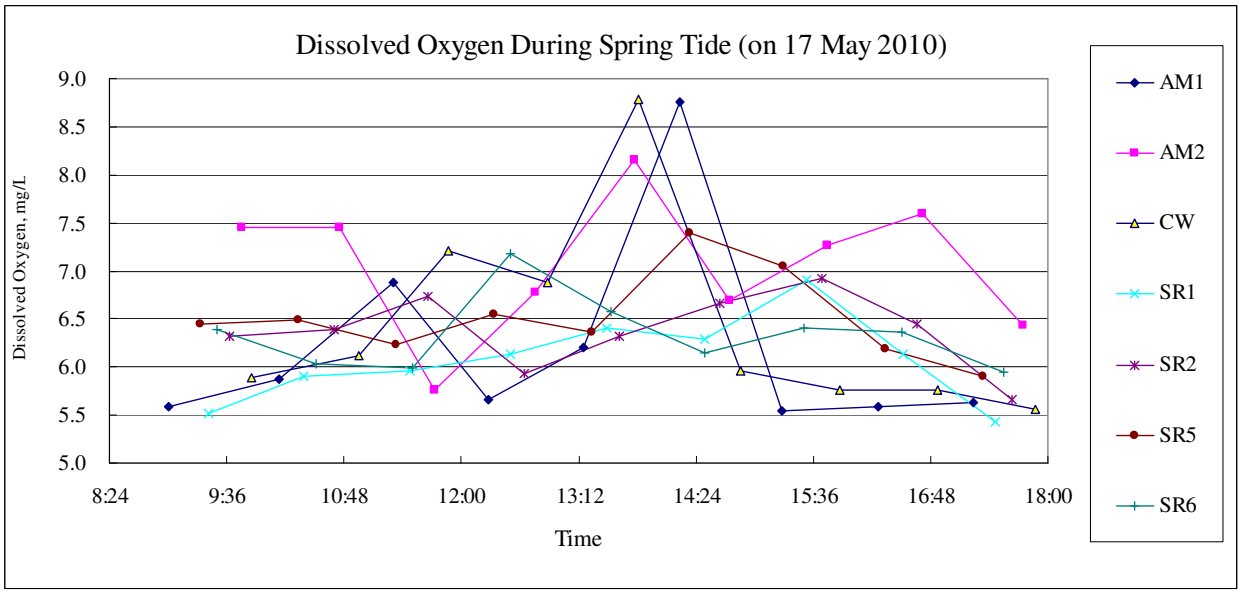
Graphical Presentation of Marine Water Monitoring Results

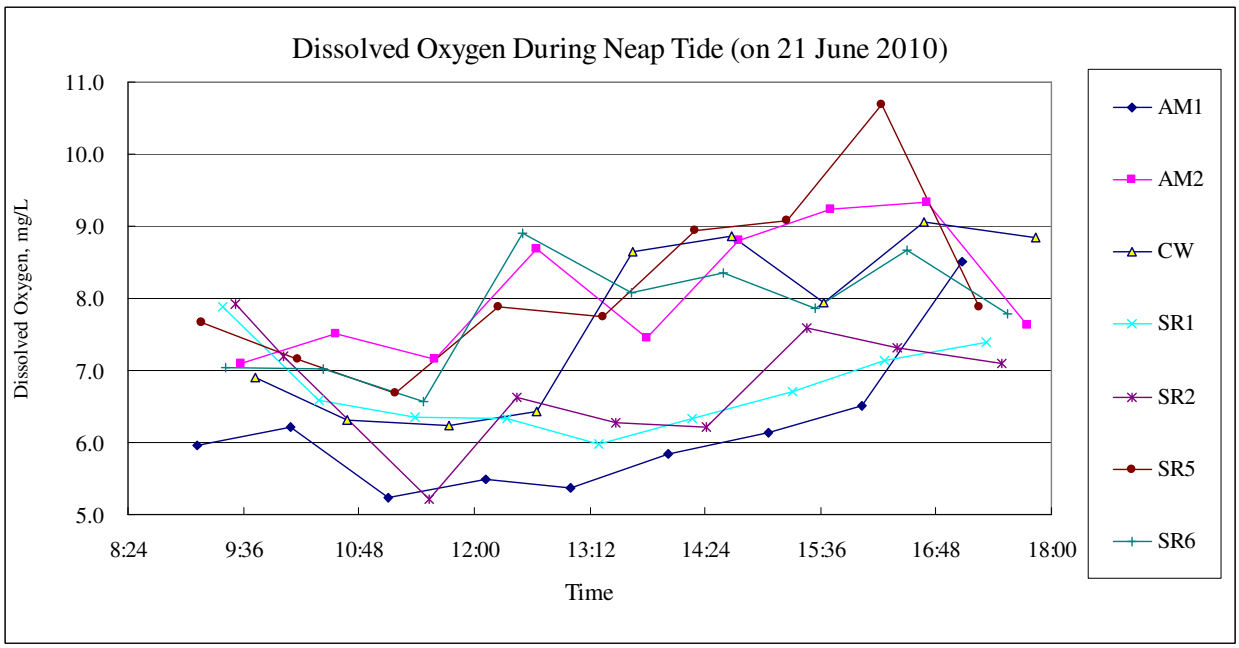
E1. Seawater Temperature



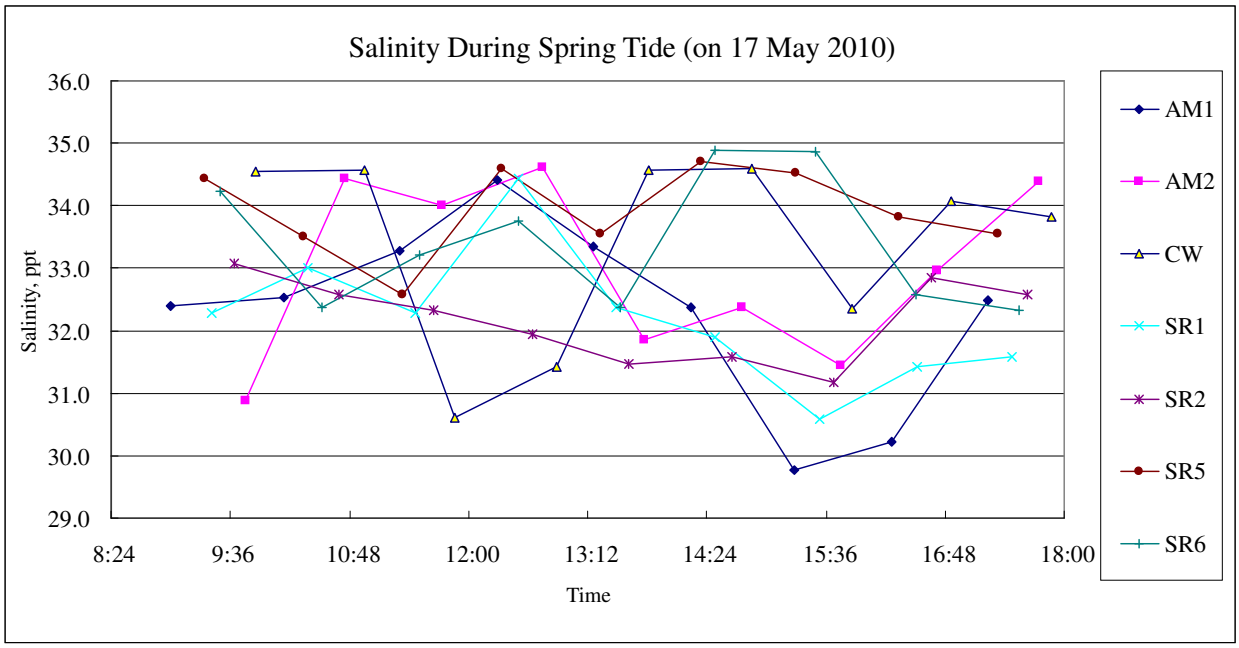


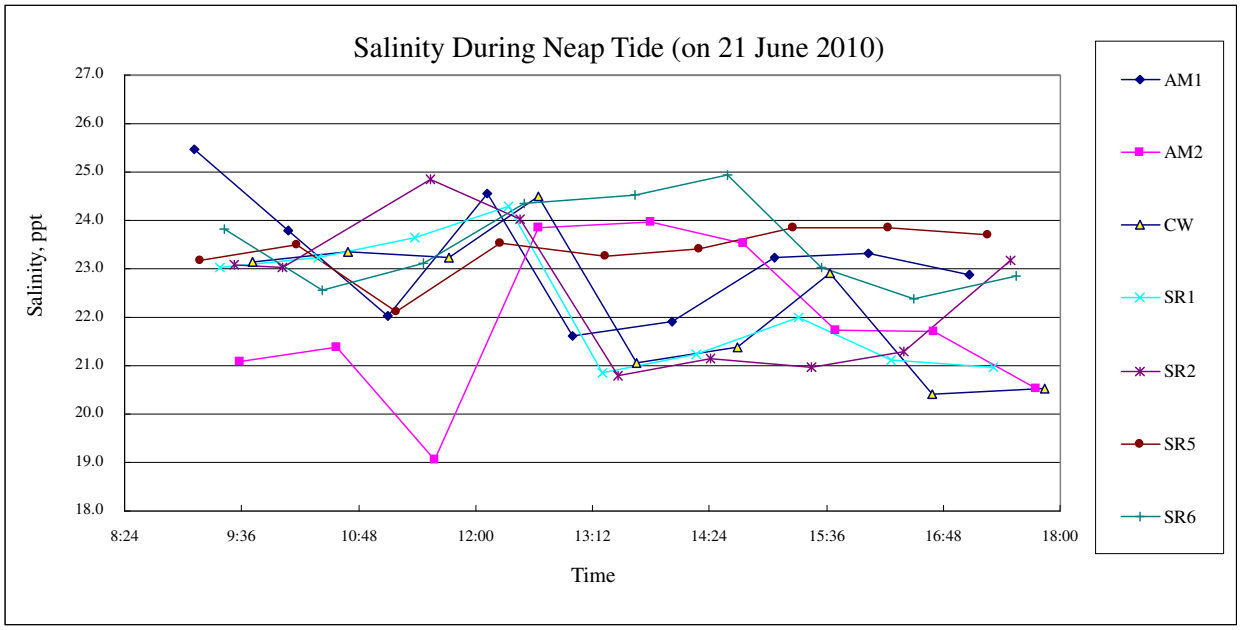
E2. Dissolved Oxygen



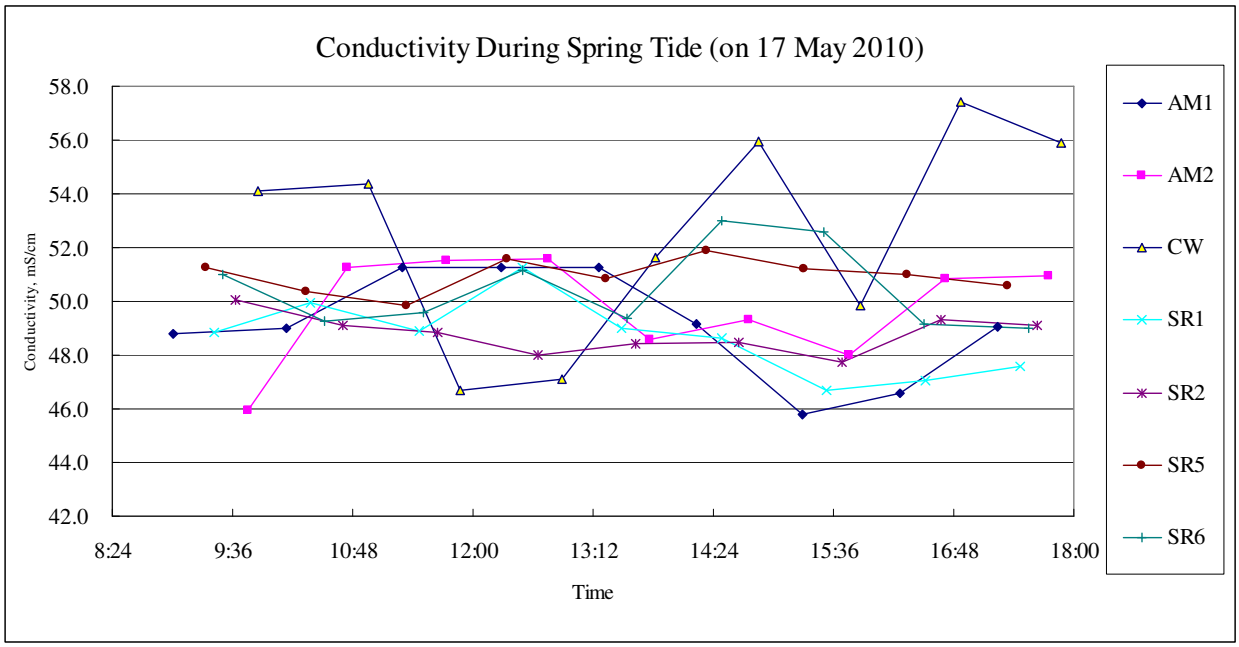


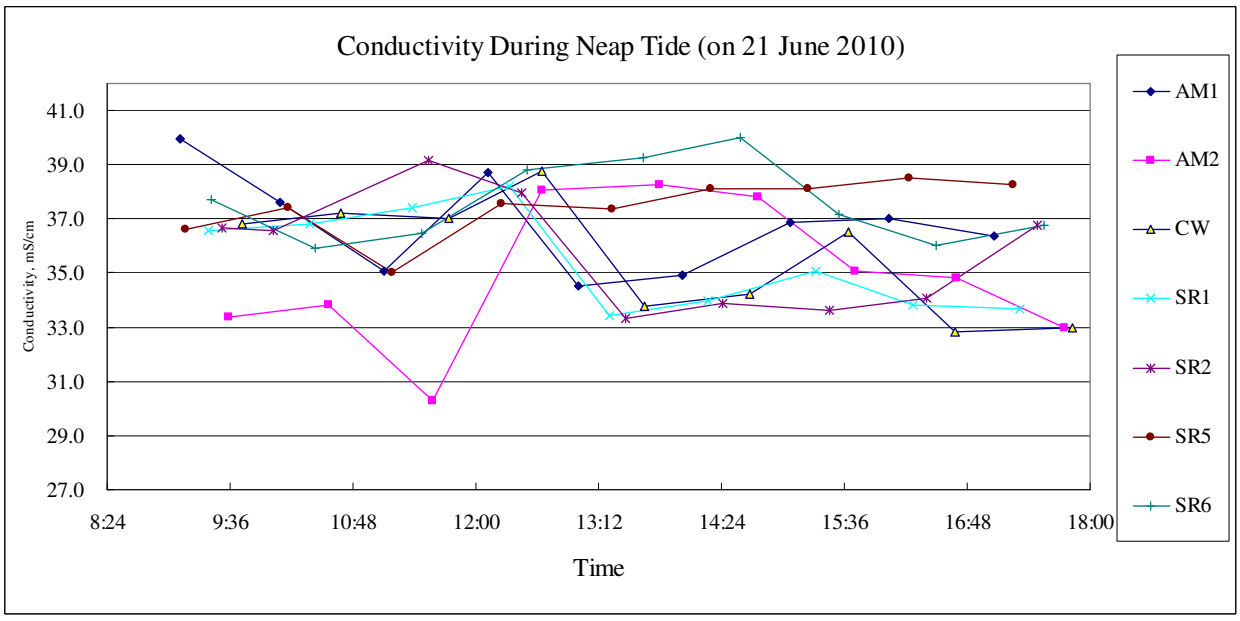
E3. Salinity


Salinity During Spring Tide (on 17 May 2010)
Salinity, ppt
36.0
35.0
34.0
33.0
32.0
31.0
30.0
29.0
8:24
9:36
10:48
12:00
13:12
14:24
15:36
16:48
18:00
Time
AM1
AM2
CW
SR1
SR2
SR5
SR6

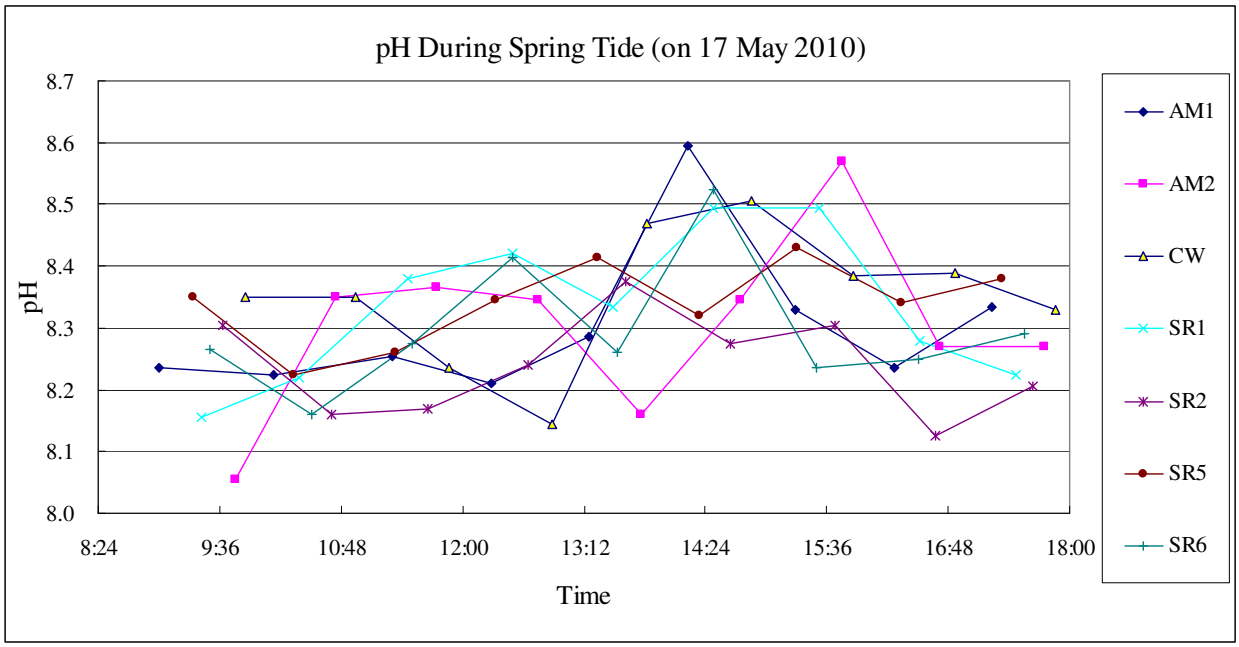

Salinity During Neap Tide (on 21 June 2010)
Salinity, ppt
27.0
26.0
25.0
24.0
23.0
22.0
21.0
20.0
19.0
18.0
8:24
9:36
10:48
12:00
13:12
14:24
15:36
16:48
18:00
Time
AM1
AM2
CW
SR1
SR2
SR5
SR6

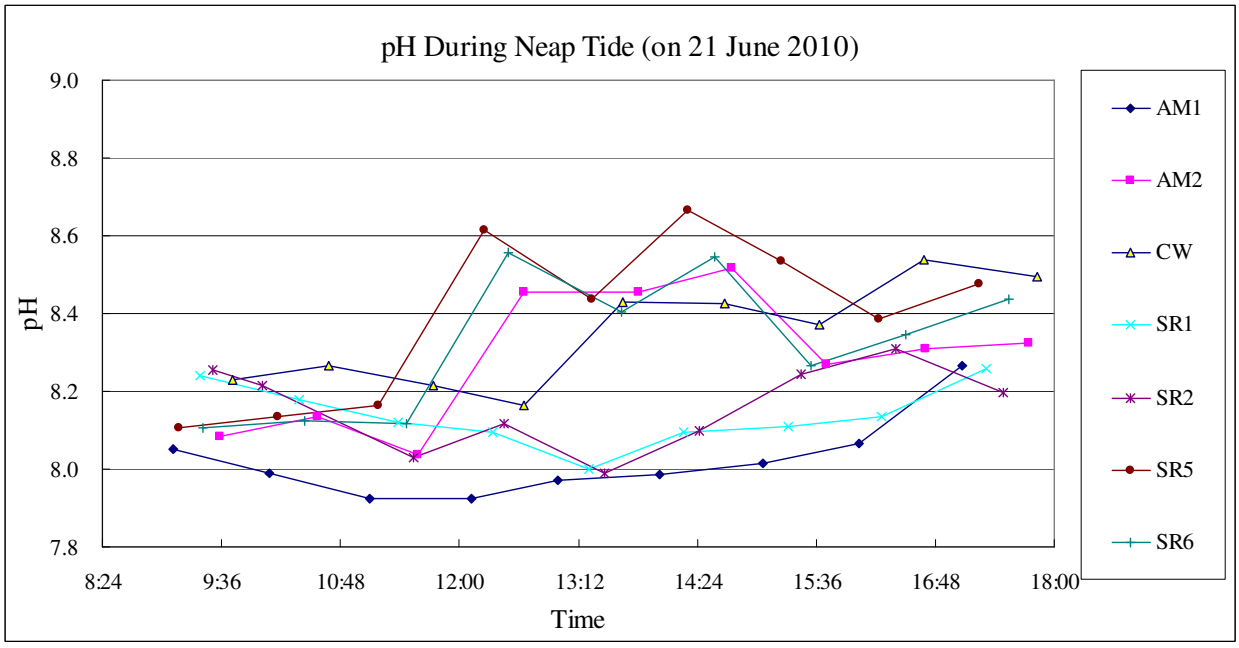
E4. Conductivity





E5. pH


pH During Spring Tide (on 17 May 2010)
pH
8.7
8.6
8.5
8.4
8.3
8.2
8.1
8.0
8:24
9:36
10:48
12:00
13:12
14:24
15:36
16:48
18:00
Time
AM1
AM2
CW
SR1
SR2
SR5
SR6


pH During Neap Tide (on 21 June 2010)
pH
9.0
8.8
8.6
8.4
8.2
8.0
7.8
8:24
9:36
10:48
12:00
13:12
14:24
15:36
16:48
18:00
Time
AM1
AM2
CW
SR1
SR2
SR5
SR6