

**Independent Environmental Checker for  
Contract No. YL/2009/01 – Hang Hau Tsuen Channel at  
Lau Fau Shan**

**Post-Construction Mangrove Monitoring  
6<sup>th</sup> Quarterly Mangrove Monitoring Report  
(September 2014)**

Prepared for:  
**Civil Engineering and Development Department**

Prepared by:  
**ENVIRON Hong Kong Limited**

Date:  
**October 2014**

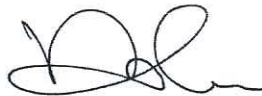
Reference Number:  
**R4042\_V1.0**

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## 1.0 INTRODUCTION

### 1.1 Project Background

- 1.1.1 Hang Hau Tsuen is situated at the southern part of Lau Fau Shan bordering the Hang Hau Tsuen stream. A channel improvement project under an Environmental Permit (EP no: EP-343/2009) has been carried out to alleviate flooding occurred in the catchment by converting the existing Hang Hau Tsuen stream between Deep Bay and Deep Bay Road to an engineered channel that will meet the required flood protection standards. Habitat restoration will be performed after finished the construction work in the channel. In accordance with Clause 2.16 of the EP and Section 6.4 of the Environmental Monitoring and Audit (EM&A) Manual (the EM&A Manual) under the EP, to mitigate the loss of 0.07 ha of mangrove patches, a total of 0.07 ha (1:1 ratio) area at tidal zone on northern side of the constructed channel will be planted with varies mangrove species. Monitoring was required to assess the growing condition of planted mangrove plants during the Operation Phase of the Project in accordance with Section 6.4 of the EM&A Manual.
- 1.1.2 The proposal and schedules for Operational Phase monitoring of compensatory mangrove planting had been submitted to AFCD on 14 May 2012. Comments on the proposal had been received from AFCD on 5 June 2012, and the revised proposal and schedules had been submitted to AFCD on 14 November 2012. No comment has been received from AFCD on 19 November 2012.
- 1.1.3 China-Hong Kong Ecology Consultants Co. (CHEC) has been appointed by ENVIRON Hong Kong Limited as ecologist to undertake the post-construction mangrove monitoring starting from June 2013 for 2 years.
- 1.1.4 Monitoring will be conducted once every quarter for two years after completion of the mangrove planting in accordance with Section 6.4 of the EM&A Manual.
- 1.1.5 This is the sixth quarterly monitoring report presents the findings of the initial monitoring survey that was undertaken on 29 September 2014.

## 2.0 MANGROVE MONITORING METHODOLOGY

### 2.1 Monitoring Equipment

2.1.1 Monitoring was involved physical measurement and photo record. Thus, tape/metallic ruler, vernier caliper and camera were used for the monitoring.

### 2.2 Quadrates

2.2.1 Locations of five quadrates of 5m x 5m in size were chosen at representative plantation area. The locations of quadrates were selected based on tidal level, species and ground characteristics as well as accessibility by foot. The location for each quadrate was marked by setting up bamboo or similar material at each corner of quadrates. The species and number of mangrove individual were counted within each quadrate. The location of mangrove zone and quadrates within the channel was shown in **Annex A**.

### 2.3 Measurement

2.3.1 In order to collect data consistent and comparable in temporal scale, for each planted plant species, 5 selected plants in each quadrate was marked by color rope or ribbon. Color rope or ribbon was tied on tree branch for marking only. No damage or any adverse effect was anticipated on the growth of mangrove trees. There was a maximum of 25 plants for each species will be selected for measurements if the species presented in all 5 quadrates. Every planted species was selected for monitoring. It is expected that at least two mangrove species was planted in the planting area. Maximum height of the selected individual plant was measured to a nearest centimeter based on growing form of plant.

2.3.2 Stem diameter for 5 selected plants of each species in each quadrate was measured by vernier caliper. A mark such as rope/ribbon was made on stem where diameter measurement will be carried out. Same orientation for the vernier caliper will be maintained for each measurement. Measurement will be taken to the nearest millimeter.

2.3.3 The overall health condition was assessed for each species within quadrate. The assessment in some inaccessible location was aided by binocular. The following was the health scheme for the assessment. The rate of survival of the mangroves after planting was estimated by visual observation.

2.3.4 Health scheme:

Good: Low mortality rate. Green foliage color. Dense foliage. No damage from floating rubbish or high water flow.

Fair: Low to medium mortality rate. Less dense foliage. Some yellowish foliage color recorded. Some leave or branches were damaged by floating rubbish, water flow or insect.

Poor: High mortality rate. Highly sparse crown and most foliage were drying up.

The plant may be seriously damaged.

## **2.4 Photo Record**

- 2.4.1 Photos of overall view for mangrove compensation area and each quadrat was taken. For consistence, same photo location and angle for each measurement will try to be maintained but it may need adjustment due to site and plant change. Other site conditions and observations should also be recorded.

## 3.0 MONITORING RESULTS

### 3.1 Visual Inspection

- 3.1.1 The species and the total number of mangrove tree were counted within each quadrat. Two native species (*Acanthus ilicifolius*, *Kandelia obovata*) were planted on the compensatory mangrove planting area.
- 3.1.2 The overall health condition of each species within each quadrat was assessed and shown in **Table 1**. The total number, density and survival rate of mangrove tree within each quadrat were shown in **Table 2**.
- 3.1.3 Generally, the overall health condition of *Acanthus ilicifolius* and *Kandelia obovata* was fair as green foliage color was observed during the monitoring survey. However, the health condition of *Kandelia obovata* in Quadrat 1 was assessed as “Poor to Fair” due to the mangrove tree on eastern side of Quadrat 1 was dead since the inspection on December 2013. As that side of Quadrat 1 was nearest to the outlet of sewage, it was believed that eastern side of Quadrat 1 was immersed by sewage and lead to the death of mangrove tree on that area. However, the affected area was small compare to the whole compensatory site, thus the influence to the mangrove by the sewage is anticipated to be minor, but continuous monitoring of the health condition is still recommended.

### 3.2 Measurement of selected plant individual

- 3.2.1 Maximum height and stem diameter of maximum 5 selected individual of each species in each quadrat was measured during the monitoring survey. Result of the measurement was shown in **Table 1**.
- 3.2.2 Height and diameter reduction was observed at an individual of *Acanthus ilicifolius* (Quadrat 3, Individual 4, 5). The reduction was due to the death of the highest stem of this individual. Another healthy stem of this individual was chosen for measurement. Thus, the measurement was reduced compared with previous record.
- 3.2.3 Mean height & diameter of *Acanthus ilicifolius* and *Kandelia obovata* was calculated and shown in **Tables 3 & 4**. The change of measurement parameters since June 2013 was shown in **Charts 1 & 2**.
- 3.2.4 By compare the measurement record for both last and current inspection, most mangrove trees were recorded in positive growth and increment in height or diameter was observed. The comparison for the measurement was shown on **Tables 1 to 4**.

**Table 1 Mangrove plant growth and health monitoring for each planted species**

Date: 26 Sep 2014

Temperature: 31°C

Tidal condition: Low

Quadrat 1	Individual 1		Individual 2		Individual 3		Individual 4		Individual 5		Overall health condition	Change of overall health condition
	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)		
<i>Acanthus ilicifolius</i>	Dead	Dead	Dead	Dead	90	9.8	94	11.2	Dead	Dead	Fair	(Unchanged/Better/Poor)
<i>Kandelia obovata</i>	Dead	Dead	58	15	Dead	Dead	Dead	Dead	54	17.4	Poor to Fair	Better
												Unchanged

Quadrat 2	Individual 1		Individual 2		Individual 3		Individual 4		Individual 5		Overall health condition	Change of overall health condition
	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)		
<i>Acanthus ilicifolius</i>	80	9.8	95	9.4	100	10.3	138	11	110	9.66	Fair	Unchanged
<i>Kandelia obovata</i>	61	15.4	74	16.3	45	17.4	87	27	71	14.5	Fair	Unchanged

Quadrat 3	Individual 1		Individual 2		Individual 3		Individual 4		Individual 5		Overall health condition	Change of overall health condition
	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)		
<i>Acanthus ilicifolius</i>	118	14.8	110	12.82	135	13.8	69	14.5	57	10.1	Fair	Unchanged
<i>Kandelia obovata</i>	66	16	105	23.8	66	23	68	16.39	78	18	Fair	Unchanged

Quadrat 4	Individual 1		Individual 2		Individual 3		Individual 4		Individual 5		Overall health condition	Change of overall health condition
	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)		
<i>Acanthus ilicifolius</i>	40	6.59	115	13.7	30	6.37	94	10.63	101	11.8	Fair	Unchanged

Quadrat 5	Individual 1		Individual 2		Individual 3		Individual 4		Individual 5		Overall health condition	Change of overall health condition
	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)	H (cm)	Dia (mm)		
<i>Acanthus ilicifolius</i>	73	12.4	84	11.58	67	10.5	37	9.1	113	13.3	Fair	Unchanged
<i>Kandelia obovata</i>	77	17.62	112	18.61	44	11.8	111	16.5	54	15.5	Fair	Unchanged



**Table 2 Record sheet for mangrove plant density and survival rate monitoring**

Date	Parameter	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Overall Survival rate in five Quadrates (%)
4 <sup>th</sup> Jun 2013	Initial total number of mangrove tree	18	24	31	20	18	N.A
	Initial density of mangrove tree (No. of mangrove tree / m <sup>2</sup> )	0.72	0.96	1.24	0.8	0.72	N.A
12 <sup>th</sup> Sep 2013	Initial total number of mangrove tree	23	26	27	31	20	N.A
	Initial density of mangrove tree (No. of mangrove tree / m <sup>2</sup> )	0.92	1.04	1.08	1.24	0.8	N.A
	Survival rate (%)	86%	100%	89%	84%	100%	91.8%
					N.A	93%	91%
03 <sup>rd</sup> Dec 2013	Initial total number of mangrove tree	23	26	27	31	20	N.A
	Initial density of mangrove tree (No. of mangrove tree / m <sup>2</sup> )	0.92	1.04	1.08	1.24	0.8	N.A
	Survival rate (%)	57%	94%	89%	84%	100%	85%
		63%	78%	94%	N.A	93%	82%

Date	Parameter	Quadrat 1	Quadrat 2	Quadrat 3	Quadrat 4	Quadrat 5	Overall Survival rate in five Quadrates (%)
04 <sup>th</sup> Mar 2014	Initial total number of mangrove tree	23	26	27	31	20	N.A
	Initial density of mangrove tree (No. of mangrove tree / m <sup>2</sup> )	0.92	1.04	1.08	1.24	0.8	N.A
	Survival rate (%)	<i>Acanthus ilicifolius</i>	94%	89%	84%	100%	85%
		<i>Kandelia obovata</i>	60%	78%	N.A	93%	82%
20 <sup>th</sup> Jun 2014	Initial total number of mangrove tree	23	26	27	31	20	N.A
	Initial density of mangrove tree (No. of mangrove tree / m <sup>2</sup> )	0.92	1.04	1.08	1.24	0.8	N.A
	Survival rate (%)	<i>Acanthus ilicifolius</i>	94%	89%	84%	100%	85%
		<i>Kandelia obovata</i>	59%	78%	N.A	93%	82%
26 <sup>th</sup> Sep 2014	Initial total number of mangrove tree	23	26	27	31	20	N.A
	Initial density of mangrove tree (No. of mangrove tree / m <sup>2</sup> )	0.92	1.04	1.08	1.24	0.8	N.A
	Survival rate (%)	55%	94%	89%	84%	100%	85%

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Date	Parameter	Quadrant 1	Quadrant 2	Quadrant 3	Quadrant 4	Quadrant 5	Overall Survival rate in five Quadrates (%)
	<i>Kandelia obovata</i>	59%	78%	94%	N/A	93%	82%
Change of survival rate compared with last month (Unchanged/ better/poor)	<i>Acanthus ilicifolius</i>	Unchanged	Unchanged	Unchanged	Unchanged	Unchanged	Unchanged
	<i>Kandelia obovata</i>	Poor	Unchanged	Unchanged	Unchanged	Unchanged	Unchanged

**Table 3 Mean height of *Acanthus ilicifolius* and *Kandelia obovata***

Month	Mean Height (cm)					Change of mean height (Positive growth, negative)	
	Jun 2013	Sep 2013	Dec 2013	Mar 2014	Jun 2014		Sep 2014
<i>Acanthus ilicifolius</i>	92.81	93.2	94.85	97.18	85.54	88.64	Negative growth
<i>Kandelia obovata</i>	75.05	73.05	65	65.92	66.525	72.41	Positive growth

**Table 4 Mean diameter of *Acanthus ilicifolius* and *Kandelia obovata***

Month	Mean Diameter (mm)					Change of mean height (Positive growth, negative)	
	Jun 2013	Sep 2013	Dec 2013	Mar 2014	Jun 2014		Sep 2014
<i>Acanthus ilicifolius</i>	11.05	10.94	10.83	11.13	10.5312	11.05	Negative growth
<i>Kandelia obovata</i>	14.26	14.96	15.39	15.59	16.0145	17.66	Positive growth

### 3.3 Photographic record

- 3.3.1 The overall view of the mangrove compensation area and each quadrat was presented by a number of photos taken at specific location along the channel. The photos will be useful to illustrate and compare the mangrove plant condition with future record. The overall view of the mangrove compensation area and each quadrat for both last and current inspection was presented in **Annex B, Photo 1-8** and **Photo 9-18** respectively.
- 3.3.2 By compare the photographic record for both last and current inspection, there was no significant change for the condition of mangrove trees in the monitoring site. The comparison for the photographic record was shown on **Photo 9-18**.

## 4.0 CONCLUSION

- 4.1.1 The post-construction mangrove monitoring survey was carried out on 26<sup>th</sup> September 2014. The species and the total number of mangrove tree were counted within each quadrat. The overall health condition of each species within each quadrat was assessed and shown in **Table 1**. The total number, density and survival rate of mangrove tree within each quadrat were shown in **Table 2**.
- 4.1.2 Generally, the overall health condition of *Acanthus ilicifolius* and *Kandelia obovata* was fair. However, the health condition of *Kandelia obovata* in Quadrat 1 was assessed as “Poor to Fair” due to the death of mangrove tree on eastern side. It was believed that eastern side of Quadrat 1 was immersed by sewage and lead to the death of mangrove tree. However, the affected area was small compare to the whole compensatory site, thus the influence to the mangrove by the sewage is anticipated to be minor, but continuous monitoring of the health condition is recommend.
- 4.1.3 Maximum height and stem diameter of maximum 5 selected individual of each species in each quadrat was measured, the result of the measurement was shown in **Table 1**. Mean height & diameter of *Acanthus ilicifolius* and *Kandelia obovata* was calculated and shown in **Tables 3 & 4**. The change of measurement parameters since June 2013 was shown in **Charts 1 & 2**. Generally, most mangrove trees were recorded in positive growth and increment in height or diameter was observed. However, height and diameter reduction was observed at some individual of *Acanthus ilicifolius* (Quadrat 3, Individual 4,5) due to the death of the highest stem of these individual. Another healthy stem of this individual was chosen for measurement. Thus, the mean height and diameter of *Acanthus ilicifolius* was reduced compared with previous record.
- 4.1.4 The overall view of the mangrove compensation area and each quadrat was presented in **Photos 1-4** and **Photos 5-9** respectively.

## Figures

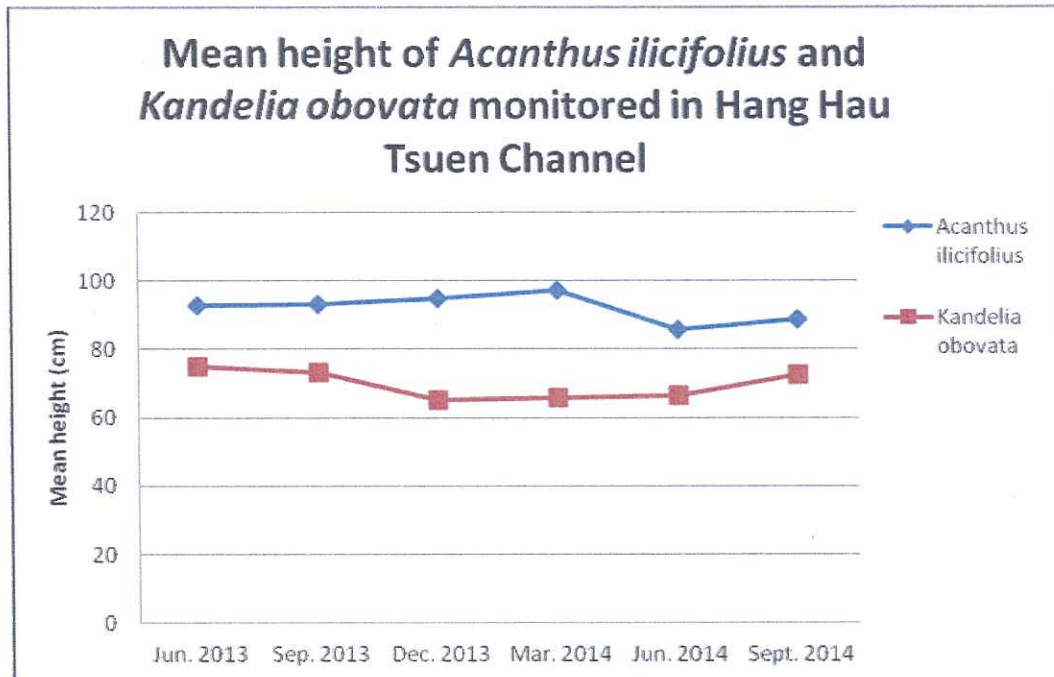


Figure 1 - Mean height (cm) of *Acanthus ilicifolius* and *Kandelia obovata* monitored at Hang Hau Tsuen Channel from Jun 2013 to Sep 2014

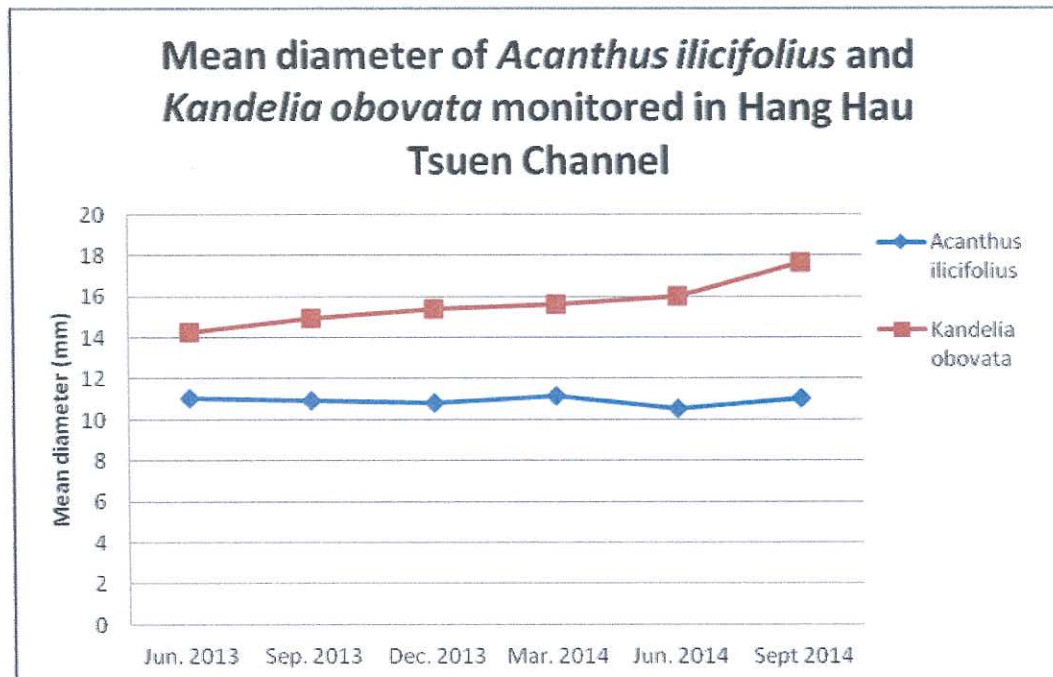
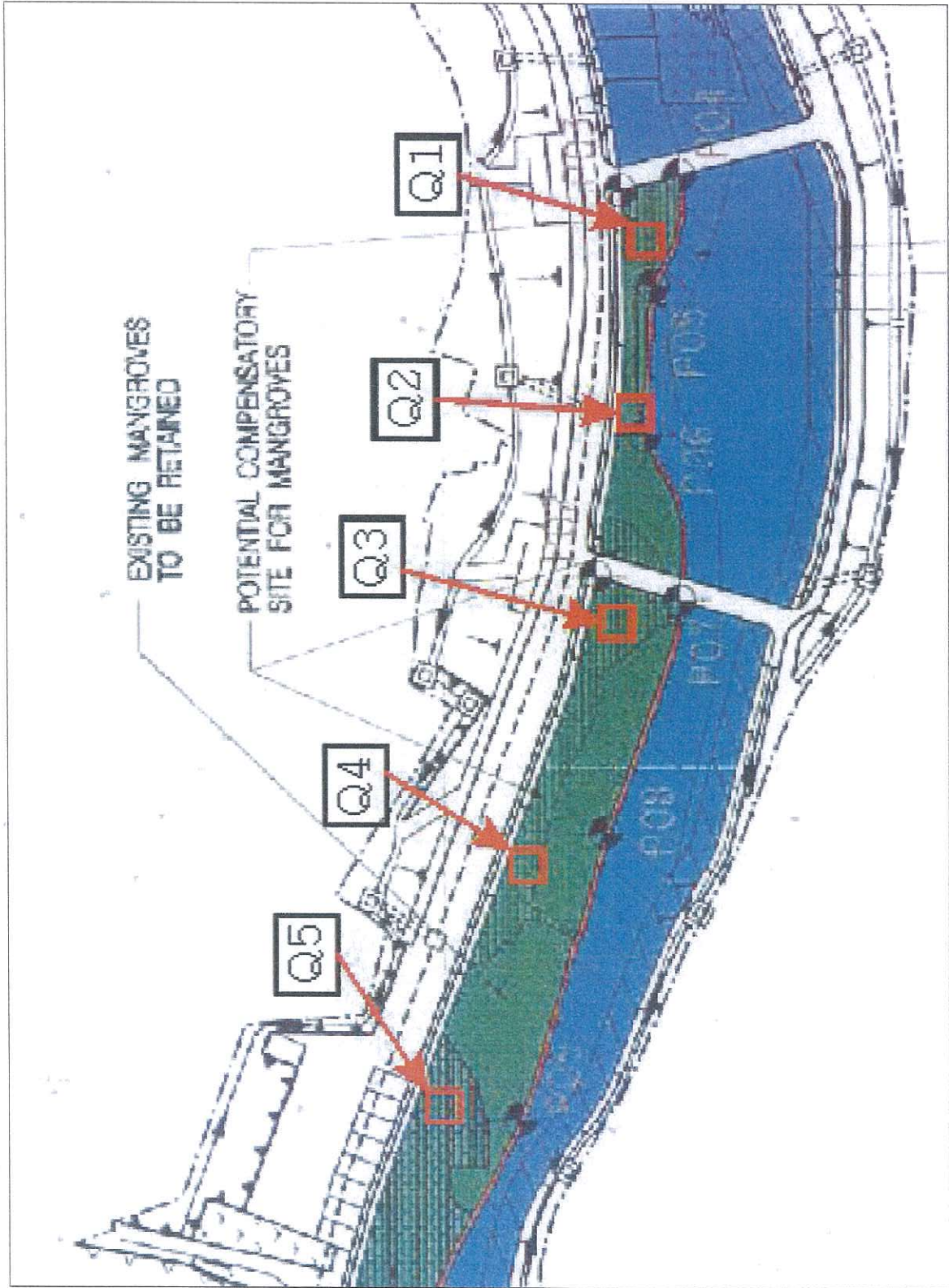


Figure 2 - Mean diameter (mm) of *Acanthus ilicifolius* and *Kandelia obovata* monitored at Hang Hau Tsuen Channel from Jun 2013 to Sep 2014

## **Annexes**





Annex A: Location of mangrove zone and quadrates within Hang Hau Tsuen Channel



1. Last inspection



2. Current inspection



3. Last inspection



4. Current inspection



5. Last inspection



6. Current inspection



7. Last inspection



8. Current inspection

Post-construction mangrove monitoring - Sep 2014

Overall view of mangrove compensation area for both last and current inspection

Photo 1 - 8

Date 26<sup>th</sup> Sep 2014

### Quadrates 1



9. Last inspection



10. Current inspection : Rubbish from upstream was cleared up in this quadrate

### Quadrates 2



11. Last inspection



12. Current inspection: No significant change

### Quadrates 3



13. Last inspection



14. Current inspection: No significant change

Post-construction mangrove monitoring - Sep 2014

Overall view of Quadrates 1 – 3 for both last and current inspection

Photo 9 - 14

Date 26<sup>th</sup> Sep 2014

### Quadrat 4



15. Last inspection



16. Current inspection: No significant change

### Quadrat 5



17. Last inspection



18. Current inspection: No significant change

Post-construction mangrove monitoring - Sep 2014

Photo 15-18

Overall view of Quadrat 4-5 for both last and current inspection

Date 26<sup>th</sup> Sep 2014