Drainage Services Department

AECOM

Agreement No. DP 04/2012

Post-Construction Ecological Monitoring

of Drainage Improvement Works in Southern Lantau

Implemented under 4128CD in Contract DC/2006/11

Monthly EM&A Report – February 2013

March 2013

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Pursuant to Condition 4.3 of Environmental Permit No. EP-237/2005/B, this monthly EM&A Report for post-construction ecological monitoring and ecological water monitoring during February 2013 has been certified by the Environmental Team Leader (ETL) and verified by the Independent Environmental Checker (IEC)

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EXECUTIVE SUMMARY

This is the third bi-monthly post-construction ecological monitoring and audit exercise for “Drainage Improvement in Southern Lantau” conducted by AECOM. This report concludes the post-construction phase ecological monitoring and audit requirement for the activities undertaken during the period of 1 February 2013 to 28 February 2013.

Ecological monitoring and ecological water quality monitoring were performed on 7 February 2013. Results obtained are presented in this report.

The Environmental Team (ET) will continue to implement the environmental monitoring & audit (EM&A) programme in accordance with the EM&A Manual and Environmental Permit requirement. The report is available for public inspection and will be uploaded to the dedicated project website (http://www.envproject.com/sldiwema.htm).

1. INTRODUCTION

1.1. Background

1.1.1. The Drainage Services Department (DSD) has implemented Contract No. DC/2006/11 "Drainage Improvement in Southern Lantau and Construction of Mui Wo Village Sewerage Phase 1". The monitoring requirements of the drainage improvement works are subject to the conditions specified in Environmental Permit (EP) No. EP-237/2005/B issued by the Environmental Protection Department (25 January 2006). In compliance with the EP, an Environmental Monitoring and Audit (EM&A) programme was established during the construction and post-construction phases of the project. The operation of the project is subject to the conditions in EP No. EP-434/2012.

1.1.2. The Post-Construction Ecological Monitoring and audit of Drainage Improvement Works in Southern Lantau under Agreement No. DP 04/2012, commenced in January 2012. AECOM Asia Co. Ltd. was appointed by DSD as the Environmental Team (ET) to conduct the above captioned monitoring project from October 2012 onwards. This is the third bi-monthly post-construction ecological monitoring and audit report under that appointment.

1.2. Project Description

1.2.1. Under Contract No. DC/2006/11, the improvement works were undertaken at Pak Ngan Heung River (PNH), Luk Tei Tong River (LTT) and Tai Tei Tong River (TTT) in Southern Lantau, west of Mui Wo. The works for which the post-construction ecological monitoring required by EP No. EP-237/2005/B covered:

- the drainage channel and a three-cell box culvert at PNH;
- the drainage channel at LTT;
- the bypass channel at LTT.

1.2.2. No ecological monitoring and ecological water monitoring was required following the drainage improvement works at TTT and village sewerage works in Mui Wo.

1.2.3. Both PNH and LTT are part of the Mui Wo River (also named as Silver River) in Lantau Island. These two tributaries of Mui Wo River, together with Tai Tei Tong River, then joined and connected to Silver Mine Bay next to Mui Wo.

1.3. Report Objectives

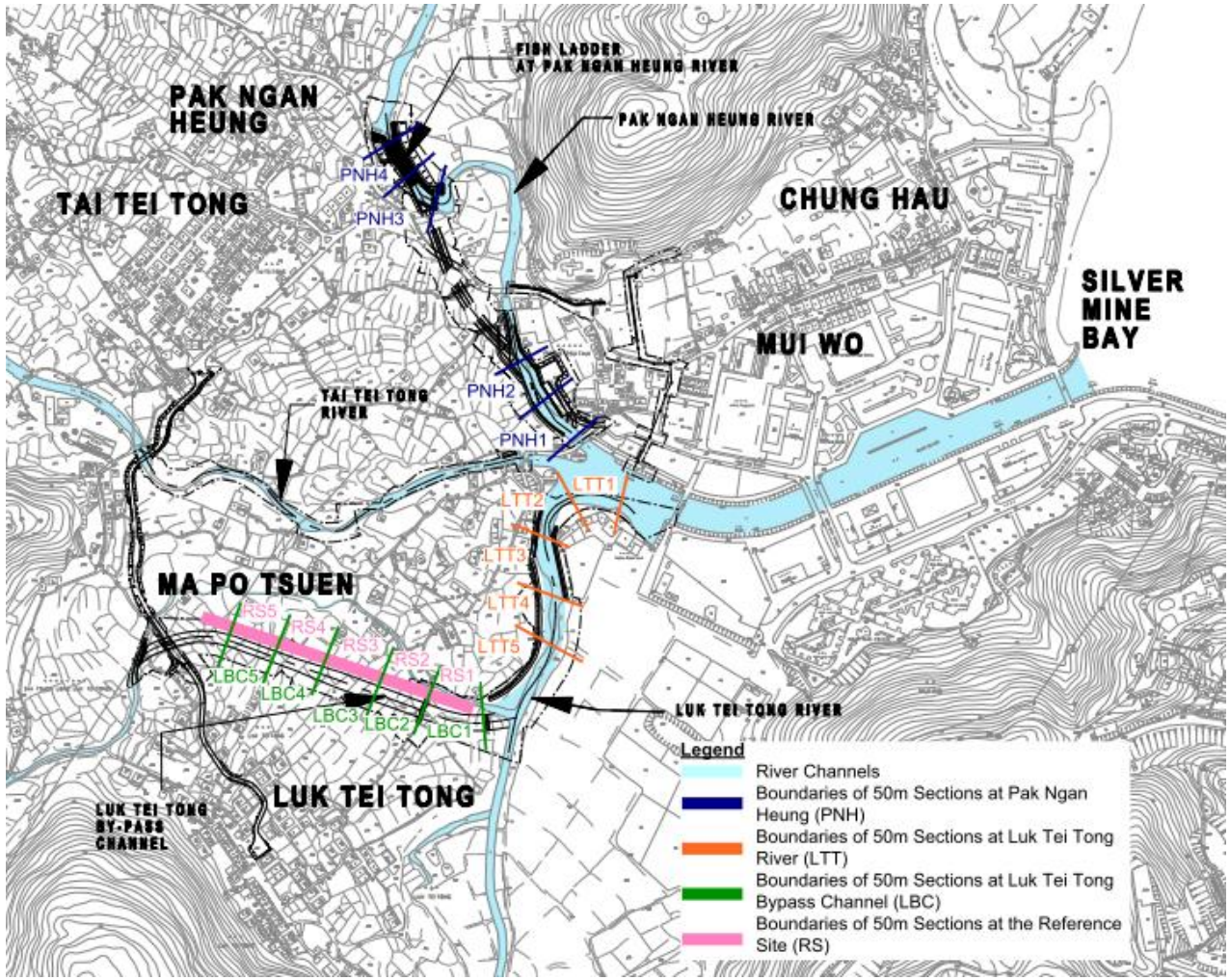
This report presents the findings of the ecological monitoring and the ecological water monitoring conducted in February 2013.

2. ECOLOGICAL MONITORING PARAMETERS

2.1. Ecological Surveys

2.1.1. Details of the monitoring parameters and survey methodology are described below. According to the Final EM&A Manual, a specific ecological monitoring programme of the improved section of PNH, LTT, Luk Tei Tong Bypass Channel (LBC) and its Reference Site (RS) is recommended.

Figure 1 Ecological Monitoring Locations at Pak Ngan Heung River, Luk Tei Tong River, Luk Tei Tong Bypass Channel and the Reference Site



Pak Ngan Heung River and Luk Tei Tong River

2.1.2. The ecological survey for these two rivers was divided into nine 50 m sections. The location plan is shown in **Figure 1** for reference.

- Two sections for downstream of PNH (PNH1 and 2), two sections for upstream of PNH (PNH3 and 4)
- Five sections for LTT (LTT1 to 5)

2.1.3. The monitoring parameters and survey methodology for each section are described below:

(a) Bird species in each 50 m section were surveyed quantitatively using transect count method. Birds within the river channel and on the riverbank were identified to species and their abundance was recorded. Birds that flew over/across the river channel without landing were not considered to be utilising the area and thus excluded from the records.

(b) Surveys on aquatic macroinvertebrate focused on determination of the diversity and abundance. Sampling methods included active searching, direct observation, hand netting and kick sampling. In each section, the macroinvertebrate species composition was identified and their relative abundance was recorded.

(c) Surveys on fish focused on determination of the diversity and abundance of fish communities. Sampling methods included active searching, direct observation, and hand netting, and were determined in accordance with site conditions. In each section, the fish species composition was identified and their relative abundance was recorded.

(d) Adult odonate community in each 50 m section were surveyed quantitatively by transect count method. Adult odonate within the river channel and on the riverbank were identified to species and their abundance was recorded. Species requiring close examination were netted.

(e) Aquatic, emergent and riparian vegetation community was recorded by walk-through survey. Plant species composition and their relative abundance were recorded.

Luk Tei Tong Bypass Channel

2.1.4. The ecological survey for the Luk Tei Tong Bypass Channel (LBC) and its Reference Sites (RS) were carried out in every 50 m section. The location plan is shown in **Figure 1** for reference.

- Five sections for LBC (LBC1 to 5)
- Five sections for RS (RS1 to 5)

2.1.5. The monitoring parameters and survey methodology are described below:

(a) Bird species in each 50 m section were surveyed quantitatively using transect count method. Birds within the river channel and on the riverbank were identified to species and their abundance was recorded. Birds that flew over/across the river channel without landing were not considered to be utilising the area and thus excluded from the records.

(b) Where/when water was present, surveys of aquatic macroinvertebrate focused on determination of their diversity and abundance of stream aquatic communities. Sampling methods included active searching, direct observation, hand netting and kick sampling. In each section, macroinvertebrate species composition was identified and their relative abundance was recorded.

(c) Where/when water was present, surveys of fish focused on determination of their diversity and abundance. Sampling methods included active searching, direct

observation, and hand netting, were determined in accordance with site conditions. In each section, fish species composition was identified and their relative abundance was recorded.

(d) Adult odonate community in each 50 m section were surveyed quantitatively by transect count method. Adult dragonflies within river channel and on the riverbank were identified to species and their abundance was recorded. Species requiring close examination were netted.

(e) Line-intercept method was adopted to determine the relative plant cover of aquatic, emergent and riparian vegetation. One line transect of 10 m was set perpendicular to the stream channel at each section, and five 1 m x 1 m quadrats were placed along the transect. Relative coverage and plants species intercepting the transect line was recorded. Percentage cover of each species within the quadrat was recorded to the nearest 10% (except "1" = present but insignificant cover, normally 1 to 2 individuals, and 5% = up to 5%). The conditions of vegetation were described.

(f) Herpetofauna community within LBC and RS were surveyed by active searching in potential habitats. Reptiles were identified and their abundance was recorded. Amphibians were identified by their calls and the number of calling males in each section was recorded.

2.1.6. For all surveys, identification of plant species and distribution status in Hong Kong were made with reference to Corlett *et al.* (2000), Hu *et al*. (2003), Hong Kong Herbarium (2012), and Hong Kong Herbarium and South China Botanical Gardens (2007; 2008; 2009; 2011).

2.1.7. In terms of assessing geographical distribution, published references specializing in the distribution of specific faunal groups in Hong Kong have been utilized. For general status, these have included Fellowes *et al*. (2002) and the Hong Kong Biodiversity Database (AFCD, 2013), and for specific faunal groups, these have included: Avifauna – Carey *et al.* (2001), Viney *et al.* (2006); Dragonflies – Tam *et al.* (2011); Butterflies – Lo (2005); and Chan *et al*. (2011); Amphibians – Chan *et al.* (2005); Reptiles – Chan *et al.* (2006), Chan *et al*. (2009), and Karsen *et al.* (1998); Terrestrial Mammals – Shek (2006); Freshwater Fish – Lee *et al.* (2004); and Freshwater Community – Dudgeon (2003). The status and rarity of vascular plants has been based on Hu *et al*. (2003) and Corlett *et al*. (2000).

2.2. Ecological Water Quality Monitoring

2.2.1. Ecological water quality monitoring along PNH, LTT, LBC, and RS was carried out. Ten locations were selected. The location plan for ecological water quality monitoring is shown in **Figure 2** for reference.

- Three locations for existing PNH (WE1 to 3)
- Three locations for existing LTT (WE4 to 6)
- Two locations for RS (WE7 to 8)
- Two locations for existing LBC (WE9 to 10)

2.2.2. Water Quality Monitoring along PNH, LTT, LBC and RS included the monitoring parameters shown below:

- Biochemical Oxygen Demand (BOD_5)
- Nitrate
- Ammonia
- Reactive Phosphorus
- Dissolved Oxygen (DO)
- Water Depth* and Water Flow Rate
- Conductivity
- pH

- Total Suspended Solids (SS)
- Salinity
- Temperature
- Sediment Characteristics

Note:

*As referred to the Final EM&A Manual, Water Depth is required only for LBC.

2.2.3. The DO, water depth and water flow rate, conductivity, pH, temperature, salinity and sediment characteristics were measured in-situ while the other water samples were analyzed in a HOKLAS accredited laboratory and the analyses followed the standard methods according to APHA Standard Methods for the Examination of Water and Wastewater, 20th Edition, or equivalent. The limit of reporting for the laboratory analysis is summarized in **Table 2.1**.

Table 2.1 Limit of Reporting for Water Quality Parameters

Parameters	**Limit of Reporting (mg/L)**
Total Suspended Solids	2
Biochemical Oxygen Demand (BOD_5)	2
Nitrate	0.01
Ammonia	0.01
Reactive Phosphorus	0.01

2.2.4. The instrument for in-situ measurement of temperature, DO, salinity and conductivity is a portable and weather proof multi-meter complete with cable and uses a DC power source (YSI 85), whereas Orion 230A+ is used as for pH measurement. Calibration certificates are attached in **Appendix 1**. The instruments are capable of measuring:

- pH in the range of 0 to 14
- Temperature of -5 to +65^{0}C
- DO in the range of 0 to 20 mg/L and 0 to 200% saturation
- Salinity in the range of 0-80ppt
- Conductivity in the range of 0 to 4999 µS/cm

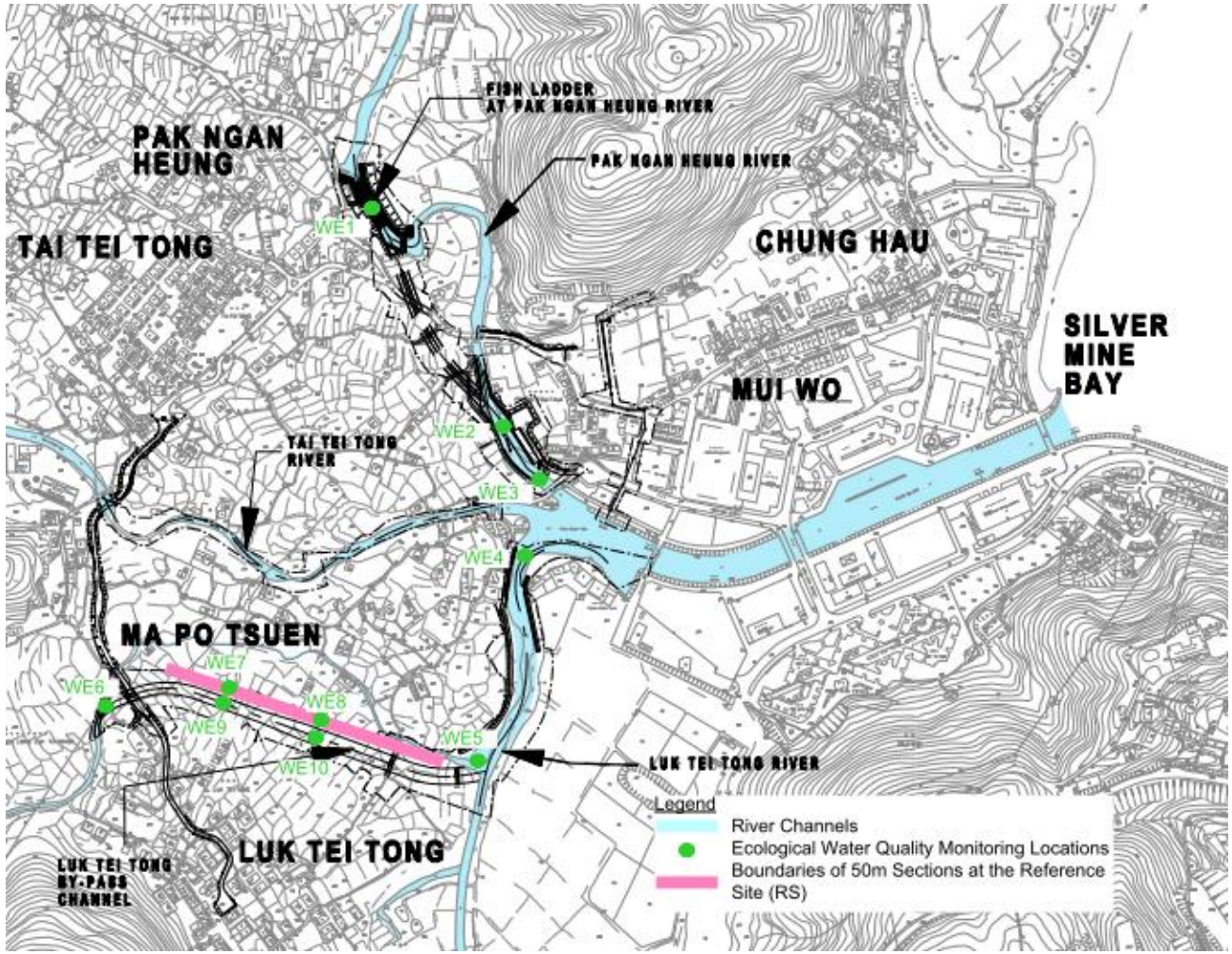
2.2.5. According to the requirement of the Final EM&A Manual, two consecutive measurements for parameters of DO concentration, and DO saturation are required to be taken at each monitoring location. When the difference in value between the first and second reading of DO is more than 25%, the reading was discarded and a further reading taken.

2.3. Limitations

2.3.1. No water was present at LBC2 to LBC5 at the time of survey, therefore aquatic fauna surveys were not undertaken in these locations.

2.3.2. No water was present at WE7 - WE10 at the time of survey, therefore water quality monitoring was not undertaken at these locations.

Figure 2 **Ecological Water Quality Monitoring Locations at Pak Ngan Heung River, Luk Tei Tong River, Luk Tei Tong Bypass Channel and the Reference Site**



3. MONITORING RESULTS

3.1. Ecological Survey Findings

Pak Ngan Heung River (PNH)

3.1.1. The lower stream of PNH (PNH1 and PNH2) is subject to tidal influence from Silver Mine Bay. Vertical concrete retaining wall formed the banks of the river channel. The two sections were located at the mouth of the PNH. PNH1 and PNH2 were adjacent to each other. The bridge formed the southern boundary of PNH1 whereas the box-culvert formed the northern boundary of PNH2. Small boulders and sandy substrate formed the main component of the streambed.

3.1.2. Rock-filled gabion formed the eastern bank and the gabion and a vertical concrete retaining wall formed the western bank of the upper stream (PNH3 and PNH4). PNH3 and PNH4 are adjacent to each other. PNH4 comprised a man-made cascade, including a fish ladder, while PNH3 comprised a pool below the cascade and was bounded by a bridge at its downstream end. Small boulders and sandy substrate were the main component in the middle streambed which allowed water flow and pool formation, whereas big boulders were scattered on both sides of the streambed and had an absence of water. The width of the fish ladder at PNH4 is around 7 m.

3.1.3. Vegetation growing over the cascade/fish ladder at PNH4 has recently been removed, exposing the feature and allowing free water flow and pools.

Vegetation

3.1.4. At PNH3 and PNH4, a total of 13 plant species were recorded. Vegetation has gradually re-established in the river channel since the removal of vegetation observed in December 2012. The major composition of re-established vegetation was *Polygonum* sp. and Mile-a-minute (*Mikania micrantha*), which was scattered along the fish ladder. *Commelina* sp. occurred close to waterbody. Seedlings of a tree species (Turn-in-the-wind, *Mallotus paniculatus*) was recorded next to the gabion wall. .

3.1.5. At PNH1 and PNH2, no plant species were recorded within the river channel. The vegetation has not changed significantly since the last monitoring period, and includes a record of *Bidens alba* and seedlings of Opposite-leaved Fig (*Ficus hispida*) on the vertical wall.

3.1.6. The list of plant species is presented in **Appendix 2a**.

Terrestrial Fauna

3.1.7. Four avifauna species were recorded at PNH, all of which are common in Hong Kong (**Table 3.1**). Little Egret (*Egretta garzetta*) was the only species of conservation importance recorded. Only one species, Little Egret, was recorded at lower PNH (PNH1). No avifauna species were recorded at PNH2. During the monitoring, the water levels at lower PNH were around 20 cm.

3.1.8. Four species were recorded at upper PNH (PNH3 and PNH4) which supported Little Egret, White Wagtail (*Motacilla alba*), Common Kingfisher (*Alcedo atthis*), and Yellow-browed Warbler (*Phylloscopus inornatus*). The birds at upper PNH were mostly observed along the banks of the river channel.

3.1.9. No dragonflies or herpetofauna were recorded at the PNH during the monitoring.

Aquatic Macroinvertebrate and Fish

3.1.10. Two fish species, two crab species, one shrimp species and nine species of other aquatic invertebrates were recorded at PNH (PNH1 to PNH4) (**Table 3.2**). At lower PNH (PNH1 and PNH2), one fish species and five other aquatic invertebrate were recorded. Redbelly Tilapia (*Tilapia zillii*), the fish species, was found foraging in the waterbody.

3.1.11. One fish species and nine other aquatic macroinvertebrate species were recorded at upper PNH (PNH3 and PNH4). *Goby* sp. was recorded in a pool at PNH3. No fish were recorded at PNH4, the fish ladder. The other aquatic invertebrates (such as the shrimp species,

Caridina cantonensis; the tube worm species, *Capitella capitata* and *Spirorbis* spp) were recorded under boulders in the waterbody at both PNH3 and PNH4.

Table 3.1 Number of Avifauna Recorded at Pak Ngan Heung River (PNH)

Common Name (1)	Scientific Name	Distribution in Hong Kong (2)	Principal Status (3)	Level of Concern (4)	Protection Status in China (5)	China Red Data Book (6)	IUCN Red List (7)	PNH1	PNH2	PNH3	PNH4
Little Egret (8)	*Egretta garzetta*	Common	P	PRC (RC)	-	-	-	1		1	
Common Kingfisher (8)	*Alcedo atthis*	Common	AM,P	-	-	-	-			1	
Yellow-browed Warbler	*Phylloscopus inornatus*	Common	W	-	-	-	-				1
White Wagtail	*Motacilla alba*	Common	W,R	-	-	-	-			1	

Note:
(1) All wild birds are protected under Wild Animal Protection Ordinance (Cap. 170).
(2) AFCD (2013) Hong Kong Biodiversity Database.
(3) R=resident; W=winter visitor; M=migrant; A=autumn; P=present all year, exact composition unknown.
(4) Fellowes *et al*. (2002); RC=Regional Concern; PRC=Potential Regional Concern. Letters in parentheses indicate that the assessment is on the basis of restrictedness in breeding and/or roosting sites rather than in general occurrence.
(5) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(6) Zheng and Wang (1998).
(7) IUCN (2012). IUCN Red List of Threatened Species. Version 2012.2.
(8) Wetland-dependent species (including wetland-dependent species and waterbirds).

Table 3.2 Relative Abundance of Aquatic Macroinvertebrate and Fish Recorded at Pak Ngan Heung River (PNH)

Fauna Group	Scientific Name	Common Name	Distribution in Hong Kong (1)	Level of Concern (2)	Protection Status in China (3)	China Red Data Book (4)	IUCN Red List (5)	PNH1	PNH2	PNH3	PNH4
Fish	*Goby* sp.	-	-	-	-	-	-			++	
Fish	*Tilapia zillii*	Redbelly Tilapia	Common	-	-	-	-	+			
Crab	-	Unknown Crab species (a)	-	-	-	-	-			++	+++
Crab	*Perisesarma bidens*	-	-	-	-	-	-				++
Shrimp	*Caridina cantonensis*	-	-	-	-	-	-			+++	+++
Tube-worms	*Capitella capitata*	-	-	-	-	-	-	+		+++	+++
Tube-worms	*Spirorbis* spp.	-	-	-	-	-	-			++	+
Snail (Nerites)	*Clithon* sp.	-	-	-	-	-	-			+++	
Snail (Lymnaei-dae)	Lymnaeidae	-	-	-	-	-	-			++	+++
Snail (Amphipoda)	Amphipoda	-	-	-	-	-	-			+++	+++
Insect	Trichoptera	Caddisflies	-	-	-	-	-		+		
Insect	*Sinulium* sp.	Blackflies	-	-	-	-	-	++	++	+++	+++
Insect	*Baetidae*	-	-	-	-	-	-		+		
Insect	*Heptageniidae*	-	-	-	-	-	-		+		

Note:
(1) AFCD (2013). Hong Kong Biodiversity Database.
(2) Fellowes *et al.* (2002).
(3) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(4) Zheng and Wang (1998).
(5) IUCN (2012). IUCN Red List of Threatened Species. Version 2012.2
(6) Relative abundance: + = occasional, less than 5 individuals were found; ++ = common, 5-20 individuals were found; +++ = abundant, more than 20 individuals were found.

Luk Tei Tong River (LTT)

3.1.12. The LTT is subject to tidal influence from Silver Mine Bay and is estuarine in nature. It is a north-south running river. A vertical concrete retaining wall formed the river bank of the LTT1 whereas rock-filled gabion formed the river bank of LTT2 to LTT5. LTT1 was located at the confluence with Pak Ngan Heung River, Tai Tei Tong River and Luk Tei Tong River. Since it is subject to tidal flow, water flowed from south to north during the survey when the tide was going out. LTT1 and LTT2 had sandy substrate whilst LTT3 to LTT5 had muddy substrate. Clusters of boulders occurred at both sides of the river channel. The width of the river channel was around 8-10 m.

3.1.13. No evidence of maintenance works (including those relevant to Conditions 2.1 to 2.4 of EP No. EP-434/2012) was observed during the monitoring period.

Vegetation

3.1.14. A total of 15 plant species were recorded in LTT. More than half of the recorded species were exotic, and all of them were herbs or shrubs growing along the gabion, except the mangrove species that grew inside the river channel. Several mature individuals and seedlings of *Kandalia obovata*, a true mangrove species, as well as *Acanthus ilicifolius*, a mangrove associate species, were recorded colonized at the interception of LTT2 and LTT3. Seedlings of *Kandalia obovata* were scattered at LTT1. Herbaceous species such as Mile-a-minute, *Wedelia trilobata*, Beach Morning-glory (*Ipomoea pes-caprae*), and Dhaincha (*Sesbania cannabina*) were occasionally recorded on the gabion along LTT2 through LTT5.

3.1.15. The list of plant species is presented in **Appendix 2a**.

Terrestrial Fauna

3.1.16. A total of eight avifauna species were recorded at LTT, all of them are common in Hong Kong (AFCD, 2013) (**Table 3.3**). Waterbirds species, including Little Egret, Grey Heron (*Ardea cinerea*) and Common Sandpiper (*Actis hypoleucos*), wagtails (White Wagtail, *Motacilla alba*, and Yellow Wagtail, *Motacilla cinerea*), and Common Kingfisher (*Alcedo atthis*) were recorded feeding in the main river channel.

3.1.17. No dragonflies or herpetofauna were recorded at the LTT during the monitoring.

Aquatic Macroinvertebrate and Fish

3.1.18. A total of four fish species, three crab species and sixteen species of other aquatic invertebrates were recorded from the LTT (**Table 3.4**). All of the fish species recorded mainly occur in river mouth or estuarine environments in Hong Kong (AFCD, 2013). Juveniles and adults of Grey Mullet (*Mugil cephalus*) were recorded through LTT1 to LTT5. *Goby* sp, Jarbua Terapon (*Terapon jarbua*), and Mottled spinefoot (*Siganus fuscescens*) were scattered along the river channel.

3.1.19. A Barnacle species (*Balanus amphitrite*) was recorded attached to the rocks within the drainage channel along LTT1 to LTT4. Green Mussel (*Perna viridis*), a rare mangrove bivalve, was recorded at LTT1 and LTT4. A Sea Anemones species, *Haliplanella lineata*, was recorded at LTT1, LTT2 and LTT5.

Table 3.3 Number of Avifauna Recorded at Luk Tei Tong River (LTT)

Common Name (1)	Scientific Name	Distribution in Hong Kong (2)	Principal Status (3)	Level of Concern (4)	Protection Status in China (5)	China Red Data Book (6)	IUCN Red List (7)	LTT1	LTT2	LTT3	LTT4	LTT5
Grey Heron (8)	*Ardea cinerea*	Common	W	PRC	-	-	-	1			1	
Little Egret (8)	*Egretta garzetta*	Common	P	PRC (RC)	-	-	-	1	1			
Common Sandpiper (8)	*Actitis hypoleucos*	Common	M,W	-	-	-	-			1		1
Common Kingfisher (8)	*Alcedo atthis*	Common	AM,P	-	-	-	-					1
Siberian Stonechat	*Saxicola maurus*	Common	W,M	-	-	-	-			1		
Large-billed Crow	*Corvus macrorhynchos*	Common	R	-	-	-	-			1		
Grey Wagtail	*Motacilla cinerea*	Common	W	-	-	-	-					1
White Wagtail	*Motacilla alba*	Common	W,R	-	-	-	-		1			

Note:
(1) All wild birds are protected under Wild Animal Protection Ordinance (Cap. 170).
(2) AFCD (2013). Hong Kong Biodiversity Database
(3) R=resident; W=winter visitor; M=migrant; A=autumn; P=present all year, exact composition unknown.
(4) Fellowes *et al.* (2002); RC=Regional Concern; PRC=Potential Regional Concern. Letters in parentheses indicate that the assessment is on the basis of restrictedness in breeding and/or roosting sites rather than in general occurrence.
(5) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(6) Zheng and Wang (1998).
(7) IUCN (2012). IUCN Red List of Threatened Species. Version 2012.2.
(8) Wetland-dependent species (including wetland-dependent species and waterbirds).

Table 3.4 Relative Abundance of Aquatic Macroinvertebrate and Fish Recorded at Luk Tei Tong River (LTT)

Fauna Groups	Scientific Name	Common Name	Distribution in Hong Kong [1][2][3]	Level of Concern [4]	Protection Status in China [5]	China Red Data Book [6]	IUCN Red List [7]	LTT1	LTT2	LTT3	LTT4	LTT5
Fish	*Mugil cephalus*	Grey Mullet	Common	-	-	-	Least Concern	++	+++	+++	+++	++
Fish	*Goby* sp.	-	-	-	-	-	-	++	+			+++
Fish	*Terapon jarbua*	Jarbua Terapon	Common	-	-	-	-		++			
Fish	*Siganus canaliculatus*	White-spotted rabbit fish	Common	-	-	-	-			+		
Crabs	*Perisesarma bidens*	-	-	-	-	-	-		+	+++		++
Crabs	*Portunus pelagicus*	-	-	-	-	-	-	+				
Crabs	*Sesarmops sinensis*	-	-	-	-	-	-		+		+	
Sea Slater	*Ligia exotica*	Sea Slater	-	-	-	-	-					+
Amphipod	Amphipoda	-	-	-	-	-	-	+++	+++	+++		++
Insect	*Sinulium* sp.	Blackflies	-	-	-	-	-	+++	+++			++
Sea-anemones	*Haliplanella lineata*	-	Common	-	-	-	-	++	+			+
Tube-worms	*Capitella capitata*	-	-	-	-	-	-			+		+
Tube-worms	*Spirorbis* spp.	-	Very common	-	-	-	-	++	++	++	+++	
Snail	*Clithon* sp.	-	-	-	-	-	-	++	++			
Snail (Nerites)	*Nerita* sp.	-	-	-	-	-	-		+++			
Snail (Nerites)	*Nerita albicilla*	-	Common	-	-	-	-	+++				
Planaxid Snails	*Planaxis sulcatus*	-	Common	-	-	-	-		+		++	
Turban Shells	*Lunella coronata*	-	Common	-	-	-	-		+			
Bivalves	Lymnaeidae	-	-	-	-	-	-	+++	++		++	+++
Bivalves	*Grafrarium pectinatum*	-	Common	-	-	-	-		++			

Fauna Groups	Scientific Name	Common Name	Distribution in Hong Kong (1)(2)(3)	Level of Concern (4)	Protection Status in China (5)	China Red Data Book (6)	IUCN Red List (7)	LTT1	LTT2	LTT3	LTT4	LTT5
Bivalves	*Perna viridis*	-	Rare	-	-	-	-	++			+	
Bivalves	*Saccostrea cucullata*	Rock oyster	Very common	-	-	-	-	+++			++	
Barnacles	*Balanus amphitrite*	-	Very common	-	-	-	-	+++	+++	++	+++	

Note:
(1) AFCD (2013). Hong Kong Biodiversity Database.
(2) Williams, G (2003). Hong Kong Field Guides – Rocky Shores
(3) Chan et al. (2003). Hong Kong Field Guides – Sandy Shores
(4) Fellowes *et al*. (2002).
(5) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(6) Zheng and Wang (1998).
(7) IUCN (2012). IUCN Red List of Threatened Species. Version 2012.2
(8) Relative abundance: + = occasional, less than 5 individuals were found; ++ = common, 5-20 individuals were found; +++ = abundant, more than 20 individuals were found.

Luk Tei Tong Bypass Channel (LBC) and Reference Site (RS)

3.1.20. The LBC is linked to the end of LTT5 and runs east to west but the connection with LTT5 is blocked by a layer of gabion wall of around 1 m which allows water flow between LBC and LTT when water level is higher than the height of the gabion. It is located in the Luk Tei Tong Marsh to the west of the original LTT. Gabion walls formed both sides of the river bank. Generally, all sections were heavily vegetated except in LBC1 where a small pool of approximately 60 m^2 in size was located at the western end of LBC1. The pool was separated from the LTT by a weir constructed from a single layer of rock-filled gabion. The substrate comprised soil which was translocated from the marsh area prior to construction of the bypass. The width of the bypass channel was approximately 15 m.

3.1.21. The RS was located parallel to the northern side of the LBC. Next to the RS was village housing. The site was vegetated and did not have any free-standing water at the time of survey.

3.1.22.

Vegetation

3.1.23. A total of 22 plant species were recorded in LBC, of which 10 species were found in the quadrats sampled. The list of plant species is presented in **Appendix 2b**. More than half of the recorded species were exotic. During the survey, only LBC1 included a small patch of open shallow water. Other sections were dry.

3.1.24. The habitat at LBC1 differed from the remaining sections in terms of vegetation type. It may be subject to tidal influence during high tide because of its location immediately next to LTT. The sedge, Ferrugineous-scale Fimbristylis (*Fimbristylis sieboldii*), dominated LBC1 with a pool of open water forming the western part of the section next to LTT.

3.1.25. Vegetation was gradually re-establishing in LBC2 to LBC5 since the clearance observed in December 2012 though it was dominated by *Wedelia trilobata*, which was most often recorded in the quadrats, followed by patches of Ciliate Microstegium (*Microstegium ciliatum*). The vegetation was short, generally less than 5 cm in heaight. Marsh species such as Ginger Lily (*Hedychium coronarium*) and Interrupted Tri-vein Fern (*Cyclosorus interruptus*) were occasionally recorded during walk through survey.

3.1.26. A total of 33 plant species were recorded in the RS, of which 11 species were found in the quadrats (**Table 3.5**). Sixteen of 33 species were exotic. All sections were dry and were located next to the village housing. The dominant species was exotic *Wedelia trilobata*, followed by exotic Rose Mallow (*Urena lobata*) and Mile-a-minute. Other species such as *Mimosa diplotricha* and *Aster subulatus* scattered across the RS sections. The majority of vegetation recorded at the RS could typically be found in disturbed land. Marsh species (e.g. Ginger Lily) was recorded only at RS2 and RS3.

3.1.27. The list of plant species is presented in **Appendix 2b**.

Table 3.5 Vegetation Coverage at Luk Tei Tong Bypass Channel (LBC) and Reference Site (RS)

	LBC	RS
No. of species recorded in quadrats	10	11
Total No. of species	22	33
Total No. of exotic species	10	16
Average vegetation coverage	77%	79%
Bare ground coverage	23%	21%

Note:
(1) The transect was not laid along any open water, thus open water coverage was not provided in this table.

Terrestrial Fauna

3.1.28. Four species of avifauna were recorded at LBC (**Table 3.6**) whereas another four species of avifauna were recorded at the RS (**Table 3.7**). All recorded species are common in Hong Kong, except White's Thrush (*Zoothera aurea*), which is an uncommon visitor in Hong Kong (AFCD, 2013). White's Thrush was recorded at LBC5 on the river bed. Only Little Egret is regarded as wetland-related species. Other species were mostly lowland bird species such as Siberian Stonechat (S*axicola maurus*), Masked Laughing Thrush (*Garrulax perspicillatus*) and Yellow-bellied Prinia (*Prinia flaviventris*).

3.1.29. One individual of dragonfly, Wandering Glider (*Pantala flavescens*), was recorded at LBC1 (**Table 3.8**). This species is widely distributed in Hong Kong (AFCD, 2013).

3.1.30. No herpetofauna were recorded at the LBC and RS during the monitoring.

Aquatic Macroinvertebrate and Fish

3.1.31. Six species of fish and one species of invertebrate were recorded at LBC1 which included Grey Mullet (*Mugil cephalus*), Common Mudskipper (*Periophthalmus cantonensis*), and Jarbua Terapon (*Terapon jarbua*) (**Table 3.9**). No species of conservation importance were recorded. Some fish species (e.g. Common Mudskipper*)* were observed using the gaps between the gabions.

3.1.32. No aquatic fauna was recorded at the RS and the remaining sections of the LBC as they were dry during the monitoring.

Table 3.6 Number of Avifauna Recorded at Luk Tei Tong Bypass Channel (LBC)

Common Name (1)	Scientific Name	Distribution in Hong Kong (2)	Principal Status (3)	Level of Concern (4)	Protection Status in China (5)	China Red Data Book (6)	IUCN Red List (7)	LBC1	LBC2	LBC3	LBC4	LBC5
Little Egret (8)	*Egretta garzetta*	Common	P	PRC (RC)	-	-	-	1				
Common Blackbird	*Turdus merula*	Common	W,M	-	-	-	-					1
White's Thrush	*Zoothera aurea*	Uncommon	W	-	-	-	-					1
Olive-backed Pipit	*Anthus hodgsoni*	Common	W	-	-							1

Note:
(1) All wild birds are protected under Wild Animal Protection Ordinance (Cap. 170).
(2) AFCD (2013). Hong Kong Biodiversity Database
(3) R=resident; W=winter visitor; M=migrant; P=present all year, exact composition unknown.
(4) Fellowes *et al.* (2002); RC=Regional Concern; PRC=Potential Regional Concern. Letters in parentheses indicate that the assessment is on the basis of restrictedness in breeding and/or roosting sites rather than in general occurrence.
(5) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(6) Zheng and Wang (1998).
(7) IUCN (2012). IUCN Red List of Threatened Species. Version 2012.2.
(8) Wetland-dependent species (including wetland-dependent species and waterbirds).

Table 3.7 Number of Avifauna Recorded at Reference Site (RS)

Common Name (1)	Scientific Name	Distribution in Hong Kong (2)	Principal Status (3)	Level of Concern (4)	Protection Status in China (5)	China Red Data Book (6)	IUCN Red List (7)	RS1	RS2	RS3	RS4	RS5
Masked Laughing Thrush	*Garrulax perspicillatus*	Abundant	R	-	-	-	-				3	
Yellow-browed Warbler	*Phylloscopus inornatus*	Common	W	-	-	-	-			1		
Yellow-bellied Prinia	*Prinia flaviventris*	Common	R	-	-	-	-		2			
Long-tailed Shrike	*Lanius schach*	Common	R	-	-	-	-	1				

Note:
(1) All wild birds are protected under Wild Animal Protection Ordinance (Cap. 170).
(2) AFCD (2013). Hong Kong Biodiversity Database
(3) R=resident; W=winter visitor
(4) Fellowes *et al.* (2002)
(5) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(6) Zheng and Wang (1998).
(7) IUCN (2012). IUCN Red List of Threatened Species. Version 2012.2.

Table 3.8 Number of Dragonfly Recorded at Luk Tei Tong River Bypass Channel (LBC)

Common Name	Scientific Name	Distribution in Hong Kong (1)	Level of Concern (2)	Protection Status in China (3)	China Red Data Book (4)	IUCN Red List (5)	LBC1	LBC2	LBC3	LBC4	LBC5
Wandering Glider	*Pantala flavescens*	Widely Distributed	-	-	-	-	1				

Note:
(1) AFCD (2013). Hong Kong Biodiversity Database
(2) Fellowes *et al.* (2002)
(3) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(4) Zheng and Wang (1998).
(5) IUCN (2012). IUCN Red List of Threatened Species. Version 2012.2.

Table 3.9 Relative Abundance of Aquatic Macroinvertebrate and Fish Recorded at Luk Tei Tong Bypass Channel (LBC)

Fauna Groups	Scientific Name	Common Name	Distribution in Hong Kong (1)	Level of Concern (2)	Protection Status in China (3)	China Red Data Book (4)	IUCN Red List (5)	LBC1	LBC2	LBC3	LBC4	LBC5
Fish	*Mugil cephalus*	Grey Mullet	Common	-	-	-	Least Concern	++	-	-	-	-
Fish	*Periophthalmus cantonensis*	-	Very common	-	-	-	-	+	-	-	-	-
Fish	*Goby* sp.	-	-	-	-	-	-	+	-	-	-	-
Fish	*Terapon jarbua*	Jarbua Terapon	Common	-	-	-	-	++	-	-	-	-
Fish	*Tilapia zillii*	Redbelly Tilapia	Not common in streams but occurs in many reservoirs and cultivated in fishponds	-	-	-	-	+	-	-	-	-
Fish	*Carassius auratus*	-	Not common in streams but occurs in many reservoirs and cultivated in fishponds	-	-	-	-	+	-	-	-	-
Lymnaeidae	Lymnaeidae	-	-	-	-	-	-	+++	-	-	-	-

Note:
(1) AFCD (2013). Hong Kong Biodiversity Database.
(2) Fellowes *et al.* (2002)
(3) List of Wild Animals Under State Protection (promulgated by State Forestry Administration and Ministry of Agriculture on 14 January, 1989).
(4) Zheng and Wang (1998).
(5) IUCN (2012). IUCN Red List of Threatened Species. Version 2012.2.
(6) Relative abundance: + = occasional, less than 5 individuals were found; ++ = common, 5-20 individuals were found; +++ = abundant, more than 20 individuals were found.

3.2. Ecological Water Quality Monitoring (EWQM)

3.2.1. The post-construction phase EWQM was conducted on 7 February 2013. The monitoring results are presented in **Appendix 3** and summarised in **Table 3.10,** which includes reference to the key Water Quality Objectives (WQOs). Baseline surveys were conducted in 2007 prior to the start of the drainage improvement works. The baseline survey results are presented in **Table 3.11**. The water quality monitoring results are discussed in **Section 5**.

Table 3.10 Summarized Ecological Water Quality Monitoring Results (February 2013)

Parameters	Key Water Quality Objectives (1)	WE1	WE2	WE3	WE4	WE5	WE6
Suspended Solids (mg/L)	<20	4.0	<2.0	10.0	6.0	4.0	4.0
Nitrogen (Ammonia) (mg/L)	-	0.14	0.14	1.40	0.46	4.70	0.05
Nitrogen (Nitrate) (mg/L)	-	0.28	0.27	0.27	0.58	0.23	<0.01
Reactive Phosphorous (mg/L)	-	0.07	0.07	0.20	0.08	0.36	0.04
5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	<5	<2.0	<2.0	2.0	<2.0	<2.0	<2.0
Dissolved Oxygen (mg/L)	>4	6.65	6.80	7.28	11.27	5.72	14.82
Temperature (°C)	-	21.20	20.60	20.70	23.10	20.70	23.10
pH	6.5 – 8 5	6.86	7.02	7.58	8.03	7.24	9.79
Salinity (ppt)	-	0.05	0.22	0.12	16.63	2.52	0.07
Conductivity (µs/cm)	-	104.1	438.7	259.5	27,088	4,681	139.1
Water Flow (m/s)	-	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Water Depth (cm)	-	21	13	13	27	15	13

Note:
(1) The available key Water Quality Objectives (WQOs) for River Monitoring Stations at Mui Wo River on Lantau Island (EPD, 2011).

Table 3.11 Baseline Results of Ecological Water Quality Monitoring Results (September 2007)

Parameters	WE1	WE2	WE3	WE4	WE5	WE6
Suspended Solids (mg/L)	1.0	2.0	3.0	3.0	<1.0	<1.0
Nitrogen (Ammonia) (mg/L)	0.07	0.12	0.11	0.23	0.03	0.02
Nitrogen (Nitrate) (mg/L)	0.12	0.13	0.13	0.31	0.04	0.05
Reactive Phosphorous (mg/L)	0.04	0.06	0.06	0.09	0.06	0.05
5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	<2.0	<2.0	<2.0	<2.0	<2.0	<2.0
Dissolved Oxygen (mg/L)	6.58	6.82	6.37	7.61	6.87	5.70
pH	6.4	7.1	7.0	6.8	6.6	6.1
Salinity (ppt)	<0.1	0.1	0.3	7.6	0.1	<0.1

4. ECOLOGICAL MONITORING SCHEDULE

4.1. The next ecological surveys monitoring and ecological water quality is tentatively scheduled for mid-April 2013.

5. DISCUSSION AND RECOMMENDATIONS

5.1. The aim of the monitoring programme is to provide data on the re-establishment of aquatic/riparian communities in the PNH and LTT, and allow an assessment of the relative success of the mitigation measures to be made. In addition, monitoring of the LBC will assess whether the proposed channel design has provided suitable compensation for the impacts to the Luk Tei Tong Marsh.

5.2. Key observations made during the February 2013 monitoring period in relation to the implemented mitigation measures are presented in **Table 5.1**. Where applicable, recommendations for improving the functionality of the mitigation measures have been made.

5.3. Re-establishment of vegetation was observed in PNH and LBC. No further recommendations were made on vegetation re-establishment at PNH since it was not overgrown that blocks water flow. However, re-establishment of vegetation at LBC posed more concern with exotic species (mainly *Wedelia trilobata*) seemed to be dominating the LBC. Whilst marsh species was also observed, the spread of weedy species may outcompete the preferred marsh species. One of potential underlying issues may lie on the fact that water retention in LBC was not sufficient to support growth of marsh species. However, more observations have to be made and more data has to be collected during wet season.

5.4. Seedlings of the mangrove species (*Kandalia obovata*) were seen at other sections of LTT in addition to the existing mangrove stand at the junction at LTT2 and LTT3. Mangrove re-colonization is occurring naturally mainly at LTT1, where is the confluence of PNH, TTT and LTT. Much of this area is intertidal and the river-bed exposed at low-tide. Mangrove planting is recommended in the drier areas close to retaining walls where there would be minimal disruption to water flow during flood events.

5.5. Whilst some differences between the original 2007 baseline surveys and the February 2013 monitoring surveys are evident, these could be attributed to a range of factors including seasonal variations, and climatic conditions and/or the influence of tidal status at the time of survey. Taking this into account, the key Water Quality Objectives (WQOs) for River Monitoring Stations at Mui Wo River (EPD, 2011) have been included to provide a comparison with standard water quality goals applicable to the area (refer to **Table 3.10**).

5.6. The Environmental Protection Department (EPD) analyses and presents data from its annual water monitoring programme to express the level of compliance with the statutory WQOs including pH, Suspended Solids (SS), 5-day Biochemical Oxygen Demand (BOD_5), and Dissolved Oxygen (DO). These WQOs specify the long-term water quality goals that the Government is to achieve and maintain for individual rivers in Hong Kong, including the Mui Wo River. As part of the programme five locations are sampled from the Mui Wo River, three of which are associated with the monitoring area for the drainage improvement works (MW1, MW2 and MW4). The objectives related to these sampling locations, have been used in this report.

5.7. Comparison of the data in **Table 3.10** demonstrates that the February 2013 monitoring results meet the key WQOs for the Mui Wo River (EPD, 2011), except pH level at WE6, indicating a reasonable water quality of the subject watercourses. The pH level at WE6 exceeded the upper limit of WQOs, which demonstrated a more alkaline pH level. WE6 is the water sampling station of the original river section of LTT. Water flows from the upper stream of LTT, where the cause of the increase in pH level was not identified. This phenomenon will be monitored during the future monitoring periods.

5.8. Results of other parameters, such as Ammonia and Nitrate, demonstrated an increase from the baseline survey; however, the reason for this and implications for the re-establishment of the aquatic/riparian communities in not currently known. The BOD_5 concentration at all

locations were still reasonable. Suspended solid concentration demonstrated a 5-fold increase at monitoring station WE3 compared to the last sampling record. No observable evidence of environmental changes such as odour, or discharge within the surveyed area, were recorded. The cause of the increase was not identified. This phenomenon will be monitored during future monitoring periods.

5.9. The February 2013 monitoring period occurs early in the post-construction monitoring programme and provides only a snap-shot of the water quality conditions. Further monitoring is required to draw conclusions regarding the overall success of the mitigation measures implemented into the project. The assessment will be on-going over the course of the monitoring programme and will be presented in subsequent reports as additional information becomes available.

Table 5.1 Observations/Comments and Recommendations Arising from the February 2013 Monitoring Period

Location	Mitigation Measure	Observations/Comments	Recommendations
PNH and LTT	Construction of a small fish ladder at the upstream end of the PNH	Vegetation has gradually re-establishedin PNH4. A mix of weedy species (*Mikania micrantha*) and native *Polygonum* sp. were the most common plant species. Yet, the growth of vegetation has not impeded water flow. The fish ladder does not meet the lip of the weir at the up-stream end of PNH4 due to a drop of approximately 30 cm. This could limit the overall function of the fish ladder for fish passage/movement up and downstream.	The retention of native species, particularly at the edges of the river channel, during any future maintenance activities is recommended, to maintain existing habitat and minimize the recolonisation of exotic species. Some planters have been incorporated into the gabion banks, but do not appear to have been planted up. Planting of small, native, riparian shrub species may also provide habitat and minimize the recolonisation of exotic species. On-going weed management is recommended, as required, to maintain the open nature of the fish ladder. Provision of some smaller pools, at the top of the fish ladder, closer to the weir, may assist the passage/movement of the fish.
	Re-establishment of aquatic / riparian communities	No fish was recorded at PNH4 during this monitoring.	The presence of species of conservation importance in both PNH3 and PNH4 including relative abundance will continue to be monitored.

Location	Mitigation Measure	Observations/Comments	Recommendations
	Re-colonization of mangrove	Patches of mangrove were recorded during the EIA study, including *Aegiceras corniculatum* and *Bruguiera gymnorrhiza,* whereas only a patch of *Kandalia obovata* and *Acanthus ilicifoli* were recorded in the current survey.	Re-planting of mangrove species at the drier area close to retaining walls at the river confluence at LTT1 is recommended. There would be minimal disruption to water flow during flood events.
LBC	Provision of suitable habitat compensation	Vegetation has gradually re-established, which is dominated by exotic plant species (*Wedelia trilobata*). Only limited marsh species were recorded.	The retention of native species (particularly marsh species) within the LBC during any future maintenance activities is recommended, to maintain existing habitat and minimize the recolonisation of exotic species. The regeneration of marsh species in the LBC is to be monitored. To avoid recolonisation of unwanted species (e.g. *Wedelia trilobata*), replanting of marsh species would be recommended upon confirmation of the water level/availability to support marsh habitat.
		The limited occurrence of typical marsh plant species (although this was also limiting in the RS) suggests that the water levels/availability within the channel may not be adequate to sustain a marsh habitat.	On-going monitoring of water levels and species composition within the channel are required. Further assessment should take into account timing of the surveys (wet/dry season).

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Appendix 1. Calibration certificate of the instruments (pH meter and multi-meter)

ALS Technichem (HK) Pty Ltd

REPORT OF EQUIPMENT PERFORMANCE CHECK/CALIBRATION

CONTACT:	MR MIKE SHEK	**WORK ORDER:**	HK1301561
CLIENT:	AECOM ASIA COMPANY LIMITED	**LABORATORY:**	HONG KONG
ADDRESS:	11/F, TOWER 2, GRAND CENTRAL PLAZA, 138 SHATIN RURAL COMMITTEE ROAD, SHATIN, N.T., HONG KONG.	**DATE RECEIVED:**	17/01/2013
		DATE OF ISSUE:	24/01/2013
PROJECT:	--		

COMMENTS

It is certified that the item under calibration/checking has been calibrated/checked by corresponding calibrated equipment in the laboratory.
Maximum Tolerance and calibration frequency stated in the report, unless otherwise stated, the internal aceptance criteria of ALS will be followed.

Scope of Test:	pH
Description:	pH Meter
Brand Name:	ORION
Model No.:	ORION 230A+
Serial No.:	020365
Equipment No.:	W.039.04
Date of Calibration:	24 January, 2013

NOTES

This is the Final Report and supersedes any preliminary report with this batch number.
Results apply to sample(s) as submitted. All pages of this report have been checked and approved for release.

ISSUING LABORATORY: HONG KONG

Address

ALS Technichem (HK) Pty Ltd

11/F Chung Shun Knitting Centre
1-3 Wing Yip Street
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Phone: 852-2610 1044
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Mr. Chan Kwok Kai Godfrey
Laboratory Manager - Hong Kong

REPORT OF EQUIPMENT PERFORMANCE CHECK/CALIBRATION

Work Order: HK1301561
Date of Issue: 24/01/2013
Client: AECOM ASIA COMPANY LIMITED

Description: pH Meter
Brand Name: ORION
Model No.: ORION 230A+
Serial No.: 020365
Equipment No.: W.039.04
Date of Calibration: 24 January, 2013 Date of next Calibration: 24 April, 2013

Parameters:

pH Value

Method Ref: APHA 21st Ed. 4500H:B

Expected Reading (pH Unit)	Displayed Reading (pH Unit)	Tolerance (pH unit)
4.0	3.98	-0.02
7.0	7.02	0.02
10.0	9.93	-0.07
	Tolerance Limit (±pH unit)	0.20

Temperature

Method Ref: Section 6 of International Accreditation New Zealand Technical Guide No. 3 Second edition March 2008: Working Thermometer Calibration Procedure.

Reading of Ref. thermometer (°C)	Displayed Reading (°C)	Tolerance (°C)
11.0	11.8	0.8
21.0	20.3	-0.7
45.0	45.3	0.3
	Tolerance Limit (±°C)	2.0

Remark: "Displayed Reading" presents the figures shown on item under calibration / checking regardless of equipment precision or significant figures.

Mr Chan Kwok Fai, Godfrey
Laboratory Manager - Hong Kong

ALS Technichem (HK) Pty Ltd

REPORT OF EQUIPMENT PERFORMANCE CHECK/CALIBRATION

CONTACT:	MR MIKE SHEK	**WORK ORDER:**	HK1302694
CLIENT:	AECOM ASIA COMPANY LIMITED	**LABORATORY:**	HONG KONG
ADDRESS:	11/F, TOWER 2, GRAND CENTRAL PLAZA, 138 SHATIN RURAL COMMITTEE ROAD, SHATIN, N.T., HONG KONG.	**DATE RECEIVED:**	30/01/2013
		DATE OF ISSUE:	06/02/2013
PROJECT:	–		

COMMENTS

It is certified that the item under calibration/checking has been calibrated/checked by corresponding calibrated equipment in the laboratory.
Maximum Tolerance and calibration frequency stated in the report, unless otherwise stated, the internal aceptance criteria of ALS will be followed.

Scope of Test:	Conductivity, Dissolved Oxygen, Salinity and Temperature
Description:	YSI PROFESSIONAL PLUS
Brand Name:	YSI
Model No.:	--
Serial No.:	12M100515
Equipment No.:	W.040.01
Date of Calibration:	05 February, 2013

NOTES

This is the Final Report and supersedes any preliminary report with this batch number.
Results apply to sample(s) as submitted. All pages of this report have been checked and approved for release.

ISSUING LABORATORY: HONG KONG

Address

ALS Technichem (HK) Pty Ltd
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Mr Chan Kwok Fai, Godfrey
Laboratory Manager - Hong Kong

REPORT OF EQUIPMENT PERFORMANCE CHECK/CALIBRATION

Work Order: HK1302694
Date of Issue: 06/02/2013
Client: AECOM ASIA COMPANY LIMITED

Description: YSI PROFESSIONAL PLUS
Brand Name: YSI
Model No.: --
Serial No.: 12M100515
Equipment No.: W.040.01
Date of Calibration: 05 February, 2013 Date of next Calibration: 05 May, 2013

Parameters:

Conductivity

Method Ref: APHA (21st edition), 2510B

Expected Reading (uS/cm)	Displayed Reading (uS/cm)	Tolerance (%)
146.9	141.9	-3.4
6667	6522	-2.2
12890	11749	-8.9
58670	55430	-5.5
	Tolerance Limit (±%)	10.0

Dissolved Oxygen

Method Ref: APHA (21st edition), 4500O: G

Expected Reading (mg/L)	Displayed Reading (mg/L)	Tolerance (mg/L)
2.20	2.19	-0.01
3.91	3.97	0.06
8.21	8.31	0.10
	Tolerance Limit (±mg/L)	0.20

Salinity

Method Ref: APHA (21st edition), 2520B

Expected Reading (NTU)	Displayed Reading (NTU)	Tolerance (%)
0	0	--
10	9.44	-5.6
20	19.13	-4.4
30	27.78	-7.4
	Tolerance Limit (±%)	10.0

Temperature

Method Ref: Section 6 of International Accreditation New Zealand Technical Guide No. 3 Second edition March 2008: Working Thermometer Calibration Procedure.

Expected Reading (°C)	Displayed Reading (°C)	Tolerance (°C)
12.0	11.7	-0.3
21.5	21.5	0.0
37.0	36.7	-0.3
	Tolerance Limit (±°C)	2.0

Remark: "Displayed Reading" presents the figures shown on item under calibration / checking regardless of equipment precision or significant figures.

Mr Chan Kwok Tai, Godfrey
Laboratory Manager - Hong Kong

Appendix 2a: Plant Species Recorded in Pak Ngan Heung River and Luk Tei Tong River

Scientific Name	Growth Form	Native / Exotic to Hong Kong	Distribution in Hong Kong	PNH1	PNH2	PNH3	PNH4	LTT1	LTT2	LTT3	LTT4	LTT5
Acanthus ilicifolius	shrub	native	common						+			
Aster subulatus	herb	exotic	n/a							+		+
Bidens alba	herb	exotic	very common				+			+		+
Colocasia esculenta	herb	native	N/A				+					
Commelina sp.	herb	n/a	n/a				+					
Conyza canadensis	herb	exotic	very common							+		
Crotalaria pallida	herb	exotic	common							+		+
Cyclosorus interruptus	herb	native	common				+					
Hibiscus rosa-sinensis	shrub	exotic	n/a				+					
Imperata koenigii	perennial herb	native	very common									+
Ipomoea cairica	climber	exotic	very common									+
Ipomoea pes-caprae	perennial herb	native	common							+		
Kandelia obovata	shrub or small tre	native	common					+	+	+		
Mallotus paniculatus	tree	native	very common				+					
Mikania micrantha	climber	exotic	very common			+	+			+		
Miscanthus sinensis	perennial herb	native	very common									+
Neyraudia reynaudiana	herb	native	very common							+	+	
Oxalis corniculata	perennial herb	native	very common				+					
Panicum maximum	herb	exotic	very common							+		
Polygonum chinense	herb	native	very common				+					
Polygonum spp.	herb	n/a	n/a				+					
Rhus succedanea	tree	native	common				+					
Sesbania cannabina	herb	exotic	common								+	
Urena lobata	shrub	native	common				+					
Wedelia trilobata	perennial herb	exotic	common				+			+		+

Note:
Code for Abundance: +++=abundant; ++=frequent; +=occasional

Appendix 2b: Plant Species Recorded in Luk Tei Tong Bypass Channel and Reference Site

LLT Bypass Channel (LBC)

Scientific Name	Growth Form	Native / Exotic to Hong Kong	Distribution in Hong Kong	LBC1	LBC2	LBC3	LBC4	LBC5	Average
Species recorded in the quadrats along the transects				**Average Percentage Cover**					
Apluda mutica	herb	native	very common	0.05	0.00	0.00	0.00	0.00	0.01
Aster subulatus	herb	exotic	n/a	0.02	0.00	0.00	0.00	0.00	0.00
Colocasia esculenta	herb	native	very common	0.00	0.00	0.00	0.01	0.01	0.00
Cyclosorus interruptus	herb	native	common	0.00	0.01	0.01	0.00	0.00	0.00
Cuperus sp.	n/a	n/a	n/a	0.00	0.00	0.00	0.00	0.00	0.00
Fimbristylis sieboldii	herb	native	common	0.93	0.00	0.00	0.00	0.00	0.19
Ipomoea cairica	climber	exotic	very common	0.00	0.02	0.00	0.00	0.00	0.00
Ipomoea pes-caprae	perennial herb	native	common	0.00	0.20	0.00	0.00	0.00	0.04
Microstegium ciliatum	perennial procumbent herb	native	very common	0.00	0.00	0.00	0.02	0.20	0.04
Wedelia trilobata	perennial herb	exotic	common	0.00	0.41	0.72	0.67	0.56	0.47
Other species recorded during the walk-through survey				**Occurrence of the Species**					
Apluda mutica	herb	native	very common	+					
Aster subulatus	herb	exotic	n/a	+					
Bidens alba	herb	exotic	very common			+		+	
Colocasia esculenta	herb	native	N/A			+	+		
Cyclosorus interruptus	herb	native	common		+	+	+		
Cyperus alternifolius subsp. flabelliformis	herb	exotic	n/a	+					
Cyperus sp.	n/a	n/a	n/a	+					
Fimbristylis sieboldii	herb	native	common	+					
Hedychium coronarium	shrub	exotic	n/a			+	+		
Ipomoea cairica	climber	exotic	very common	+	+		+		
Ipomoea pes-caprae	perennial herb	native	common		+				
Kandelia obovata	shrub or small tree	native	common	+					
Macroptilium atropurpureum	procumbent herb	exotic	common	+					
Microstegium ciliatum	perennial procumbent herb	native	very common		+		+	+	
Mikania micrantha	climber	exotic	very common		+	+	+	+	
Neyraudia reynaudiana	herb	native	very common	+					
Paspalum conjugatum	perennial herb	exotic	common					+	
Phragmites spp.	n/a	native	very common	+					
Plantago major	herb	native	very common				+		
Polygonum chinense	herb	native	very common			+	+	+	
Ruellia coerulea	herb	exotic	N/A	+					
Wedelia trilobata	perennial herb	exotic	common		+	+	+	+	

Note:

Code: +=occurrence of the species

Appendix 2b: Plant Species Recorded in Luk Tei Tong Bypass Channel and Reference Site

Reference Site (RS)

Scientific Name	Growth Form	Native / Exotic to Hong Kong	Distribution in Hong Kong	RS1	RS2	RS3	RS4	RS5	Average
Species recorded in the quadrats along the transects				**Average Percentage Cover**					
Axonopus compressus	perennial procumbent herb	exotic	common	0.00	0.00	0.00	0.00	0.08	0.02
Hedychium coronarium	shrub	exotic	n/a	0.00	0.05	0.00	0.00	0.00	0.01
Lantana camara	shrub	exotic	very common	0.00	0.00	0.00	0.00	0.01	0.00
Microstegium ciliatum	perennial procumbent herb	native	very common	0.00	0.01	0.00	0.00	0.00	0.00
Mikania micrantha	climber	exotic	very common	0.00	0.00	0.00	0.00	0.19	0.04
Mimosa diplotricha	herb	exotic	rare	0.05	0.00	0.00	0.01	0.06	0.03
Paspalum conjugatum	perennial herb	exotic	common	0.00	0.00	0.01	0.00	0.00	0.00
Pueraria phaseoloides	climber	native	very common	0.00	0.00	0.00	0.00	0.05	0.01
Sporobolus fertilis	perennial herb	native	very common	0.02	0.00	0.00	0.00	0.00	0.00
Urena lobata	shrub	native	common	0.20	0.00	0.02	0.00	0.01	0.05
Wedelia trilobata	perennial herb	exotic	common	0.56	0.68	0.72	0.77	0.44	0.63
Other species recorded during the walk-through survey				**Occurrence of the Species**					
Acacia confusa	tree	exotic	n/a		+		+		
Ageratum houstonianum	herb	exotic	common	+				+	
Artemisia japonica	herb	native	common			+	+		
Aster subulatus	herb	exotic	n/a	+	+	+		+	
Axonopus compressus	perennial procumbent herb	exotic	common					+	
Bambusa sp.	bamboo	n/a	common	+					
Bidens alba	herb	exotic	very common			+	+		
Celosia argentea	herb	native	very common	+					
Celtis sinensis	tree	native	common			+			
Conyza canadensis	herb	exotic	very common	+	+		+		
Crotalaria pallida	herb	exotic	common	+					
Eleusine indica	herb	native	very common		+				
Emilia sonchifolia	herb	native	very common				+		
Ficus hispida	tree	native	very common			+	+		
Hedychium coronarium	shrub	exotic	n/a		+	+			
Imperata koenigii	perennial herb	native	very common		+			+	
Ipomoea cairica	climber	exotic	very common	+			+		
Ipomoea pes-caprae	perennial herb	native	common		+				
Lantana camara	shrub	exotic	very common				+	+	
Leucaena leucocephala	tree	exotic	common				+		
Mallotus paniculatus	tree	native	very common				+	+	
Microstegium ciliatum	perennial procumbent herb	native	very common		+			+	

Note:
Code: +=occurrence of the species

Appendix 2b: Plant Species Recorded in Luk Tei Tong Bypass Channel and Reference Site

Reference Site (RS)

Scientific Name	Growth Form	Native / Exotic to Hong Kong	Distribution in Hong Kong	RS1	RS2	RS3	RS4	RS5
Other species recorded during the walk-through survey				**Occurrence of the Species**				
Mikania micrantha	climber	exotic	very common	+				+
Mimosa diplotricha	herb	exotic	rare	+	+	+	+	+
Miscanthus floridulus	perennial herb	native	common	+	+			
Paspalum conjugatum	perennial herb	exotic	common	+	+	+		
Pueraria phaseoloides	climber	native	very common	+	+	+		+
Sageretia thea	shrub	native	very common	+	+			
Sapium sebiferum	tree	native	common					+
Solanum americanum	herb	exotic	very common		+	+		
Sporobolus fertilis	perennial herb	native	very common	+				
Urena lobata	shrub	native	common	+	+	+		+
Wedelia trilobata	perennial herb	exotic	common	+	+	+	+	+

Note:
Code: +=occurrence of the species

Appendix 3: Ecological Water Quality Monitoring Raw Data

(February 2013)

Date of Monitoring: 7 February 2013 **Weather : Cloudy**

Monitoring Location	Suspended Solids (mg/L)	Nitrogen (Ammonia) (mg/L)	Nitrogen (Nitrate) (mg/L)	Reactive Phosphorous (mg/L)	5-day Biochemical Oxygen Demand (BOD5) (mg/L)	Dissolved Oxygen (mg/L)	
						M1	M2
WE1	4.0	0.14	0.28	0.07	<2.0	6.65	6.64
WE2	<2.0	0.14	0.27	0.07	<2.0	6.78	6.81
WE3	10.0	1.40	0.27	0.20	2.0	7.30	7.25
WE4	6.0	0.46	0.58	0.08	<2.0	11.28	11.26
WE5	4.0	4.70	0.23	0.36	<2.0	5.70	5.73
WE6	4.0	0.05	<0.01	0.04	<2.0	14.89	14.74
WE7	No water - Not sampled						
WE8	No water - Not sampled						
WE9	No water - Not sampled						
WE10	No water - Not sampled						

Monitoring Location	Temperature (^{o}C)		pH		Salinity (ppt)		Conductivity (µs/cm)	Water Flow (m/s)	Water Depth (cm)
	M1	M2	M1	M2	M1	M2			
WE1	21.2	21.2	6.86	6.85	0.05	0.05	104.1	<0.1	21
WE2	20.6	20.6	7.02	7.02	0.22	0.22	438.7	<0.1	13
WE3	20.7	20.7	7.59	7.57	0.12	0.12	259.5	<0.1	13
WE4	23.1	23.1	8.03	8.03	16.62	16.63	27,088	<0.1	27
WE5	20.7	20.7	7.24	7.24	2.51	2.53	4,681	<0.1	15
WE6	23.1	23.1	9.79	9.78	0.07	0.06	139.1	<0.1	13
WE7	No water - Not sampled								
WE8	No water - Not sampled								
WE9	No water - Not sampled								
WE10	No water - Not sampled								

Note:
Where more than one measurement was taken, the data is represented by Measurement M1 and M2.