

Appendix 8-10

Wetland Restoration Plan

1 INTRODUCTION

- 1.1.1 The Project Area mainly comprises agricultural land (both active and inactive as well as wet and dry) and fish ponds which are largely inactive or overgrown with vegetation. Some ponds are believed to have a low level of management for provision of limited fish stock for self-consumption by villagers.
- 1.1.2 The Project Area falls within the Deep Bay Area, an ecologically sensitive area of international importance which is covered by Town Planning Board Guidelines TPB PG-No. 12C. The north of the Project Area (containing fish ponds and agricultural land) is continuous with the Deep Bay wetland system and lies within the Wetland Conservation Area (WCA). The central and southern portions of the Project Area lie within the Wetland Buffer Area (WBA) (**Figure 8-1**). The fish ponds in the north of the site are contained within a priority site for enhanced conservation under the New Nature Conservation Policy (Deep Bay Wetland outside Ramsar Site, ranked as 9 out of the 12 listed priority sites).
- 1.1.3 The Project Area is located within the area covered by the Approved Mai Po and Fairview Park Outline Zoning Plan (OZP) No. S/YL-MP/6 and is zoned as 'Other Specified Use – Comprehensive Development and Wetland Protection Area'. According to the OZP 'the planning intention of this zone is to allow the consideration of comprehensive low-density residential development or redevelopment provided that all the existing continuous and contiguous fish ponds within the zone are protected and conserved. The "no-net-loss in wetland" principle is adopted for any change in use within the zone. Development or redevelopment within this zone should involve no pond filling and no decline in wetland function of the fish ponds. Any new development should be located on the formed land and as far away from the existing fish pond within the development site.'
- 1.1.4 Since the Project Area falls within the Deep Bay Area, Town Planning Board Guideline TPB PG-No. 12C requires a 12-month ecological survey be conducted as part of any planning application. In accordance with the guideline, an ecological survey of the Project Area and surrounding 500m was conducted between September 2007 and August 2008. Additional surveys were conducted in 2009 and 2011 to investigate bird flight-lines over the Project Area. The Ecological Impact Assessment recommended the establishment of a Wetland Restoration Area (WRA) to mitigate for impacts identified to wetland habitats. This Wetland Restoration Plan (WRP) provides the basis for the establishment of the WRA, including details of the habitats to be provided, target species to be attracted, procedures for site preparation, management requirements to ensure suitable habitats are provided and monitoring requirements.

2 DESCRIPTION OF THE SITE

2.1 Location

- 2.1.1 The Project Site covers Lot Nos. 3054 BRP and 3055 in DD 104 near Yau Mei San Tsuen, Mai Po, Yuen Long, with a total site area of about 8.1 ha. Most of the site currently comprises agricultural land alongside Yau Pok Road near Kam Pok Road. It is located at the fringe of the Deep Bay area and bounded by a number of existing and planned residential developments adjacent to the Castle Peak Road and San Tin Highway.

2.2 Baseline Ecological Condition of the Project Area and Environs

2.2.1 A baseline assessment of the ecological value of the Project Area (including both the area proposed to be developed for housing and the proposed WRA) and the area within 500 m of the Project Area (the Assessment Area) was undertaken between September 2007 and August 2008 (with subsequent updates in 2011). This assessment is included in provided in Section 8 of the Ecological Impact Assessment in the main report. The baseline assessment and other relevant literature has been reviewed in the preparation of this WRP, with the following objectives:

- to identify any habitats and species within the Project Area and the surrounding area which are of ecological significance and which require to be taken into account in the development of the residential area and restored wetland areas either by avoidance, minimisation or compensation of any adverse ecological impacts; and
- to inform decisions as to the appropriate design, habitats and target species for the WRP.

Assessment Area

2.2.2 The Assessment Area for all aspects of the project falls within 500 m of the boundary of the Project Area, together with any area outside this where there is potential for significant ecological impacts arising from the Project (Figure 8-1).

2.2.3 This Assessment Area includes three existing large-scale residential developments (Fairview Park to the west and Palm Springs and Royal Palms to the north) and scattered small village housing in nearby Yau Mei San Tsuen and Chuk Yuen Tsuen.

Project Area

2.2.4 An area of continuous and contiguous fish ponds, most of which are inactive or overgrown with vegetation, extends northwest from the Project Area to connect with the extensive fish pond areas in the Deep Bay wetland system. These fish ponds to the northwest of the Assessment Area are included within one of the priority sites for enhanced conservation under the New Nature Conservation Policy (Deep Bay Wetland outside Ramsar Site).

2.2.5 To the southwest of the Project Area is an extensive mosaic of shrubland and grassland and a few scattered overgrown ponds. A channelised river, Ngau Tam Mei Drainage Channel, is located to the south and south-east of the Project Area. Beyond this channel is agricultural land, most of which is managed for dry crops, with some small and isolated ponds, an extensive mosaic of shrubland and grassland, seasonally wet grassland and a small natural stream.

2.2.6 A smaller low-rise residential area (Casa Paradizo), a few scattered village areas and a small hillside plantation and secondary woodland are located to the east of the San Tin Highway and Castle Peak Road. The San Tin Highway provides an ecological barrier between these areas and the Deep Bay wetlands (including the Project Area).

2.3 Geology and Topography

2.3.1 Based on the existing ground investigation records from Geotechnical Information Unit of Civil Engineering and Development Department, the solid geology underlying the Project Area is 'volcanic/tuff'. The superficial layers comprise fill of approximately 1 m to 3 m thick underlain by marine/pond deposits which are mainly clay in nature

over alluvial clay/sand. The current topographical survey records indicate that the existing ground level is approximately +2.2 mPD.

2.4 Hydrology

2.4.1 The site is located within the San Tin catchment of the Shenzhen (south) river basin. This catchment includes a series of low hills to the south of Castle Peak Road, rising to 66 mPD. To the north of Castle Peak Road there is a flat floodplain which remains largely covered by fishponds. This area was formerly highly susceptible to flooding, however recent flood control works, most notably in the Shenzhen River and the San Tin Eastern Drainage Channel, have considerably reduced flood risk in recent years.

2.4.2 Most of the site drains into a channel which originates close to Castle Peak Road. This channel flows along the easterly and northerly perimeters of the site before flowing north past Palm Springs and discharging into Mai Po River. Flow in the channel is variable and may be low in the absence of recent rainfall. Water in the channel is often highly polluted with organic material. A small part of the western side of the site drains to a channel which enters a concrete-lined storm drain surrounding the Fairview Park residential development. There are no direct hydrological linkages between the Project Area and nearby fish ponds.

2.5 Habitats

Habitats/ vegetation present within the Project Area

2.5.1 Sixteen habitats were identified in the Assessment Area; the area of each of these is given in Table 1. Six habitats (agricultural land, pond, marsh, reed bed, seasonally wet grassland and grassland/shrubland) were identified within the Project Area.

2.5.2 Over the years, some ponds within the Project Area have been drained and converted into agricultural use with little or no import of fill material. Pond 17 was drained in October 2007 and converted to agricultural land during the survey period in 2007-08, but was found to contain shallow water in May 2011 and is classified as pond in the Ecological Impact Assessment.

2.5.3 All habitats in the Project Area and Assessment Area support a low diversity of plant species, all of which are common to very common in Hong Kong. The continuous active management of active and inactive agricultural land and abandoned/inactive ponds contributes to the low floristic diversity of these habitats.

Table 1. Habitats present in the Project Area and the Assessment Area

Habitats	Project Area		Assessment Area (Excluding Protect Area)	
	ha	%	ha	%
Agricultural land (including wet and dry agricultural land)	4.9	60.1	4.8	3.3
Pond	1.2	14.9	22.6	15.8
Marsh	0.9	11.6	0.5	0.3
Stream	-	-	0.6	0.4
Reedbed	0.2	2.4	0.4	0.3
Seasonally wet grassland	0.7	8.7	4.1	2.8
Reedbed/marsh	-	-	1.3	0.9
Secondary woodland	-	-	0.6	0.4
Plantation	-	-	4.6	3.2
Grassland/shrubland	0.2	2.3	14.0	9.8
Drainage channel	-	-	6.3	4.4
Village area	-	-	9.9	6.9
Wasteground	-	-	0.5	0.4
Developed area	-	-	60.3	42.0
Road	-	-	10.2	7.1
Open storage	-	-	2.9	2.0
Total	8.1	100	143.6	100

Note: The above summation may not equal to the sum of the categories due to roundings.

Agricultural land

2.5.4 Agricultural land is the major habitat identified within the Project Area, covering 4.9 ha or 60.1% of the area. Agricultural land is a very dynamic habitat in Hong Kong. Due to agricultural practice and seasonal rainfall patterns the proportions of active and inactive and wet and dry agricultural land are subject to frequent change and any survey thus provides a 'snapshot' of conditions at one point in time. These conditions can change over a relatively short period of time if fields are left fallow or are resumed for active cultivation, and if prevailing weather conditions or agricultural practices lead to fields becoming flooded or drained. As a result, it is considered appropriate to include all active and inactive, wet and dry agriculture into a single habitat category, the evaluation of which is based upon the conditions observed over the course of the entire study period, rather than being reliant on any single visit. However, in practice, since site management actions (such as draining or flooding a field) hinge on the requirements of the planted crop, understanding of the farming intention for the fields is important in informing the process of wetland calculation. The dominant crop of the agricultural land, when it is actively farmed, is lettuce, which is a dry crop, hence the area is considered non-wetland. Subsequent site visit during the wet season will be required to identify, if any, fields which are flooded seasonally for wet crop cultivation, or any fields left fallow (temporarily) and flooded as a result.

2.5.5 Throughout the survey period most of the agricultural fields were used for cultivation of dry farmland crops. Judging from aerial photographs, all areas mapped as agricultural land have a history of active agricultural use dating back at least 10 years. Due to active management for agriculture, plant diversity recorded in this habitat is low; a total of 30 species was recorded in the survey, with the crop species Chinese White Cabbage *Brassica chinensis* and Lettuce *Lactuca sativa* being the most abundant and dominant species in the active dry agricultural land and *Ipomoea aquatica* in the wet agricultural land. The native grass *Cynodon dactylon* is common

and widespread and exotic herbs, including *Emilia sonchifolia* and *Bidens alba*, together with isolated fruit trees *Dimocarpus longan* and *Litchi chinensis* are present on the bunds.

- 2.5.6 The inactive agricultural land was found to have similarly low floral diversity, with the dominant vegetation in the dry fields again being by *Cynodon dactylon*, *Brachiaria mutica* and other grasses, *Mikania micrantha*, *Emilia sonchifolia* and *Bidens alba* while wet areas were dominated by *Phragmites*.

Pond

- 2.5.7 Most ponds are located in the north of the Project Area, although one small isolated pond is located at the southeastern corner of the Project Area. . Four ponds of various sizes are present, occupying a total of 1.2 ha. Fish ponds in the Deep Bay Area are recognized as a habitat of ecological importance for a suite of medium to large fish-eating bird species (Anon 1997). Actively managed fish ponds are beneficial to wildlife for a number of reasons: the presence of open water providing suitable foraging habitat; the presence (and continuous replenishment) of prey items of suitable sizes; and the periodical drain-down of these ponds for harvesting providing favourable foraging conditions for fish-eating species. Ponds within the Project Area are not managed actively (no periodic drain-down for fish harvesting), though fish from these ponds may be cultivated for non-commercial purposes. A variety of fish species, including Bighead Carp *Aristichthys nobilis*, White-spotted Catfish *Clarias fuscus*, Grass Carp *Ctenopharyngodon idellus* Mosquito Fish *Gambusia affinis* and Tilapia *Oreochromis niloticus* are present. The small pond at the south-eastern corner is inactive or abandoned, and no fish species were observed during the survey. Pond 17 was drained and changed into agricultural land temporarily from October 2007 but has since been re-flooded and has reverted to pond conditions.

- 2.5.8 A total of 20 plant species was recorded in the fish pond areas. The water surface of the ponds had very little emergent vegetation, while the bunds were dominated by grassy vegetation (> 70%) such as *Brachiaria mutica* and *Panicum repens*, with some common herbs also present, including exotic *Bidens alba* and *Euphorbia hirta*, and native *Eleusine indica*. Isolated fruit trees such as *Dimocarpus longan*, *Litchi chinensis* and *Clausena lansium* were planted around the pond bunds, while a limited number of the native tree *Macaranga tanarius* were naturally established on the bunds.

Marsh

- 2.5.9 Marsh was identified in Pond 9, covering an area of 0.9 ha. This marsh has evolved on an abandoned fish pond following years of natural succession, resulting in a habitat dominated by exotic herbaceous vegetation *Typha angustifolia* (40%), *Mikania micrantha* and *Brachiaria mutica* (together comprising 60% of vegetation). These species are aggressive, and can quickly occupy extensive areas in abandoned or inactive ponds. A small area of reed *Phragmites australis* is also established in the pond. The formation of extensive blankets of *Mikania micrantha* and *Brachiaria mutica* limits the establishment of other naturally invading plants. The bund vegetation is dominated by grassy vegetation including *Panicum maximum* and *Brachiaria mutica*, and common exotic herbaceous species such as *Wedelia trilobata* and *Bidens alba*. Isolated fruit trees *Litchi chinensis* are planted along the bund. .

Seasonally wet grassland

2.5.10 Seasonally wet grassland has developed on abandoned ponds following the process of natural succession of vegetation and is flooded only during the wet season. A total of 0.7 ha is present within the Project Area. A small seasonally wet grassland patch was located at the northwestern corner of the Project Area. It is dominated by grassy vegetation *Brachiaria mutica* and *Panicum maximum*. Numbers and diversity of other plant species is limited, possibly due to the presence of an extensive grassy blanket which prevents the establishment of other plant species. The floral and faunal groups supported by these small areas are not significant, but the grassland in the northwest may provide a potential corridor of semi-natural habitat between Fairview Park and the agricultural land in the Project Area.

Reedbed

2.5.11 Reedbed has developed on abandoned ponds following the process of natural succession of vegetation. A total of 0.2 ha is present within the Project Area. A small reed patch was located at Area 40 of the Project Area. It is dominated by *Phragmites australis*, and *Brachiaria mutica* and *Panicum maximum*, and numbers and diversity of other plant species is limited. The floral and faunal groups supported by these small areas are not significant, but the area appears to be used by a number of birds as their flight line between the Deep Bay area and the Ngau Tam Mei Drainage Channel.

Grassland/shrubland

2.5.12 Grassland/shrubland has potentially developed on abandoned fields following the process of natural succession of vegetation. A total of 0.2 ha is present within the Project Area at the northwestern corner. This area situates largely on raised ground around the channel adjacent to Fairview Park and the abutting site zoned "Recreation". The area adjacent to the "Recreation" zone is subject to routine vegetation management and supports very low floristic diversity, while the grassland/shrubland adjacent to the channel has a slightly higher plant diversity, with scattered *Musa x paradisiaca*, *Macaranga tanarius*, *Ficus microcarpa* and *Melia azedarach* and bamboo spp., Other common and widespread herb species such as *Panicum maximum*, *Bidens alba*, *Eleusine indica* and *Eclipta prostrata*.

3 OBJECTIVES AND GUIDING CONCEPTS

3.1 Plan Objectives

3.1.1 The primary objective of this WRP is to detail the specifications for the habitats and ecological functions to be provided by the wetland habitats that are to be restored/enhanced within the WRA. The wetland areas will comprise a mixture of micro-habitats designed to provide the habitat requirements for a number of identified target species, as well as providing benefit for non-target species. Target species have been selected after a review of the existing ecological interest of the site and its environs, the potential adverse impacts of the residential development on habitats and species of conservation importance, and the opportunities and constraints on the site.

3.1.2 It should be noted that the detailed design of the wetland is still required and that this will be undertaken upon approval of a Section 16 Application for the proposed development. Details of the Plan should be approved by relevant Government departments prior to commencement of the construction of the WRA.

3.2 Guiding Principles

3.2.1 The guiding principles upon which this WRP has been drafted are described below:

- (a) Recognition of the value of the Deep Bay wetlands, especially the Mai Po Inner Deep Bay Ramsar Site and the priority site for enhanced conservation, and the importance of the WCA in protecting these sites.
- (b) Recognition of the potential of the WRA to contribute to the maintenance and enhancement of the wildlife value and microhabitat diversity of the Deep Bay wetland system.
- (c) Recognition that fauna targets for the WRA should be based upon clear conservation objectives arising from the constraints of the site (including its size and proximity to established developments), opportunities presented on site (especially its location on the southern fringe of the Deep Bay wetland system) and the need to mitigate for any potential adverse impacts of the residential development on habitats, flora or fauna of conservation importance.
- (d) Recognition that wetland enhancement or rehabilitation has a proven track record in Hong Kong, including at locations that were once wetland but which were drained or filled for periods of time (relevant examples here include wetland rehabilitation or enhancement for the Lok Ma Chau Spur Line, West Rail, The Hong Kong Wetland Park, and the Yuen Long Bypass Floodway).
- (e) Requirement that hydrological changes as part of the wetland rehabilitation must not increase the flood risk to other catchment users.
- (f) Requirement that the wetland habitats should be largely self-sustaining, such that once the wetlands are established, management should largely be limited to maintenance works. This should still allow for adaptive management, whereby management practices change in response to on-site conditions (especially in response to any failures to attract target species, or to the use of the site by species of conservation importance that are not target species).
- (g) Understanding of the habitat requirements of target species, the feasibility of the provision of the required habitats and a realistic assessment of the likelihood that the habitats will be utilized once they are provided.
- (h) Recognition of the ecological value of any existing habitats on site, whilst acknowledging that wetland enhancement or rehabilitation may require significant alterations to other habitats which are of little or no ecological value at present.
- (i) Recognition that monitoring is essential to assess the success or otherwise of the rehabilitated wetlands and to inform management decisions.

3.2.2 Part of the site falls within the boundary of the WCA, and the entire site is currently zoned as “Other Specified Uses” annotated “Comprehensive Development to include Wetland Protection Area” (“OU(CDWPA)”); thus, the planning intentions and guiding principles as outlined in TPB PG No.12C and the explanatory note under OU(CDWPA) of OZP No. S/YL-MP/6 apply. Relevant guiding principles are listed below:

- ‘no-net-loss in wetland’ principle;
- avoidance of loss of fish ponds and habitat fragmentation;
- all existing continuous and adjoining active/abandoned fish ponds are to be conserved;
- the integrity of the habitat should be maintained to avoid disturbance and/or fragmentation;

- consideration of alternative ecologically beneficial uses to existing fish ponds which would perform ecological functions similar to or better than the existing fish ponds and would be compatible with the conservation objectives of the wetland in Deep Bay Area;
- no increase to the pollution loading of the Deep Bay Area;
- consideration of limited low-density private residential/recreational development at the landward fringe of the WCA in exchange for committed long-term conservation and management of the remaining ponds within the development site;
- any new development should be located on formed land and as far as possible from existing fish ponds within the development site, with no pond filling;
- no decline in the wetland function of the fish ponds within and near the development site; and
- provision of a wetland and visual buffer to separate the development from the WCA to minimize its impact on the wetland for areas directly abutting the WCA.

3.2.3 The conclusion from the guiding principles outlined above is that, all factors being equal, proposed development should be located on existing formed land with no pond-filling, the development should be placed as far away from Deep Bay wetlands as possible and alternative ecologically beneficial habitats other than fish ponds should be considered for incorporation into the proposed WRA, if appropriate.

3.2.4 In addition, a wetland and visual buffer is to be provided at the interface between the WBA and WCA to minimize potential disturbance from to the WCA.

4 TARGET SPECIES FOR THE REHABILITATED WETLANDS

4.1 Following a review of the baseline data, target species for the rehabilitated wetlands have been identified as those species of conservation importance which were recorded in significant numbers during the baseline ecological surveys and which therefore may be impacted by the proposed development.

4.2 Target Species

4.2.1 To qualify as a Target Species as species must fulfill the following requirement:

- Species of Conservation Importance based upon criteria provided by IUCN Species Survival Commission (2001), BirdLife International (2006 and web updates) and/or Fellowes *et al.* (2002), which was recorded during the baseline ecological surveys in numbers considered to be of significance.

4.2.2 In addition to this, all data from the baseline surveys were reviewed to determine whether or not there were species (especially wetland-dependent species) which, although not of conservation concern, were recorded in particularly high numbers in a local context. The aim of this review was to determine whether or not the site was of importance to species which, although not of conservation importance, would be significantly impacted by the proposed development, in the context of their distribution and abundance in Deep Bay or Hong Kong as a whole. Based upon this review it was concluded that no species fell into this category. A summary of this data is provided in the Ecological Impact Assessment (Section 8 of the main report) and the rationale behind the inclusion of species and the exclusion of other potential targets is given below.

Birds

4.2.3 Of the species recorded during surveys for the Ecological Impact Assessment, Little Egret *Egretta garzetta*, Chinese Pond Heron *Ardeola bacchus* and Red-throated Pipit *Anthus cervinus* are species of conservation importance that were regularly recorded and in numbers deemed to be of significance and are therefore selected as targets. The maximum counts of these three species within the Project Area were 18 Little Egret, 9 Chinese Pond Heron and 30 Red-throated Pipit. It is also recognized that Little Egret and Chinese Pond Heron breed nearby at Mai Po Village egretty. Although survey findings indicated that the Project Area is not used extensively as a foraging habitat for birds from the egretty, the species are included partly on the basis that provision of suitable foraging habitat may be beneficial in the longer term by providing potential foraging habitat in future.

4.2.4 A single male Greater Painted-snipe *Rostratula benghalensis* was recorded in an inactive wet agricultural field containing *Ipomoea aquatica* during the bird survey in June 2008 and a pair was seen in a similar area during a dragonfly survey in late June 2008. This species has a restricted distribution in Hong Kong and is often associated with wet agriculture. The birds recorded on site were seen near suitable breeding habitat, and it is possible that small numbers breed at Yau Mei San Tsuen, although probably not within the Project Area during the survey period. Given that it was not recorded regularly or in significant numbers, this species did not meet criteria listed above for selection as a target species; nevertheless it is included as a target species on a precautionary basis with the rider that the ability of the rehabilitated

wetland to attract this species will be dependent in a large part on habitat changes and habitat management in the wider area, outside the control of this WRA.

- 4.2.5 Moderate numbers of Little Ringed Plover *Charadrius dubius* (up to 25 individuals) were recorded within the agricultural fields during September and October 2007 and during June to August 2008. This is a species which favours bare ground or short vegetation and is common around fish ponds and agricultural land throughout Hong Kong during winter. The listing of this species in Fellowes *et al.* (2002) as a species of Local Concern is based upon the importance of breeding populations, which favour bare ground in wetland areas. There is no evidence for the species breeding at Yau Mei San Tsuen and the disturbance caused by agricultural practices probably make the habitat unsuitable for breeding. On the basis that the species does not breed on site and the wintering population is not considered to be important in a Hong Kong context, this species is not considered to qualify as a target under the criteria listed above. It is acknowledged, however, that appropriate habitat management under the WRP may be beneficial to the species, especially if this is able to provide potential breeding habitat.
- 4.2.6 All other bird species of conservation importance recorded during the surveys were either recorded sporadically or in low numbers in the context of the size and distribution of their relevant populations in the Deep Bay area and therefore impacts were not deemed to be of significance during the review process.

Mammals

- 4.2.7 No mammals were recorded in the Project Area and the Assessment Area in the survey period. Small numbers of Short-nosed Fruit Bats *Cynopterus sphinx* and Japanese Pipistrelle *Pipistrellus abramus* are known to roost at Palm Springs (AEC unpublished data) but were not recorded during any faunal surveys. Both are common and widespread species in Hong Kong. No mammals were considered to qualify as targets during the review process.

Reptiles

- 4.2.8 Six species of reptile were observed during the 2007-08 survey period, including Bowring's Gecko *Hemidactylus bowringii*, Changeable Lizard *Calotes versicolor*, Checkered Keelback *Xenochrophis piscator*, Chinese Skink *Eumeces chinensis*, Many-banded Krait *Bungarus multicinctus* and Red-eared Slider *Trachemys scripta*. Three of these species (Changeable Lizard, Checkered Keelback and Many-banded Krait) were observed within the Project Area. One Many-banded Krait was observed in active agricultural land within the Project Area during a night-time survey. This species is regarded as Vulnerable in China (Zhao 1998) and is of Potential Regional Concern (Fellowes *et al.* 2002), despite being relatively widespread and common in a variety of habitats in Hong Kong (Karsen *et al.* 1998, Chan *et al.*, 2005). Other species recorded are considered as widespread in the territory (Karsen *et al.*, 1998) and are of low conservation concern. No reptiles were considered to qualify as targets during the review process.

Amphibians

4.2.9 Nine amphibian species were recorded in the 2007-08 survey period, eight of which were found within the Project Area. None of these species is of conservation concern, and all are common and widespread in the New Territories (Chan *et al.* 2005). A maximum of only two individuals of Spotted Narrow-mouthed Frog *Kalophrynus interlineatus* was recorded during the daytime survey within the Project Area, while moderate numbers of Ornate Pigmy Frog *Microhyla ornata* and Paddy Frog *Fejervarya limnocharis* were recorded during the wet season night-time surveys in the wet agricultural fields within the Project Area.

4.2.10 Amphibians have low mobility and cannot easily re-locate to habitats which are separated by anthropogenic features, and some species may not easily escape from construction activities. Development of the site may therefore result in significant mortality or habitat fragmentation, resulting in significant impacts to the amphibian community. Although the species are common in Hong Kong and the impacts would not be significant in a Hong Kong context, it is proposed to relocate as many amphibians as possible into the restored wetlands to minimise direct mortality and to facilitate the early establishment of a viable amphibian community within the restored wetlands. Amphibians have therefore been selected as a target group for the restored wetlands during the review process.

Butterflies

4.2.11 A total of 38 butterfly species was recorded within the Assessment Area in the survey period from September to October 2007 and March to August 2008. Most species recorded are common or very common in the territory, although five species are considered to be uncommon: Plain Hedge Blue *Celastrina lavendularis*, Painted Jezebel *Delias hyparete*, Common Jay *Graphium doson*, Danaid Egg-fly *Hypolimnas misippus* and Swallowtail *Papilio xuthus* (Young and Yiu 2002). The greatest diversity and abundance of butterfly species occurred in the contiguous fish ponds to the northwest of the Project Area. Fifteen butterfly species were recorded within the Project Area.

4.2.12 Two species, Plain Hedge Blue (*Celastrina lavendularis*) and Danaid Egg-fly (*Hypolimnas misippus*), are listed as species of Local Concern in Fellowes *et al.* (2002). Single Danaid Egg-flies were found within the Project Area in Pond 7 and agricultural land to the east, and the species was also recorded in the contiguous fish ponds in the northwest of the Assessment Area. A single Plain Hedge Blue was recorded in agricultural land south of the Ngau Tam Mei Drainage Channel; this is not typical habitat for the species and is outside the usual range in Hong Kong, and it is not expected that a resident population is present in the Project Area. Since publication of Fellowes *et al.* (2002) there has been increase in knowledge and/or a genuine increase in population for both species, and both are now known to occur throughout the territory (Lo 2005). On this basis no butterflies were considered to qualify as targets during the review process.

Dragonflies

4.2.13 A total of 25 dragonfly and damselfly species was recorded during the survey period from September to October 2007 and March to August 2008. Two of these (Coastal Glider *Macrodiplax cora* and Scarlet Basker *Urothemis signata*) are listed as species of Local Concern (Fellowes *et al.* 2002). Wilson (2004), however, considered that Scarlet Basker is a common species in the territory as its population has rapidly

increased since late 1990s. During the survey period, all Scarlet Baskers recorded were seen in abandoned fish ponds adjacent to the Project Area which were rich in emergent and floating vegetations, a favoured habitat for this species (Wilson 2004). A single Coastal Glider individual was seen flying over farmland within the Project Area in September 2007. Although it has been listed as a species of Local Concern by Fellowes *et al.* (2002), this species is also one of the most abundant and widespread dragonfly species in the world (Wilson 2004). No dragonflies were considered to qualify as targets during the review process.

Fish

4.2.14 Small numbers of pollution-tolerant fish species were observed in channels in the Project Area and the Assessment Area, including Edible Goldfish *Carassius auratus* and the exotic Mosquito Fish *Gambusia affinis*, Nile Tilapia *Oreochromis niloticus*, North African Catfish *Clarias gariepinus* and Snakehead Murrel *Channa striata*. Higher numbers of some of these pollution-tolerant fish species (Mosquito Fish and Nile Tilapia) occurred upstream of the irrigation ditch within the Project Area, where water is of higher quality.

4.2.15 Fish surveys in the ponds within the Project Area and the Assessment Area revealed that these ponds support low numbers of fish species, including Bighead Carp *Aristichthys nobilis*, Grass Carp *Ctenopharyngodon idellus*, Mosquito Fish, Nile Tilapia and some ornamental Common Carp *Cyprinus carpio*. These fish species were either in the ponds for ornamental purposes or for self-consumption. A limited number of fish species (Bighead Carp, Grass Carp, Mosquito Fish and Tilapia) was observed in inactive/abandoned ponds.

Summary

4.2.16 A summary of the target species is provided in Table 2.

Table 2. Target species for the WRA

Species	Reason for selection	Conservation Status
Birds		
Little Egret <i>Egretta garzetta</i>	Regularly recorded in the Project Area with counts up to 18 individuals. Breeds nearby at Mai Po Village egretty.	Potential Regional Concern. Breeding/roosting sites of Regional Concern (Fellowes <i>et al.</i> 2002)
Chinese Pond Heron <i>Ardeola bacchus</i>	Regularly recorded in the Project Area with counts up to nine individuals. Breeds nearby at Mai Po Village egretty.	Potential Regional Concern. Breeding/roosting sites of Regional Concern (Fellowes <i>et al.</i> 2002)
Greater Painted-snipe <i>Rostratula benghalensis</i>	One observation in the Project Area and one observation nearby; does not strictly meet selection criteria but included on a precautionary basis.	Local Concern (Fellowes <i>et al.</i> 2002)
Red-throated Pipit <i>Anthus cervinus</i>	Relatively large population (max. of 30 individuals) was recorded wintering in agricultural land of the Project Area	Local Concern (Fellowes <i>et al.</i> 2002)
Amphibians	Moderate populations recorded in the agricultural land of the Project Area.	N/A

4.3 Habitat Requirements for the Target Species

4.3.1 Habitat requirements for each of the Target Species are given below and summarised in **Table 3**.

Little Egret

4.3.2 Little Egrets are found in Hong Kong throughout the year, primarily in the northeast and northwest New Territories. Habitat utilization has been studied by Young (1994), Young and Chan (1997) and Cornish (1996). These studies showed that Little Egrets in Hong Kong feed primarily in fishpond and intertidal areas. Little Egrets also feed opportunistically on stranded fish in ponds which are being drained, and are often the most abundant bird species in such circumstances. Breeding birds typically forage within 3 km of egretries (Young 1994).

4.3.3 Whilst this species is reasonably widespread across wetland habitats in Hong Kong, it is highly localised as a breeding species. It breeds close to the Project Area in the Mai Po Village egretty, although evidence from surveys suggest the Project Area is not important for the population breeding at Mai Po Village.

4.3.4 Little Egret was recorded in the Project Area on nine out of 12 surveys within the 12-month survey period. Numbers in the Project Area in most months were comparatively small, with the highest count of 18 individuals recorded in late July 2008 (this probably involving birds dispersing after breeding). Most were recorded in wet agriculture fields but birds were observed around inactive/abandoned ponds and grassy bunds around ponds and fields. During the breeding season, none were recorded on surveys in April or May 2008 and only single individuals in March and June 2008. These observations were supported by flight-line surveys conducted in 2011, which suggested that the Project Area is not used by significant numbers of birds from the egretty.

Chinese Pond Heron

4.3.5 Chinese Pond Herons are found throughout the year in Hong Kong, and although widespread, most records are from the New Territories. Habitat utilization has been studied in Hong Kong by Young (1994) who showed that birds breeding at the Mai Po Village egretty fed mainly around fishponds. Individuals typically forage solitarily along the edges of open water areas or in areas with sparse or short vegetation. Chinese Pond Herons utilize communal day or night roosting sites in areas with medium-sized trees or tall bamboo, either immediately adjacent to, or overhanging, ponds or creeks. They eat small fish, but also invertebrates and amphibians (Carey et al. 2001).

4.3.6 Chinese Pond Heron breeds in the Mai Po Village egretty, but surveys conducted in 2011 suggest that the Project Area is not used as a foraging site by significant numbers of birds from the egretty. The species was, however, recorded regularly during surveys in 2007-08.

4.3.7 Small numbers of Chinese Pond Herons were recorded in the Project Area on eight out of 12 surveys. Numbers in the Project Area in the surveyed months were small, with the highest count of 9 individuals recorded in December 2007 and March 2008 (this occurring prior to the peak breeding season for this species). The abundance of Chinese Pond Herons was highest along grassy bunds of the inactive/abandoned ponds and marsh (i.e. Ponds 8, 9 and 40). Only very small numbers of Chinese Pond Heron were recorded in the Project Area on surveys during the 2008 breeding

season, with none seen in May or July, two seen in June and three seen in April. The higher count in March is earlier than the peak breeding season for this species. Flight-line surveys in 2011 supported the idea that the Project Area is not an important foraging ground for birds breeding at the egretty.

Greater Painted-snipe

- 4.3.8 Greater Painted-snipe is a passage migrant and winter visitor, with a small breeding population which is extremely localised and has previously declined (Carey *et al.* 2001). Although formerly widespread this species is now largely restricted to freshwater agricultural land and in recent years has bred at a few sites in the northwest New Territories, notably Long Valley and Kam Tin but has recently also spread to Mai Po and Lok Ma Chau.
- 4.3.9 Greater Painted-snipe prefers areas with low, dense herbaceous vegetation and shallow water (0-10cm). It is able to make use of suitable ephemeral wetlands, and is also regularly forced to abandon sites that dry out during the dry season. However, areas of suitable habitat that contain even small areas that remain wet in the dry season may support relatively high numbers and often have birds throughout the year.
- 4.3.10 There was only one observation of Greater Painted-snipe within the Project Area and one within the Assessment Area during surveys, indicating that this species' occurrence in the Project Area may be irregular and dependent upon suitable habitat being present in the wider area. Although it has been identified as a target species, it is emphasised that the occurrence of the species may be related to nearby land use outside the influence of this WRP.

Red-throated Pipit

- 4.3.11 Red-throated Pipit is a common winter visitor and passage migrant (October to April) which utilises low-lying marshy or open grassy areas, wet and dry agricultural areas and bunds between fishponds. It is a species listed as Local Concern (Fellowes *et al.* 2002). It was recorded on seven out of 12 surveys within the Project Area, with a maximum count of 30 individuals recorded in winter in agricultural land within the Project Area. This moderately large population is potentially significant relative to its abundance in the Deep Bay area as a whole.

Amphibians

- 4.3.12 Though no species of conservation importance was recorded during the survey period, moderate numbers of seven amphibian species were recorded during the night-time surveys in the wet season. More than 50 individuals of Ornate Pigmy Frog were recorded in the agricultural fields within the Project Area, where the presence of open earth ditches with some riparian vegetation around the fields may provide good concealment and potential breeding sites (Karsen *et al.*, 1998). Most amphibians favour permanent or, particularly, seasonal marsh habitats (from which predatory fish are absent), with good development of emergent and/or edge vegetation and variable, but generally shallow, water depth.

Table 3. Summary of the habitats to be provided for the Target Species in the Project Area at Yau Mei San Tsuen.

Target Species	Shallow water	Reedbed	Marsh	Grassy bund	Wooded bund	Bamboo clump	Gravel
Little Egret	F	F		R	R	R	R
Chinese Pond Heron	F	F	F	R	R	R	
Greater Painted-snipe	F		B, F, R				
Red-throated Pipit			F	F			
Amphibians	F, B		F, B, R	F, R	D		

Key: habitat important for B = Breeding; F = Foraging; R = Roosting/resting; D = Dispersal.

Target levels

4.3.13 The target level, in general, will be occurrence at a density higher than the density across the site as a whole recorded during the baseline data collection period, subject to approval from the relevant Government Departments. In practice, different target levels might be set for different target group. The baseline will be derived from data collected during Baseline Ecological Monitoring as detailed in paragraph 7.1.1. The list of target species may be expanded as required during the Baseline Ecological Monitoring or the Operational Phase Monitoring to accommodate species of conservation importance which may colonise the wetlands. The management of the wetland will be revised on an annual basis to reflect any such changes; these will be reflected in annual updates of the Wetland Restoration Plan.

4.4 Proposed design for the Restored Wetland

4.4.1 Loss of existing habitat is an inevitable consequence of development. Findings from literature review and the current study demonstrate that the Project Area is of relatively low ecological value to wildlife (compared to other parts of Deep Bay), and as discussed in the Ecological Impact Assessment (Section 8 of the main report), retaining most habitats in their present form is not considered ecologically beneficial. However, under the guiding principles and precautionary principles listed in Section 3.2.2, design of the site should comply with the “No-Net-Loss in Wetland” principle and involve no pond filling or other works detrimental to the ecological function of the wetland.

4.4.2 In addition, in order to comply with TPB PG No.12C, a Wetland and Visual Buffer is to be provided to “separate the development from the WCA to minimize its impact on the wetland and to restore some of the lost fish ponds to an appropriate form of wetland adjoining the WCA.” Accordingly, it is proposed to provide an additional 5m strip of reedbed (associated with some screening trees and shrubs) on the WBA-side of the proposed development. This additional area will be managed as part of the WRA. Management objectives of this area will follow that of the proposed reedbed habitat within the WRA and be maintained as a wetland habitat according to the requirements of the target species.

4.4.3 The proposed site layout involves the retention of the existing fish ponds as wetland habitats and wetland restoration / enhancement on land currently used for agriculture. The retained ponds and wetland restoration / enhancement would be included within a Wetland Restoration Area (WRA). The differences between the current and proposed habitats in the Project Area are summarised in **Table 4**.

Table 4. Existing and proposed habitats within the Project Area at Yau Mei San Tsuen

Time Frame	Existing Habitat		Proposed Habitat	
	2008		Recommended Option	
Habitat	ha	%	ha	%
Agricultural Land	4.9	60.1	-	-
Pond	1.2	14.9	1.6	19.3
Marsh	0.9	11.6	0.8	10.1
Reed	0.2	2.4	0.6*	7.5
Seasonally Wet Grassland	0.7	8.7	-	-
Grassland/Shrubland	0.2	2.3	-	-
Grassy Bund	-	-	0.4	4.9
Wooded Bund	-	-	0.3	4.6
Bamboo Clump	-	-	<0.1	0.5
Gravel	-	-	<0.1	0.8
Development Area	-	-	4.3	52.3
Total Area	8.1	100	8.1	100
Wetland habitat total	3.0	37.0	3.8	47.7

Note: Figures above are rounded to the nearest decimal place. Hence, figures may not add up to the total value.
* including 0.1 ha provided as wetland and visual buffer along the interface between WCA and WBA.

4.4.4 All existing ponds with the Project Area will be retained as wetland within the WRA, and these will be managed to increase their ecological value. Furthermore agricultural land in A1 and A2 will be managed as part of the WRA. These fields are adjacent to the existing fishponds and thus provide a buffer between the development and existing wetland habitats, as well as minimizing fragmentation within the WRA. The WRA design also incorporates recommendations made by the environmental NGOs during the CPI process, in which an ecological linkage for herpetofauna movement between the WRA and adjacent pond to the southwestern part is proposed. The isolated Area 40 at the southeastern corner will be connected with the WRA by an ecological corridor and corridor strip of buffer planting will be provided on the western side of the site, between the development and Fairview Park. A total of 3.8 ha of wetland habitat will be restored/enhanced within the WRA.

4.4.5 In order to prevent the ongoing degradation (in ecological functions and habitat quality) of the existing ponds and to enhance their ecological value, alternative habitats which are expected to be utilized by species which are likely to be impacted by the proposed development and species which are known to or likely to utilize habitats at the landward edge of the Deep Bay wetland system are proposed. The proposed habitat conditions that will provide for the species listed in **Table 3** are as follows:

- Deep water pond with shallow water zones;
- Reedbed;
- Marsh;
- Wooded bund;
- Grassy bund;
- Bamboo clump; and
- Gravel.

4.4.6 Under the Recommended Scenario seven habitats are proposed for the WRA. Descriptions of the proposed habitats are given in **Tables 5 – 12**.

Table 5. Description of the proposed deep water pond zone with justification for habitat provision and species expected to use the habitat in the Wetland Restoration Area.

	Pond with deep water area
Description	Three areas of open water of 1 - 2.5 m in depth, surrounded by reeds and grassy bunds will be provided in the northern section of the WRA. The existing Area 40 will be retained as an open pond with deep water area in order to maintain the ecological linkage between Ngau Tam Mei Drainage Channel and other wetland habitats within the WRA. The deep water pond will be bordered by reedbed in the south, east and northeast to shield/buffer the area from the proposed development and a grassy bund will border the northwestern boundary.
Justification	<ol style="list-style-type: none"> 1. Deep water pond is an existing habitat on site considered to be of low to moderate ecological value at present; 2. Secluded small ponds provide a good loafing environment for some migratory waterbird species such as ducks; 3. These areas will be deep enough to prevent reed encroachment, and the muddy margins will provide additional foraging habitats for ardeids; 4. The pond will also serve as a water reserve and prevent the wetland from drying out completely in the dry season.
Predicted use by target species	Little Egret and Chinese Pond Heron (on bunds)
Other species which may utilize the habitat	Foraging: some waterbirds, dragonflies Roosting: waterbirds, dragonflies

Table 6. Description of the proposed shallow water pond zone with justification for habitat provision and species expected to use the habitat in the Wetland Restoration Area.

	Pond with shallow water area
Description	Berms of shallow water (20cm - <1m) with gentle slopes will be provided in the deep water ponds described in Table 5 .
Justification	1. Deep water pond is of limited value for foraging waterbirds except species with very long legs/necks or diving species. It is important to provide an area where birds can forage.
Predicted use by target species	Foraging: Little Egret, Chinese Pond Heron, Greater Painted-snipe, amphibians Breeding: amphibians
Other species which may utilize the habitat	Breeding: dragonflies. Foraging: waterbirds, dragonflies. Roosting: waterbirds, dragonflies.

Table 7. Description of the proposed marsh with justification for habitat provision and species expected to use the habitat in the Wetland Restoration Area.

	Marsh
Description	An area of native marsh will be planted with an undulating substrate, bordering the deep water pond and between Project Area and the WCA. Exotic and non-marsh plant species will be controlled to encourage native species, and the marsh will be divided into cells to facilitate water management
Justification	<ol style="list-style-type: none"> 1. Marsh is an existing habitat type on-site but is currently of low ecological value as it supports very low diversity of flora and fauna.; 2. Marsh area is an important habitat for species such as snipe and some wetland-dependent species such as Red-throated Pipit and Little Ringed Plover. This is an important habitat for breeding Greater Painted-snipe in the Kam Tin/Deep Bay area; 3. Vegetated wet area in the wet season serves also as a suitable breeding habitat for amphibians.
Predicted use by target species	Breeding: Greater Painted-snipe, amphibians. Foraging: Greater Painted-snipe, Red-throated Pipit and amphibians. Resting: Greater Painted-snipe, amphibians.
Other species which may utilize the habitat	Breeding: dragonflies; Foraging: Waterbirds, dragonflies; Roosting: Waterbirds, dragonflies.

Table 8. Description of the proposed reedbed with justification for habitat provision and species expected to use the habitat in the Wetland Restoration Area.

Reedbed	
Description	An area of reed <i>Phragmites australis</i> will be planted bordering the deep water pond to provide screening from the residential development.
Justification	<ol style="list-style-type: none"> 1. Reedbed will provide screening for the WRA to minimise disturbance from the residential development; 2. Reedbed is an important habitat in the Deep Bay area and is known to have high ecological value for a number of wetland-dependent species, including several species that are of global/regional conservation concern; 3. Reedbed serves a good habitat for cryptic species as a foraging and roosting ground.
Predicted use by target species	Foraging: possibly Little Egret, Chinese Pond Heron at perimeter.
Other species which may utilize the habitat	Breeding: reed-associated species, dragonflies. Foraging: reed-associated species other waterbirds, dragonflies. Roosting: reed-associated species, dragonflies.

Table 9. Description of the proposed wooded bund with justification for habitat provision and species expected to use the habitat in the Wetland Restoration Area.

Wooded bund	
Description	Tree/shrub species that are tolerant of flooding conditions and waterlogged soils will be planted along the boundaries of the marsh, WBA-side fringe of reedbed, the herpetofauna corridor buffer, and around Area 40.
Justification	<ol style="list-style-type: none"> 1. Although woodland is not used by breeding amphibians the shade and cover, and the presence of leaf litter will provide a locally favorable microclimate for herpetofauna during the dry season to facilitate dispersal of these between wetland areas fragmented by development; 2. Planted trees/shrubs will provide screening of the WRA from sources of disturbance to the south of the Project Area (including the proposed cycle track); 3. Trees/shrubs are used by a suite of species of conservation importance including roosting egrets, Red-billed Starling, kingfishers, and raptors.
Predicted use by target species	Roosting: Little Egret, Chinese Pond Heron. Foraging: Amphibians. Dispersal: Amphibians.
Other species which may utilize the habitat	Foraging: Passerines, reptiles, butterflies and dragonflies. Roosting: Passerines, egrets, kingfishers, butterflies and dragonflies. Dispersal: Reptiles.

Table 10. Description of the proposed grassy bund with justification for habitat provision and species expected to use the habitat in the Wetland Restoration Area.

Grassy bund	
Description	Grassy bunds planted with native herb species will be provided on the northern, western and eastern boundaries of the WRA and between the pond and marsh cells. A few existing trees of fair/good form and health condition would be retained for screening in accordance with the proposed landscape design.
Justification	<ol style="list-style-type: none"> 1. Grassy bunds serve as a roosting and foraging area for ardeids and other species of conservation importance such as Red-throated Pipit; 2. These will form a footpath in which the site will be monitored and maintained at a later stage.
Predicted use by target species	Foraging: Red-throated Pipit, Little Egret, Chinese Pond Heron. Resting: Little Egret, Chinese Pond Heron.
Other species which may utilize the habitat	Foraging: Reptiles, passerines and dragonflies. Roosting: Waterbirds.

Table 11. Description of the proposed bamboo clump with justification for habitat provision and species expected to use the habitat in the Wetland Restoration Area.

	Bamboo clump
Description	Several clumps of bamboo <i>Bambusa eutuldoides</i> and <i>B. gibba</i> will be planted on the grassy bunds in the western and northern boundaries.
Justification	1. Bamboo is known to be favoured by egrets for roosting and nesting. 2. Provision of bamboo will diversify the habitats provided for wildlife.
Predicted use by target species	Roosting: Little Egret, Chinese Pond Heron. Breeding: Potentially Little Egret, Chinese Pond Heron.
Other species which may utilize the habitat	Foraging: Passerines, dragonflies. Roosting: Passerines, dragonflies.

Table 12. Description of the proposed gravel with justification for habitat provision and species expected to use the habitat in the Wetland Restoration Area.

	Gravel
Description	Islands of unvegetated bare ground will be provided in the deep water pond.
Justification	1. Exposed area of bare ground serves as favourable roosting and loafing area for waterbirds; 2. The muddy margins between gravel and the shallow water area provide favourable foraging area for waders; 3. Large area of undisturbed, open gravel near freshwater habitats provides favourable breeding habitat for Little Ringed Plover, which are known to breed in the Deep Bay Area; 4. Gravel in the middle of a large pond will diversify the micro-habitats for wetland-dependent species.
Predicted use by target species	Foraging: Little Egret. Roosting: Little Egret, Chinese Pond Heron.
Other species which may utilize the habitat	Breeding: Potentially Little Ringed Plover. Foraging: Waterbirds and dragonflies. Roosting: Waterbirds and dragonflies.

Planting Lists

4.4.7 Proposed planting lists for the different habitats are provided in **Annex 1** of this document.

4.5 Predicted habitat use by the target species

Little Egret

4.5.1 Shallow water is important to this species when foraging and this will be provided at the margins of the open water sections of the site and also at the margins of the marsh and reedbed areas. The design of the restored wetlands will provide roosting opportunities for Little Egrets in the form of non-vegetated bunds and tall trees adjacent to water which are potential daytime roost sites for this species. As a part of the restoration process, the wetlands will be stocked with small fish and shrimp which are preferred prey of Little Egrets.

4.5.2 At times when water levels drop on site (especially during the dry season) additional shallows with stranded shrimp and small fish will create opportunistic foraging opportunities for this species.

Chinese Pond Heron

4.5.3 Chinese Pond Herons tend to forage in areas of shallow water with aquatic vegetation which will be provided within the fringes of the ponds and reedbed areas,

and in the marsh cells. This species feeds primarily upon shrimps and small fish and these will be introduced to the restored ponds to ensure that suitable food items are available for this species. Suitable roosting habitat will also be provided in the form of bamboo and tall trees on the wooded bunds.

Greater Painted-snipe

- 4.5.4 Greater Painted-snipe favours freshwater marsh using well-vegetated areas for nesting and roosting, especially where wetland plants such as *Polygonum* spp. form a canopy and movement below this canopy is relatively unrestricted. Such marsh areas are also used for foraging, but this species also forages in more open areas (wet mud and shallow water) at dawn and dusk if suitable cover is available nearby. Prey items are a range of small invertebrates including annelid worms and mollusks (AEC 2009). As is noted above, this species was not regularly recorded in the Project and Assessment Areas, hence it is likely that presence within the restored wetlands will be irregular and will remain dependent on the presence of suitable habitat in the surrounding area.

Red-throated Pipit

- 4.5.5 Areas of short grass will provide suitable foraging habitat for this species. These areas will be maintained on a regular basis through mechanical cutting to prevent them from becoming overgrown and unsuitable for this species. Areas of wet mud within the marsh cells will also provide suitable foraging habitat as these become available due to evaporation.

Amphibians

- 4.5.6 The amphibian species that occur in this area of lowland Hong Kong require standing freshwater for breeding, with a mosaic of habitat types for the terrestrial phases of their life circles for foraging and shelter. Seasonal wetlands, such as marshland, provide good breeding habitat for smaller amphibian species (including Pigmy frogs and Spotted Narrow-mouthed Frog), due to the absence of fish and the abundance of vegetation cover. Larger species, such as Günther's Frog, will also utilize deeper pools with a good emergent vegetation cover. The terrestrial habitats and the ecological corridor buffer within the WRA will provide suitable microhabitats for foraging and sheltering amphibians outside the breeding season.

5 MANAGEMENT STRATEGY

5.1 Responsibility for Habitat Restoration, Enhancement and Management

5.1.1 The Project Proponent will be responsible for the restoration, enhancement and management of the rehabilitated wetland area during the construction phase and initial operation phase, until the agreement with relevant government authorities is reached on the long-term maintenance, management and monitoring package of the WRA. An appropriately qualified ecologist with wetland design and management experience will be responsible for supervising implementation of the WRP and for long term maintenance and monitoring of the WRA; in addition a specialist contractor with experience in wetland construction and planting will be appointed to carry out the works for the construction and establishment of the wetland and subsequent management.

5.1.2 The wetland will be maintained and managed as a separate unit from the residential estate.

5.2 Management of Habitat Characteristics

5.2.1 Habitat characteristics within the wetland habitats are planned to be broadly as follows (to be refined at detailed design stage). These prescriptions for habitat characteristics are based on criteria and habitat condition targets which have been successfully followed in a managed wetland elsewhere in the Deep Bay area (AEC 2005, 2007, 2008) and are intended to provide clear directions to inform the practical adaptive management process. Thus, the values proposed do not represent exact targets which must be reached in order to achieve a specific threshold; rather they are indicative of workable objectives which it is known can be achieved on a regular and replicable basis by the management agency. They are, however, carefully selected in order to determine the proportion of each habitat on site so that the required balance of habitats (for example between reedbed and open water) can be monitored and maintained through adaptive management.

Deep water ponds

- 1 – 2.5 m deep
- >70% covered with water by the start of the dry season and >40% at any other time;
- emergent or floating vegetation < 10 % cover;
- undesirable flora species < 10% of vegetation cover.

Shallow water area

- 20cm - <1 m deep
- >70% covered with water by the start of the dry season and >40% at any other time;
- emergent or floating vegetation < 10 % cover;
- undesirable flora species < 10% of vegetation cover.

Reedbed

- at least 80% with reed cover;
- undesirable flora species < 10 % of vegetation cover;
- standing water in range 25 – 80%.

Marsh

- at least 70% with vegetation cover;

- undesirable flora species < 10 % of vegetation cover;
- standing water in range 25 – 80% of which > 25% of depth 10 cm or less.

Wooded bund

- >70% tree canopy cover and shrub cover;
- undesirable flora species < 10 % of vegetation cover.

Grassy bund

- 80% of grass < 10 cm high;
- planted area > 80% cover;
- undesirable flora species < 10 % vegetation cover.

Bamboo clump

- at least 80% with bamboo cover;
- undesirable flora species < 10 % of vegetation cover.

Gravel

- > 80% bare gravel;
- < 20% herbaceous cover of which < 10% undesirable flora species.

5.3 Hydrological Management

5.3.1 Rainfall during the wet season will be the only regular source of water for the WRP. Due to seasonal variation in rainfall, however, there is likely to be a deficit during the months of November to March (HKO data). Since annual rainfall is significantly higher than annual evaporation, the management concern is not the feasibility of maintaining the wetland with only rainfall as a water source, but rather the need to design and manage the wetland such that sufficient water is stored during each wet season in order to maintain wetland function during the following dry season. Thus, as well as the requirement to discharge surplus water once holding capacity has been reached during the wet season, the wetland must be designed to allow for fluctuations in water levels over the course of the year in at least some parts of the wetland.

- 5.3.2 Such an approach to water management requires that all rainfall is stored on site . In order to achieve this, a system of pipes and sluices will be installed, with uPVC pipes located within each internal bund to permit rapid distribution of water between the ponds and marsh cells within the WRA and larger sluice(s) at the discharge point to permit the rapid discharge of water when the ponds and marsh cells are full or following heavy rainfall events. Indicative locations of water control structures are shown in **Figure 8-5**.
- 5.3.3 As there will be areas 2.5 m deep within each pond, these would remain wet throughout the dry season even in the absence of management. This is important for the maintenance of fish stocks and a healthy reedbed. As water levels drop during the dry season, areas of shallow water with stranded fish and shrimp will provide additional foraging opportunities for Little Egret and Chinese Pond Heron.
- 5.3.4 The ponds within the WRA will function as a reservoir and water from these will be extracted during the dry season to prevent the marsh cells becoming completely dry. This will be undertaken through the use of a permanent pipe and pump system or the use of mobile diesel pumps and pipes.
- 5.3.5 Water depth markers will be placed in the deepest part of each of the areas of open water, allowing water depths to be accurately measured, especially in the deep water areas, which will function as refugia for fish and shrimps during period of low water levels.
- 5.3.6 At times of drought, water will be pumped between ponds within the WRA to ensure the wetland does not dry out entirely. In extreme drought one or more of the ponds could be permitted to dry out, provided that sufficient water remains within at least one of the ponds to facilitate recolonisation of the other pond(s) by fish, shrimp and other wetland fauna once water levels rise across the wetland. In the unlikely event of the function of the wetland as a whole being threatened by water shortage, water could be purchased from a fish pond operator and imported via a tanker. The exact source would depend on conditions at the time, although water quality and availability will inevitably drive the decision making process. The project proponent would enter into commercial agreements with pond operators if required.
- 5.3.7 Operational water levels will be between 1.5 and 2.5 m. This is based on the deepest parts of site being 2.5 m deep when the wetland is at full water capacity and reflects the need to prevent water levels being too shallow, leading to both low dissolved oxygen levels and higher temperatures, which can have profoundly negative impacts on fish and shrimp stocks and other wetland fauna. During normal operation water will be shed from the site once maximum operational levels are reached and water will be added before levels drop below 1.5 m. Adjacent streams are tidal and/or grossly polluted and are unsuitable as an alternate water supply. However, should water quality improve over time water could be extracted when salinity levels were sufficiently low (e.g. following heavy rainfall events).
- 5.3.8 Vegetation to be established in the proposed Shallow Water Area and Reedbed is carefully selected for species able to survive fluctuations of water level. Reed is capable of growth in water of up to 1m in depth and in dry ground (though it would be lost from permanently dry areas over time through vegetational succession in the absence of active management). Proposed species of wetland plants for the Shallow Water Area are species which would tolerate some drying out in the dry season and water levels would be deliberately manipulated to assist the establishment and spread of these wetland plants (see **Section 5.5** below).

5.4 Management of fish stocks

- 5.4.1 Fish stocks will fulfill three functions: the provision of food for birds, the control of vegetation and the maintenance of water quality. However, fish can be effective predators of the eggs and larvae of amphibians and dragonflies (AEC 2005), and control of fish numbers within the marsh cells will therefore be required. As water will be extracted from the ponds to water the marsh cells during the dry season (see below) it will be difficult to keep the marsh cells free of fish on a permanent basis, but fish populations within the marsh cells will be controlled through periodic draindown, or through allowing cells to dry out for short periods of time during the dry season. Large fish will be removed manually as required. Natural predation by piscivorous birds will also control fish populations in the marsh cells.
- 5.4.2 In addition, the shrimp species *Macrobrachium nipponense* will be stocked as a prey species of several of the bird targets.
- 5.4.3 The aim of stocking is to establish and maintain self-sustaining fish and shrimp communities within the restored ponds. An initial stocking of ponds as part of the wetland restoration process will be required because the ponds will be devoid of fish following restoration. Following this, fish and shrimp stocks will be monitored regularly and additional stocking will only be undertaken if these are found to be low. Regular stocking of 'trash fish' to attract piscivorous waterbirds will not be part of the routine management of the restored wetland.
- 5.4.4 Stocking of ponds will be undertaken as follows:
- Grass Carp *Ctenopharyngodon idellus* for vegetation control;
 - Edible Goldfish *Carassius auratus* to provide food for birds and to maintain water quality;
 - *Macrobrachium nipponense* to provide food for birds;
 - Small native fish (species will depend upon commercial availability at time of stocking) to provide food for birds.
- 5.4.5 Fish and shrimp species and stocks will be monitored regularly and if fish removal, transfer or supplementary stocking is required, this will be undertaken within one month of the problem being identified.
- 5.4.6 Fish will not be artificially fed, nor will the water be mechanically aerated; rather fish stocks will be permitted to reach a level that is sustainable given the naturally-available food and oxygen levels within the ponds.

5.5 Vegetation management

- 5.5.1 Vegetation management will be required to achieve two fundamental aims: to maintain a suitable wetland plant community and to prevent colonization of terrestrial plants and/or unwanted exotics.
- 5.5.2 In general this will be achieved through careful maintenance of water levels and the removal of unwanted plant species as required. In addition, emergent vegetation in ponds will be controlled in the open water and reedbed fringes by Grass Carp (which consume grasses in preference to reeds). The maximum water depth of 2.5 m within each of the wetland ponds is sufficiently deep for this species.
- 5.5.3 The control of vegetation on the bunds and islands and in the marsh cells will be required on a monthly basis in order to maintain the habitat characteristics described in section 5.2.1. Without such frequent management common and rapidly colonizing fishpond bund grasses such as *Brachiaria mutica* and *Panicum maximum*, pantropical weeds such as *Bidens alba* and *Mimosa pudica* and exotic creepers such as *Mikania micrantha* may become established and these would in time out-compete or smother most of the species to be planted in these areas during the wetland restoration process. Some of these may also invade the reedbed where they would be more difficult to control should they become established. Frequent vegetation management would also minimise disturbance impacts, as it would be preferable to have low levels of regular disturbance than intermittent high levels of disturbance.
- 5.5.4 Frequent cutting of the areas of grassy bund (as shown in **Figure 8-5**) will be required to maintain the desired vegetation height and to prevent unwanted grass species and exotics becoming established. This would be undertaken at a minimum frequency of once per month, but may be required more frequently during the wet season. Cutting will be undertaken mechanically, with the cut grass being removed to prevent a buildup dry grasses which can become a fire hazard and may also inhibit grass growth, encouraging the spread of unwanted weed species such as *Mikania micrantha*. Cut grass will be placed into open water areas where it would be consumed by Grass Carp and can be useful in maintaining water quality.
- 5.5.5 Pruning of trees and shrubs will be required to prevent them encroaching onto adjacent habitats. The requirement for pruning will be assessed on an annual basis, and any pruning will be undertaken at the end of the wet season. Wherever possible, dead trees, branches and shrubs will be retained if these do not pose a safety hazard and do not adversely affect the management of the WRA. Cuttings from trees and shrubs will be placed in neat piles where they will be permitted to decompose naturally, providing refugia for reptiles and amphibians.
- 5.5.6 One aim of the vegetation management will be for all cut vegetation to be recycled on site with no vegetation being sent to landfills; as discussed above this will be achieved through a combination of consumption by fish and decomposition.

5.6 Control of human access and disturbance

- 5.6.1 The wetland has the potential to be highly disturbed by human activities, both legitimate activities outside the wetland area and unauthorized human intrusion into the wetland. Accordingly, the wetland will be secured to prevent unauthorized access and actual and visual barriers will be provided to minimise disturbance. Unsupervised public access (including access by resident of the proposed project) will not be permitted.

- 5.6.2 Along the interfaces between the proposed residential areas and the WRA, it is proposed to erect a 1.8 m high perimeter fencing (such as chain-link). Buffer planting will be provided at selection locations of the fence to prevent visual disturbance to wildlife. This will prevent direct human intrusion, visual disturbance, and adverse effects of human activities (e.g. litter dumping and fires) and will reduce disturbance caused by noise. This perimeter wall would be buffered from the wetland by the planting of moderate- to tall-sized trees and shrubs along the northern and western perimeters and lines of shrubs and small-sized trees along the eastern perimeter of the wetland, as shown in **Figure 8-5**. Mature reedbed along the northern and northeastern perimeters will act as additional visual barrier from the proposed residential area. The aim of tree and shrub planting and reedbed would be to minimise the visual impact of the wall to the wetland. It would also provide habitat for less disturbance-sensitive species utilising the wetland.
- 5.6.3 Access into the WRA will be required to facilitate monitoring and management. In order to minimise disturbance in the morning, when bird activity is typically highest, monitoring activities will be undertaken during the early afternoon whenever possible (for example monitoring of water quality and fish stocks). Monitoring will only be conducted in the early morning when this is necessary (for example bird monitoring to coincide with the early morning peak in bird activity). Likewise, management (including weeding and vegetation management) activities will avoid the early morning period and will be scheduled so as to concentrate work in a small part of the area at any one time (to avoid disturbing large areas of the site). Routine management activities (such as grass cutting) will be conducted on a monthly basis to avoid the need for large scale and/or intensive vegetation management.
- 5.6.4 Along the western and northern side of the WRA, which is contiguous with the existing Deep Bay wetland system, a 1.8 m high wire mesh fence will be erected to delineate the site boundary and to prevent access and disturbance from outside the site whilst maintaining ecological linkages with the fishpond system. It is noted that such a fence may exclude larger wild mammals, but the need to exclude dogs from the site (which cause extensive disturbance to wildlife and may prey upon waterbirds) overrides this disadvantage.

5.7 Standard Management Actions

- 5.7.1 A list of standard management actions that must be undertaken for the wetland is provided in **Table 14**.

Table 14. Regular management actions for the WRA.

Action	Frequency	Notes
Water Control		
Measure water levels and adjust sluice heights/other water control structures or pump water to meet target levels	Weekly and/or within 24 hours of heavy rainfall events or during addition of water other than from rainfall.	Target levels to be set and reviewed monthly in accordance with management regime. Water to be added if required.
Measure water quality to cover most critical concerns for short term management (pH, BOD, salinity)	Monthly or more frequently if required.	More frequent measurements required when active steps to adjust water quality are being taken.
Inspect condition of water control structures and water	Monthly or more frequently if required.	Also to be inspected after lowering of Typhoon Signal

Action	Frequency	Notes
courses and repair / maintain as necessary		No. 3 or Rainstorm Warning.
Inspect condition of pumps and water supply structures and repair / maintain as necessary	Every six months at start of wet and dry season or more frequently if required.	
Clear sluices and uPVC pipes	Weekly or more frequently if required.	Also after flooding / heavy rainfall and lowering of Typhoon Signal No. 3 or Rainstorm Warning.
Structural maintenance		
Inspect condition of tracks / paths and repair / maintain as necessary	Every 6 months or more frequently if required.	Also after any flood events and lowering of Typhoon Signal No. 3 or Rainstorm Warning.
Inspect condition of bunds and repair / maintain as necessary	Monthly or more frequently if required.	Also after any flood events.
Vegetation management		
Supplemental planting	Requirement to be assessed on a monthly basis.	Planting to be restricted to the wet season.
Cutting or pruning and removal	Monthly grass cutting or on-need basis, and weeding across the entire site.	
Removal of exotic / undesirable invasive plants (including algae) (weeding)	Monthly checking with removal to be scheduled for subsequent 30 days.	Aggressive exotics such as Water Hyacinth to be removed immediately.
Pest control	Monthly checking for Red Imported Fire Ants, Apple Snails with necessary treatment to be scheduled for subsequent 30 days. Control of domestic dogs required whenever noted on site.	Additional pests to monitored and treated if required.
Fish Stocks		
Fish transfer, clearance and stocking	Annually or more frequently if required.	

6 IMPLEMENTATION

6.1 Wetland Restoration

6.1.1 The detailed construction programme for the wetland restoration will be finalized at the detailed design stage but will involve the following fundamental steps:

- Temporary Fencing/Hoarding: To define the site and prevent unauthorized access, prior to commencement of other works.
- Nursery Provision: a nursery with suitable shading and an adequate freshwater supply will be provided on-site in advance of the construction works to house any trees awaiting transplantation and for the establishment and temporary storage of terrestrial and wetlands plants. The nursery will be located within the WRA but will avoid any areas, either on- or off-site, of moderate to high ecological value. It is expected that the vast majority of plants will be imported from commercial plant nurseries prior to planting. As such the primary function of the on-site nursery will be as a temporary holding facility where imported plants can be stored, watered and kept out of direct sunlight until they can be planted within the wetland.
- Construction of temporary wetland enhancement area: an area at the west of the Project Area has been identified as a temporary enhancement area comprising 0.75ha of shallow ponds and 0.35ha of marsh which will be adapted from the existing farmland using traditional wetland agricultural practices. This will be operated during the construction period of the WRA to provide mitigation for temporary impacts of habitat loss during the restoration and enhancement works in the WRA.
- Removal from site of invasive plants: certain invasive exotic plant species are presently established on site. These will be removed at an early stage to prevent them being accidentally transplanted into the newly restored wetland areas where they could become a nuisance.
- Reuse of substrate: if suitable, substrate (pond mud) within the site will be retained and will form the base of some or all of the wetland area. A mud depth of 6 to 10 cm is considered sufficient for the growth of herbaceous wetland plants. Initial site investigations indicate that pond mud below the filled areas varies in depth from 0.5 to 2.0 m; this may need to be stockpiled on site at the site clearance stage.
- If insufficient substrate is available on site, wetland soils will be imported.
- Remove all existing structures, concrete, hardcore or asphalt pavements, solid waste and rubble from the site.
- Re-contour the wetland area.
- Install water control features: these will facilitate regulation of water to the desired depth. Regulation of water depth will be critical at the early stages to aid plant establishment.

- Plant or introduce wetland vegetation: whilst some wetland plants would be expected to colonise the restored wetlands naturally, planting is essential to ensure rapid establishment of a diverse plant community.
- Introduce fishes and crustaceans, primarily Grass Carp, Edible Goldfish, small fish and shrimps.
- Supplemental planting: some die-off of plants is to be expected and these should be replaced through supplemental planting.

6.2 Implementation Programme

6.2.1 It is expected that it will take the WRA approximately 1.5 years from commencement of construction to being fully established and functional. Site clearance and site formation works would be undertaken during the wet season to avoid disturbance to birds during the dry season. Construction will progress cell by cell and once formation of each cell has been completed planting will be undertaken, thus condensing the WRA construction period to one wet season. During the second wet season, any replacement planting and plant maintenance would be undertaken. By the start of the second dry season all plants should be established and water levels should be at the operational maximum; at this point the wetland itself should be established and start to function.

6.2.2 Because the site of the proposed WRA and the area proposed for residential development are currently of relatively low ecological value, it is not considered that construction period ecological mitigation measures are essential. However, in response to advice received during the Continuous Public Involvement (CPI) process, it has been resolved to provide a temporary wetland enhancement area of 1.1 ha in the west of the Project Area. By means of minor adjustment to existing agricultural practice this area will be adapted to provide 0.75ha of shallow pond and 0.35ha of marsh suitable for utilization by Little Egret, Chinese Pond Heron, Greater Painted-snipe and Red-throated Pipit during the WRA construction period. This area will form the temporary wetland enhancement area described in paragraph 6.1.1.

6.2.3 In addition, temporary visual barriers will be established to minimize noise/visual disturbance and impact to the adjacent wetland systems. The wetland restoration works will be completed and the wetland will be constructed prior to the site clearance, formation and construction of the residential development.

6.2.4 A summary of the proposed habitat changes involved with establishment of the WRA is provided in Table 15.

Table 15. Proposed habitat restoration within the WRA.

Location	Existing habitat condition	Proposed habitat in WRA
Pond 7	Inactive pond and grassy bund with low numbers of fish for self-consumption. Supports very low bird and dragonfly diversities	Pond with deep water zone, reedbed and grassy bund. Suitable habitats for waterbirds, reed-associated species and dragonfly.
Pond 8	Inactive pond and grassy bund with very low numbers of fish for self-consumption. Supports low bird and dragonfly diversities.	Pond with deep water, shallow water zone, grassy bund, reedbed and gravel. Suitable habitats for waterbirds, reed-associated species and dragonfly.
Pond 9	Marsh and grassy bund developed from abandoned pond through natural succession. Supports very limited flora and fauna.	Connected with Pond 17 to provide pond with deep water zone, shallow water zone, grassy bund, reedbed, gravel and bamboo clumps. Suitable habitats for waterbirds,

Location	Existing habitat condition	Proposed habitat in WRA
Pond 17	Was agricultural land during the survey period and grassy bund developed from drained pond with little or no pond filling. Agricultural land was found to be abandoned in May 2011 and filled with shallow water. Supports very low numbers of birds.	reed-associated species and dragonfly. Connected with Pond 9 to provide pond with deep water zone, shallow water zone, grassy bund and reedbed. Suitable habitats for waterbirds, reed-associated species and dragonfly.
Pond 18	Inactive pond and grassy bund. Supports very low numbers of birds.	Pond with deep water, shallow water, grassy bund and reedbed. Suitable habitats for waterbirds.
Area 40	Inactive pond with grassy bund. Supports very low number of birds.	Pond with deep water, shallow water, reedbed and wooded bund. Suitable habitats for waterbirds, reed-associated species and dragonfly.
A1 – A2	Agricultural land with grassy bund supporting low number of birds and amphibians.	Marsh and grassy bund. Suitable habitats for waterbirds and amphibians.
A3	It was agricultural land with grassy bund supporting low number of birds. It was found to be abandoned and became marshy area in May 2011.	Marsh with grassy and wooded bund; connected with A1-A2. Suitable habitats for waterbirds and amphibians.
A4 – A10	Agricultural land with grassy bund supporting low number of birds.	Developed area. Wooded bund will be provided along the site boundary in A4, A5 and A8 to provide an ecological corridor between the WRA and the adjacent ponds to the west/southwest. A portion of the eastern side of A10 will be converted to shallow water lined with reedbed to provide a corridor between Area 40 and other wetland habitats within the WRA.
Seasonally wet grassland near Pond 9	Seasonally wet grassland and grassy bund developed from abandoned pond through natural succession. Supports very low flora and fauna diversity.	Connected with Pond 9 and provide reedbed, grassy bund and bamboo clumps. Potential habitats for egrets and waterbirds to roost and forage.
Seasonally wet grassland near A8	Seasonally wet grassland and grassy bund developed from part of the abandoned pond through natural succession. Supports very low flora and fauna diversity.	Will be filled and the pond area will be reprovided and planted with woody species as part of the buffer planting.

7 ECOLOGICAL MONITORING

7.1 Baseline Ecological Monitoring

7.1.1 If a prolonged period (longer than 2 years) elapses between the application for an Environmental Permit for the proposed development and commencement of construction, target species (including Little Egret, Chinese Pond Heron, Greater Painted-snipe, Red-throated Pipit and amphibians) and other wetland-dependent fauna would be monitored within the Project Area and Assessment Area during the 12 months prior to commencement of any site clearance required for wetland and/or residential construction. This would fill any ecological information gaps due to changes from the baseline ecological surveys which might be pertinent to the wetland restoration process. This would also provide the baseline for evaluation of the success in achieving numerical targets for the target species. The frequency of monitoring is given in **Table 16** and the methodology for each survey is detailed below under Operational Phase Monitoring. Target species for the WRA may be revised in light of the findings of the Baseline Ecological Monitoring.

7.2 Construction Phase Ecological Monitoring

7.2.1 Target species and other wetland-dependent fauna will be monitored within the Project Area and Assessment Area during the wetland and residential construction phase. This will be important to ensure that any unexpected events or impacts either on- or off-site are quickly identified so that remedial action can be taken. The frequency of monitoring is given in **Table 16** and the methodology for each survey is detailed below under Operational Phase Monitoring.

7.3 Operational Phase Ecological Monitoring

7.3.1 Ecological monitoring during the operational phase is essential to determine the effectiveness of the WRA in attracting wildlife and to permit the timely implementation of proper wetland management in the event of any unexpected circumstances. In addition to the monitoring of target species, it is proposed that monitoring would also be conducted for other faunal groups (birds, dragonflies, butterflies, herpetofauna, aquatic invertebrates, benthic invertebrates and freshwater fish) in order to evaluate the success of establishment of the wetland and the suitability of the site for non-target groups and to investigate whether the site could be managed for further ecological benefit. Long-term monitoring effort for non-target groups may be reduced or discontinued following establishment of the WRA.

Monitoring of bird species

7.3.2 Monitoring of bird species is required in order to demonstrate success in reaching the target of the restored wetland supporting, as a minimum, the number of individuals of bird target species recorded during the Baseline Survey. Surveys will be undertaken monthly. During each survey visit, the surveyor will walk slowly around the perimeter of the wetland and along bunds, and will identify and enumerate all birds recorded. Surveys will commence within one hour of sunrise.

Monitoring of Dragonflies and Butterflies

- 7.3.3 Transect surveys for dragonflies and butterflies will be undertaken once per month between March and November during the Baseline Ecological Monitoring and Construction Phase Ecological Monitoring and once per month between March to September during the operational phase. During the surveys a fixed survey route will be followed. All dragonfly species observed will be identified and all sexually mature male and ovipositing female individuals counted. All butterfly species will be identified and numbers estimated quantitatively or semi-quantitatively. These groups are not targets for the wetlands and monitoring may be reduced or discontinued during the operation phase, depending upon the results obtained during establishment of the WRA.

Monitoring of Herpetofauna

- 7.3.4 Herpetofauna surveys focus on breeding amphibians and the reptile community. One day-time survey (primarily aimed at detecting reptiles) will be conducted each month during April to November. Surveys will take place during the warmer part of the day, the peak period of reptile activity. One night-time survey (primarily aimed at detecting breeding amphibians) will be conducted each month during the period from March to August, starting shortly after dusk. During the surveys a fixed survey route will be walked. All reptiles and amphibians observed or heard will be identified, and their abundance estimated.

Monitoring of aquatic invertebrates

- 7.3.5 Aquatic invertebrate will be surveyed during wetland establishment to confirm that invertebrate food for avifauna and amphibians is available. Monitoring of aquatic invertebrates will be conducted at six monthly intervals at the end of the wet season (September) and the end of the dry season (March). Sweep-netting using a D-shaped net of 30 cm diameter with a 1 mm mesh will be used to sample aquatic species in the water column and clinging to vegetation at the water-bund interface. Each sample will comprise two 2-metre sweeps of the net, the first at the water surface and the second as close to the wetland bed as possible. Two randomly located replicate samples will be taken from each pond and marsh cell (giving eight samples in total). Samples will be stored in preservative for transfer to the laboratory, where they will be sorted for identification to species level using a binocular microscope. The number of each macro-invertebrate species will be ascertained for each replicate sample for all taxa groups. The number and species of any fish captured incidentally during the sampling will be recorded.

Methodology for monitoring benthic invertebrates

- 7.3.6 As with the monitoring of aquatic invertebrates, benthic invertebrates will be surveyed to confirm the colonisation of invertebrates into the WRA. Monitoring will be conducted at six monthly intervals at the end of the wet season (September) and the end of the dry season (March). Cylindrical benthic cores 10 cm in diameter and 10 cm in depth will be taken from the substrate at the base of the wetland to obtain quantitative data on benthic invertebrate populations. Five randomly located replicate cores will be collected from the shallows of each pond and marsh cell and will be analysed in the same way as for sweep netting.

Methodology for monitoring freshwater fish and crustaceans

- 7.3.7 The purpose of freshwater fish survey during the operational phase is to monitor the prey availability for the target waterbirds (especially Little Egret and Chinese Pond

Heron). Monitoring of freshwater fish and crustaceans will be conducted by throw and drag-netting at six monthly intervals at the end of the wet season (September) and the end of the dry season (March). A fishing throw-net with a mesh size of 30 mm, a diameter of about 4 m and a surface area of about 14 m² will be used to catch larger fish and a drag net of mesh size <10 mm will be used to sample smaller fish and shrimps. Five randomly-placed replicates with each net will be conducted in each pond. Fish will be identified to species and the weight and length recorded (if fish length is greater than 10 cm) and then released back into the wetland. Undesirable fish in the marsh cells (which may predate amphibian eggs or larvae) will not be released back into these cells.

Monitoring of habitats

7.3.8 Habitat monitoring will be conducted at six monthly intervals at the end of the wet season (September) and the end of the dry season (March) by mapping following the parameters listed in **Table 17**, to identify habitats on-site and to inform management actions.

Monitoring of vegetation cover

7.3.9 Detailed floristic surveys will be conducted in each habitat at six monthly intervals at the end of the wet season (September) and the end of the dry season (March). Transects with a fixed number of 2m x 2m quadrats will be located in major habitats in the WRA. Within each 2 m x 2 m quadrat, all plant species will be identified to species-level and their densities will be estimated. The percentage cover of bare ground, leaf litter cover and coverage by each species will also be measured. The tallest height of each plant species will be measured to be the nearest cm. Any rare or protected species will also be identified within the quadrats. Along the fixed transects placed in the wooded bund area, all woody species and their health conditions will be recorded and assessed respectively.

Pedology Monitoring

7.3.10 Pedology monitoring will investigate pond soil condition at the start of WRA construction to advise any necessary management action, and will also provide a baseline for comparison in case of any future contamination event. Sediment in each pond and marsh cell will be monitored at the beginning of the establishment period of the WRA and/or after any contamination event. Three sediment samples will be collected from each pond and marsh cell and sent to a HOKLAS-accredited laboratory for analysis. The following parameters will be monitored:

- % volatile solids
- Oxidation/Reduction (Redox) potential
- pH
- Total nitrogen
- Total oxidized carbon
- Total phosphorus
- Total reactive phosphorus

Monitoring of Water Quality

7.3.11 In-situ water quality will be measured in each pond and marsh cell once per month. Additional measurements of these parameters should also be made in order to inform

management decisions (e.g. fish re-stocking programme) and in response to unexpected events (e.g. algal blooms or fish die-offs). The following parameters will be monitored:

- Temperature
- pH
- Salinity
- Turbidity
- Dissolved oxygen

7.3.12 In addition, every six months (at the end of the wet season and end of the dry season) water samples will be sent to a HOKLAS-accredited laboratory for analysis. The following parameters will be monitored:

- Ammoniacal nitrogen
- Biochemical oxygen demand
- Total oxidized nitrogen
- Total phosphorus
- Total reactive phosphorus (orthophosphate)

Table 16. Summary of Baseline, Construction and Operational Phase Ecological Monitoring for the WRA within the Project Area.

Monitoring parameter	Baseline Ecological Monitoring	Construction Phase Ecological Monitoring	Operational Phase Ecological Monitoring
Birds	Twice monthly (including Assessment Area)	Weekly (including Assessment Area).	Monthly (excluding Assessment Area).
Dragonflies and Butterflies	Once per month during March to November.	Once per month during March to November.	Once every two months during March to September.
Herpetofauna	Once per month during April to November.	Once per month during April to November.	Once per month during April to November.
Aquatic invertebrates	Not required.	Not required.	At six monthly intervals at the end of the wet season (September) and the end of the dry season (March).
Benthic Invertebrates	Not required.	Not required.	At six monthly intervals at the end of the wet season (September) and the end of the dry season (March).
Freshwater fish	Not required.	Not required	At six monthly intervals at the end of the wet season (September) and the end of the dry season (March).
Habitat types	Not required.	Not required.	At six monthly intervals at the end of the wet season (September) and the end of the dry season (March).
Vegetation cover	Not required.	Not required.	At six monthly intervals at the end of the wet season (September) and the end of the dry season (March).
Pedology	Not required.	Not required.	At the beginning of the establishment period of the WRA.
Water Quality	Not required.	Following filling with water monthly for in situ water quality and every	Monthly for in situ water quality and every six months (end of the wet

Monitoring parameter	Baseline Ecological Monitoring	Construction Phase Ecological Monitoring	Operational Phase Ecological Monitoring
		six months (end of the wet season and end of the dry season) for laboratory testing.	season and end of the dry season) for laboratory testing.
Site Inspections	Not required.	Weekly.	Twice per month.

7.4 Review of wildlife and habitat monitoring programme and consequent adaptive management

7.4.1 An overall review of the performance of the WRA and its management and monitoring requirements to be conducted at the site will be agreed with the relevant Government authority after the establishment period.

7.4.2 In general, findings of the wildlife and habitat monitoring programme detailed above will be reviewed on a monthly basis (or more frequently if species targets are not being met) by a Wetland Ecologist to identify necessary adjustments to the management regime.

7.4.3 In addition, weekly inspections of the WRA and adjacent areas will be conducted during the construction and establishment phase, during which any events detrimental to the operation of the wetlands will be highlighted and suitable remedial action will be taken.

7.4.4 The monitoring programme will be sufficiently flexible to allow additional inspections in case of events which may materially affect wetland function (e.g. typhoons, flooding, pollution events) and the monitoring of subsequent remedial actions.

7.5 Contingency Plan

7.5.1 Should the monitoring programme identify that the target levels for target species are not being met; actions will be conducted to improve the habitats. **Table 17** describes the action and limit levels and the action plan.

Table 17. Contingency Plan.

Parameters	Action Level #	Limit Level #	Action
Flooding/storm damage	N.A.	N.A.	Review damage in conjunction with short-term weather forecast. Shed water from site or transfer internally if possible using combination of sluices, pipes and pumps. Review damage and determine severity and undertake repairs/modifications to the design.
Area of water in the pond – wet season levels	< 70 or > 95%	< 60 or 100%	Action level exceedance: double the monitoring frequency, identify and review the problem. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: adjust water level by pumping/ re-profiling/ other measures.
Area of water in the pond – dry season levels	< 50 or >95%	<40 or >95%	Action level exceedance: double the monitoring frequency, identify and review the problem. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: adjust water level by pumping to reinstate the area/ re-profiling/ other

Parameters	Action Level #	Limit Level #	Action
			measures.
Emergent or floating vegetation in the open water pond ^	> 10 %	> 20 %	Action level exceedance: double the monitoring frequency, identify and review the problem. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: manual or mechanical vegetation clearance; check nutrient levels and fish stocks; adjust water quality and fish numbers (in case water quality is affecting herbivorous fish stock levels or there are low levels of herbivorous fish).
Reedbed reed cover	< 80%	< 60%	Action level exceedance: double the monitoring frequency, identify and review the problem. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: carry out weeding or planting.
Reedbed water cover	< 25 or > 80%	<15 or > 95%	Action level exceedance: pump to restore water levels. Limit level exceedance: pump to restore water levels; review water management regime in medium term.
Marsh vegetation cover	< 70%	< 50%	Action level exceedance: review plant status and growth. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: undertake supplemental planting.
Wooded bund canopy cover	< 70%	< 50%	Action level exceedance: review tree status and growth. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: undertake supplemental tree planting.
Grassy bund cover	< 80 %	< 50%	Action level exceedance: review grass status and growth. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: undertake supplemental planting.
Bamboo clump cover	< 80 %	< 50%	Action level exceedance: review bamboo status and growth. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: undertake supplemental planting.
Gravel vegetation cover	> 20%	> 30%	Action level exceedance: double the monitoring frequency, identify and review the problem. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: manual or mechanical vegetation clearance.
Undesirable plant species (all wetland)	> 10% of vegetation in WRA or in any pond or marsh cell	> 20% of vegetation in WRA or in any pond or marsh cell	Action level exceedance: removal by weeding. Limit level exceedance: removal by weeding, if problem is likely to return/deteriorate review design and management regime.
Undesirable fauna including invasive/exotic aquatic invertebrates	Presence	Negatively impacting wetland function	Action level exceedance: treatment or removal (or other method if suitable). Limit level exceedance: increase frequency of treatment or removal (or other method if suitable), review management protocols and design.
Salinity	> 2 ppt	> 5 ppt	Action level exceedance: double the monitoring frequency, identify and review the problem. If the

Parameters	Action Level #	Limit Level #	Action
			problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: water exchange/ add water/ remove identified contamination source/ other measures.
pH	pH outside the range between 6.5 – 8.0	pH outside the range between 6.0 – 8.5	Action level exceedance: double the monitoring frequency, identify and review the problem. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: lime/ add peanut residue/ mix with other water sources/ drain and lime/ other measures.
Dissolved oxygen	< 2 mg/l	< 1 mg/l	Action level exceedance: double the monitoring frequency, identify and review the problem. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: pump and mix water/ aeration/ remove identified contamination source/ other measures.
Total oxidized nitrogen (nitrite and nitrate) concentration	> 5 mg/l	> 10 mg/l	Action level exceedance: double the monitoring frequency, identify and review the problem. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: water exchange/ add water/ remove identified contamination source/ other measures.
Total phosphorus concentration	> 5 mg/l	> 10 mg/l	Action level exceedance: double the monitoring frequency, identify and review the problem. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: water exchange/ add water/ remove identified contamination source/ other measures.
Total ammonia concentration	> 3 mg/l	> 6 mg/l	Action level exceedance: double the monitoring frequency, identify and review the problem. If the problem is likely to deteriorate, the action plan for limit level exceedance should be implemented. Limit level exceedance: water exchange/ add water/ remove identified contamination source/ other measures.
Target species abundance	Abundances of all target species < specified target levels in two successive monitoring periods	Abundances of all target species < specified target levels in four successive monitoring periods	Action level exceedance: Review the monitoring data and reasons for low numbers of target species. If the reduction in abundance is attributable to activities within the site, stop/ reduce such activity or carry out other measures (e.g. erect buffering screen or buffer planting). If the reduction in abundance is attributable to disturbance from outside the site (e.g. intense construction activity outside the site), increase buffering screen (short-term) and/or buffer planting (long-term) or carry out other measures. If the reduction in abundance is attributable to external factors (e.g. natural population fluctuation) or other man-made factors increase the monitoring frequency, identify and review the problem, and review the management regime. If the problem is likely to worsen, the action plan for limit level exceedance should be carried out. Limit level exceedance: Review the management regime and carry out restocking/ increase draining period and/or frequency/ erect buffering screen (short-term)/ increase buffer planting (long-term)/ other measures

These values serve as a general guideline to the design intention of the WRA. Certain action and limit levels may be adjusted during the detailed design stage for the WRA.

^ It is not proposed to plant emergent or floating vegetation as part of the restoration process, but it is expected that these will colonise the wetland over time

7.6 Resources Requirement for Wetland Construction and Operating

Construction

7.6.1 The resources requirement given in Table 18 is based on the assumption that the construction is undertaken by a landscape contractor; detailed design, project management and contract supervision by the developer or his representative are not included. It is assumed that no electricity supply is required (i.e. no lighting). Water management will be primarily by manually operated weirs or sluices with diesel pumps as back-up. It is assumed that any items required on the fringes of the Wetland Restoration Area for the benefit of residents (such as paths, chairs, rain shelter, viewing platform etc.) would be funded from the landscape budget. All estimates are indicative at this stage and are subject to detailed design.

Table 18. Construction Phase Resources Requirement

Item	Notes
Site formation	May require import or export of fill material from site. Bulldozer and/or backhoe. Includes clearance/removal of vegetation and structures.
Wetland plants & planting	Approx 1.4 ha planting area, comprising 0.6 ha of reeds and 0.8 ha of marsh plants.
Tree/shrub/bamboo/grasses planting	Approx. 0.8 ha planting, trees planted as whips, pot grown shrubs, bamboos and hydroseeding of grasses required.
Sluices/ weirs	As shown in Figure 8-5 .
Pipework	Material and installation cost. Dependent upon detailed design.
Tracks	Grasscrete or similar finish.
Ecological monitoring team	Surveys of birds, herpetofauna, dragonflies, butterflies, aquatic & benthic invertebrates, pedology and water quality
Wetland Ecologist (construction phase)	Advise on wetland restoration, enhancement and management.

Annual Management and Maintenance Resources Requirement

7.6.2 The estimated Annual Management and Maintenance Resources Requirement are shown in **Table 19**. This is based upon the requirement that a wetland contractor will undertake the instructed management actions. The wetland contractor may be the same landscape or horticultural contractor appointed to undertake landscape works in the residential part of the site. If the same contractor is employed some equipment may be utilized in both the wetland and for landscape maintenance on the residential site. The monitoring effort required for the ecological monitoring team is given in **Table 16**.

Table 19. Annual Management and Maintenance Phase Resources Requirement

Item	Quantity	Notes
Site Foreman	One	Full-time
Labourer	Two	Full-time
Small backhoe	10 days	Hired as needed for maintenance.
Open top truck	10 days	Hired as needed for delivery/removal of bulky material or could be shared with requirement for maintenance of residential areas.
Mobile pumps	2 (600 l/minute capacity)	Assume annual replacement.
Pipe for pumps	100 m	Assume annual replacement.
Fuel for pumps	As required	Annual budget required.

Item	Quantity	Notes
Strimmer	3	Assume annual replacement
Misc. hand tools	Four sets of general hand tools (rakes, shears, etc)	
Protective equipment	Four sets of suitable protection equipment (including goggles, gloves etc.)	
Lime	3000 kg	Est. 0.1 kg/m ³ of water
Peanut residue	1500 kg	Est. 0.05 kg/m ³ of water
Plant material	700 m ²	Replacement planting
Fencing repairs	As required	Annual budget required.
Sluice repairs	As required	
Misc. materials	As required	Annual budget required.
Ecological monitoring team (operation phase)	No. of surveyors as required	Surveys of birds, herpetofauna, dragonflies, butterflies, aquatic & benthic invertebrates, pedology and water quality
Fish Stocks	As required	Fish removal, transfer or supplementary stocking to be undertaken within one month of any problem being identified during monitoring.
Wetland ecologist	One	Advise on adaptive management of wetland.

7.7 Ownership, management and financial arrangements

Issues to Consider

- 7.7.1 The establishment of a wetland in concert with residential development is a relatively new proposition for Hong Kong but has been successfully applied elsewhere, most notably in the United States and United Kingdom. The requirement is that the restored wetland is sustainable for the long term, not only with respect to the ecological component but also the financial and management basis on which it is established.

Management and Maintenance Options – 4 different approaches

- 7.7.2 Four different approaches to long-term ownership and management and financial responsibility have been considered, as discussed in the following paragraphs.
- 7.7.3 One option would be for the WRA to be placed in the ownership of an independent Trust which would be established to own, manage and maintain the distinctive portion of the site which is defined as “Wetland”. In addition to the land, the Trust would receive an endowment fund which would be specifically managed by an Investment Bank to provide a long-term source of funding to cover all of the costs of maintaining the WRA in accordance with all of the approval requirements placed on the Project Proponent by Government through the EIA approval and the Town Planning Board approval.
- 7.7.4 The second option would be for the Project Proponent to retain that part of the site demarcated as WRA in accordance with all of the approval requirements placed on the Project Proponent by Government through the EIA approval, the Town Planning Board approval and under the new land grant.
- 7.7.5 The third option would be to have the land retained as ‘common area’ by the future owners of the residential development. They would then have collective responsibility to manage and maintain the WRA in accordance with the various approvals given by Government and as required by the Deed of Mutual Covenant (DMC). This could be

done in conjunction with managing the other communal areas within the development such as the Club House.

- 7.7.6 A final option may be to provide an upfront donation to the Environment and Conservation Fund (ECF) of the HKSAR government, which could be used as a seed fund to provide future funding of the management and maintenance of the WRA, with the ECF providing funding to a designated body responsible for the site management. Such an approach to funding of wetland management has recently been endorsed by HKSAR government and has been adopted at the nearby Wo Shang Wai development.
- 7.7.7 However, irrespective of which of these, or alternative, options is selected in the long term, until such time as agreement has been reached with Government, the Project Proponent shall provide an undertaking to assume the responsibility of the funding, implementation, management and maintenance of the WRA as part of the development. The final long-term arrangements of funding and management of the WRA are subject to the approval from relevant government departments in the detailed design stage prior to commencement of the construction of the WRA.

8 REPORTING

- 8.1.1 The data obtained from the monitoring programme will be used to inform adaptive management measures. Monitoring data and information regarding adaptive management measures undertaken will be submitted to relevant authorities, including various relevant stakeholders and relevant Government Departments such as AFCD and EPD. The frequency of reporting will conform to the requirements of the Environmental Permit.

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Annex 1. Proposed plant list of Wetland Restoration Area at Yau Mei San Tsuen.

Deep water

- No vegetation will be planted within the deep water zone.

Shallow water

- Vegetation to be planted in patches within the shallow water zone.

Species	Growth form	No. of Blocks
<i>Cyperus malaccensis</i>	Herb	50
<i>Eleocharis spiralis</i>	Herb	80
<i>Juncus effusus</i>	Herb	80
<i>Ludwigia adscendens</i>	Herb	100
<i>Polygonum barbatum</i>	Herb	50
<i>Polygonum glabrum</i>	Herb	80

Note: Size of block is 0.5 m x 0.5 m

Reed

- Reed to be planted in the whole reedbed area.

Species	Growth form	Proportion (%)
<i>Phragmites australis</i>	Perennial herb	100

Marsh

- Marsh habitat is mainly maintained with short vegetation and herbs *Eleocharis spiralis*, *Ludwigia octovalvis*, *Polygonum barbatum*, *Polygonum glabrum* and *Saururus chinensis* are planted in patches around the marsh habitat.

Species	Growth form	No. of Blocks
<i>Bacopa monnieri</i>	Herb	200
<i>Commelina diffusa</i>	Herb	200
<i>Eleocharis spiralis</i>	Herb	80
<i>Panicum repens</i>	Herb	100
<i>Ludwigia adscendens</i>	Herb	100
<i>Ludwigia octovalvis</i>	Herb	50
<i>Polygonum barbatum</i>	Herb	50
<i>Polygonum glabrum</i>	Herb	50
<i>Saururus chinensis</i>	Herb	80

Note: Size of block is 0.5 m x 0.5 m

Grassy bund

Species	Growth form	Planting method
<i>Paspalum paspaloides</i>	Herb	hydroseeding
<i>Cynodon dactylon</i>	Herb	hydroseeding

Note: Size of block is 0.5 m x 0.5 m

Wooded bund

- Between residential area and proposed marsh and reed habitats at Areas 17, 18, A3, A1 and A2

Species	Growth form	Proportion (%)
<i>Gardenia jasminoides</i>	Shrub	10
<i>Ilex asprella</i>	Shrub	10
<i>Ilex pubescens</i>	Shrub	15
<i>Melastoma candidum</i>	Shrub	5
<i>Rhaphiolepis indica</i>	Shrub	20
<i>Rhodomyrtus tomentosa</i>	Shrub	10

Species	Growth form	Proportion (%)
<i>Hibiscus tiliaceus</i>	Shrub/small tree	5
<i>Ligustrum sinense</i>	Shrub/small tree	20
<i>Livistona chinensis</i>	Palm tree	5

Note: Native *Gardenia jaminoides* instead of its variety *Gardenia jasminoides* var. *fortuniana* is used.

2. Along the herpetofauna corridor buffer

- Woody shrubs and trees to be planted on the slope of the ecological corridor buffer

Species	Growth form	Proportion (%)
<i>Rhodomyrtus tomentosa</i>	Shrub	10
<i>Gardenia jasminoides</i>	Shrub	10
<i>Ilex pubescens</i>	Shrub	15
<i>Melastoma candidum</i>	Shrub	10
<i>Hibiscus tiliaceus</i>	Shrub/small tree	15
<i>Ligustrum sinense</i>	Shrub/small tree	10
<i>Livistona chinensis</i>	Palm tree	5
<i>Sapium sebiferum</i>	Tree	15
<i>Sterculia lanceolata</i>	Tree	10

Note: Native *Gardenia jaminoides* instead of its variety *Gardenia jasminoides* var. *fortuniana* is used.

3. Around Area 40

Species	Growth form	Proportion (%)
<i>Melastoma candidum</i>	Shrub	10
<i>Rhodomyrtus tomentosa</i>	Shrub	10
<i>Ligustrum sinense</i>	Shrub/small tree	10
<i>Celtis sinensis</i>	Tree	20
<i>Cleistocalyx operculatus</i>	Tree	20
<i>Hibiscus tiliaceus</i>	Tree	20
<i>Sapium sebiferum</i>	Tree	5
<i>Sterculia lanceolata</i>	Tree	5

Native vegetation for enhancement along buffer planting

- This buffer is planted in association with the proposed woody shrubs and trees

Species	Growth form	No. of Blocks
<i>Bacopa monnieri</i>	Herb	100
<i>Commelina diffusa</i>	Herb	50
<i>Colocasia esculenta</i>	Herb	25
<i>Lindernia antipoda</i>	Herb	50
<i>Saururus chinensis</i>	Herb	50

Note: Size of block is 0.5 m x 0.5 m

Bamboo clump

Species	Growth form	Proportion (%)
<i>Bambusa eutuldoides</i>	Clumped tree bamboo	100

Gravel

- No vegetation will be planted on the gravel.