

Proposed Comprehensive Development at Wo Shang Wai, Yuen Long

Environmental Impact Assessment

Appendix H Wetland Restoration Plan

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PREFACE

Wo Shang Wai to the north of Royal Palms and Palm Springs is zoned “OU(CDWRA)”. This area comprises formed land, fish ponds filled prior to the publication of the Mai Po and Fairview Park Interim Development Permission Area (IDPA) Plan, and fragmented and partially filled marshland. The western portion is currently mostly vacant while the eastern portion is currently partly vacant and partly occupied by a mix of uses including open storage uses, container yards and container vehicle parks.

The planning intention of this location is to provide incentive for the restoration of degraded wetlands adjoining existing fish ponds and to encourage the phasing out of sporadic open storage and port back-up uses on degraded wetland. This can be achieved through comprehensive residential and/or recreational development to include wetland restoration area. Development or redevelopment schemes on the degraded wetlands directly adjoining the existing continuous and contiguous fish ponds should include wetland restoration and buffer proposals to separate the development from and minimize its impact on the fish pond areas. Any new building should be located farthest away from Deep Bay. (Approved Mai Po and Fairview Park OZP No. S/YL - MP/6). This Wetland Restoration Plan provides details required for the construction and long-term management as part of a development proposal which will meet the planning intention for the site.

1 INTRODUCTION

1.1 Background

- 1.1.1 The Project Area referred to in this report comprises an area of land at Wo Shang Wai, to the north of the residential developments at Palm Springs and Royal Palms. Land here comprises formed land, fishponds filled prior to the publication of the Mai Po and Fairview Park Interim Development Permission Area (IDPA) Plan and partially-filled marshland. The western portion of the Project Area is currently vacant, while the eastern area is largely occupied by a mix of uses including open storage area, container yards and container vehicle parks.
- 1.1.2 The Project Area lies within the Deep Bay wetland ecosystem. This is an ecologically sensitive area of international importance. The core of the wetlands is contained within the Mai Po Inner Deep Bay Ramsar Site, listed under the Ramsar Convention. According to the Ramsar Convention, any negative impacts to the ecological value of a listed site require compensation or provision of additional nature reserves. In order to further protect the ecological integrity of the Deep Bay wetlands, the Town Planning Board of the Hong Kong SAR Government has designated areas surrounding the Ramsar Site as Wetland Conservation Area (WCA) and Wetland Buffer Area (WBA). The planning intention of these areas is, respectively, ‘to conserve the ecological value of the fish ponds which form an integral part of the wetland ecosystem in the Deep Bay Area’ and ‘to protect the ecological integrity of the fish ponds and wetland within the WCA and prevent development that would have a negative off-site disturbance impact on the ecological value of fish ponds’ (TPB PG-No. 12B).

- 1.1.3 The northern boundary of the Project Area is contiguous with the boundary of the WCA, while the entire site lies within the WBA. The Project Area itself is zoned as OU(CDWRA), for which the planning intention is to provide incentive for the restoration of degraded wetlands adjoining existing fishponds (within the WCA) and to encourage the phasing out of sporadic open storage and port back-up uses on degraded wetland. This can be achieved by comprehensive residential or recreational developments on the degraded wetlands. Such development schemes should include proposals for the creation of a wetland restoration area to separate the development from adjoining wetland habitats, in order to minimise the impacts of the development on the existing wetlands and thus conserve the ecological integrity of the Deep Bay ecosystem. New buildings should be located farthest away from existing wetlands (Approved Mai Po and Fairview Park OZP No. S/YL – MP/6).
- 1.1.4 No sites of recognised conservation importance lie within the Project Area; however, several sites are nearby, including the Mai Po Nature Reserve, Mai Po Inner Deep Bay Ramsar Site, Mai Po Marshes SSSI, Mai Po Village SSSI and Inner Deep Bay SSSI. Adverse impacts to these ecologically-sensitive areas should be avoided during planning and construction of the project.

2 DESCRIPTION OF THE PROJECT AREA

2.1 Location

2.1.1 The Project Area and the proposed Wetland Restoration Area (WRA) is located on the southern fringe of the Deep Bay wetland, west of Mai Po San Tsuen and northwest of Castle Peak Road (refer to **Figure 8.1** of the EIA report). It is bordered to the east, south and west by low-rise residential development at Royal Palms and Palm Springs. The northern boundary of the Project Area is contiguous with the boundary of the WCA, while the entire site lies within the WBA.

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) as well as the area within 500m of the Project Area has been undertaken and also accompanies the planning application. This assessment, together with previous literature, has been reviewed in the preparation of the 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 housing and restored wetland areas either by avoidance of, minimisation of, or compensation for any adverse ecological impacts; and
- to inform decisions as to the appropriate design, habitats and target species for the WRP.

2.3 Geology and Soils

2.3.1 The underlying solid geology of the area consists of decomposed and metamorphosed volcanic tuffs. These are overlain by a considerable depth of estuarine deposits of marine and fluvial origin, including alluvium and marine clays. Prior to recent filling using imported material, the surface layer would have comprised a mixture of these clays and silts with recent organic deposits deriving from fish farming. Some hydric soils exist on site and although their exact extent and depth is presently unknown, initial site investigations have confirmed that pond mud deposits still exist below the filled areas and indicate that these vary in depth from 0.5 to 2.0 m. The surface layer of mixed imported materials is thought to be comprised largely of mineral soils and inert builders' rubble. Some contaminated soils were also identified during initial site investigations.

2.3.2 The original fishpond soils are derived from mangrove soils and ultimately from marine sediments and riverine alluvium and consist of silts and clays. These are generally acidic (pH 4.5 – 6.0), with moderate to high organic matter content. Soils in the filled area are likely to be more variable, depending on the source of fill.

2.4 Topography and Hydrology

2.4.1 The Project Area is relatively flat with areas varying between +2.5 and +4.2 m PD, although most of the Project Area is between +2.8 and +3.2. Ponds form in the lower parts of the site

during the wet season.

- 2.4.2 The Project Area 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 m PD. To the north of Castle Peak Road there is a flat floodplain which remains largely covered by fishponds despite some reduction due to filling in recent years. 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.
- 2.4.3 The Project Area itself is drained by a ditch which originates to the south of Castle Peak Road. Having passed under Castle Peak Road it enters the eastern boundary of the Project Area and flows in a steep-sided channel along the southern, westerly and then northerly perimeters of the Project Area before discharging into Mai Po River, a partly tidal watercourse, which flows north into the Shenzhen River. Flow in the ditch is variable and flow may be low in the absence of recent rainfall. Water in the ditch is often highly polluted with organic material.
- 2.4.4 Except for the ditch there are no extant hydrological linkages between the Project Area and nearby fish ponds.

2.5 Habitats

- 2.5.1 Most of the Project Area is on land derived from the filling of fishponds in the early 1990s, which has since undergone vegetative succession, although this succession has been largely arrested in a relatively early stage due to regular maintenance work on site (especially cutting of vegetation). This has allowed the habitat to become dominated by a relatively low diversity of invasive plant species tolerant of this regular cutting. In lower-lying areas which hold water for some or all of the year, wetland vegetation has become established, creating seasonal and permanent marsh habitats. Six habitats were identified on site: grassland, seasonal marsh, freshwater marsh/reedbed, drainage channels/ ditches, bare ground and developed areas (**Figure 8.3** of the EIA report).
- 2.5.2 A total of 66 species of plants were recorded in the Project Area during the vegetation surveys, all of which are common or very common species in Hong Kong, including a number of non-native species. No protected plant species or plant species of conservation importance were recorded within the Project Area.

Grassland

- 2.5.3 Grassland habitats cover approximately 11.05ha in the Project Area, this being just over half of the land area of the Project Area. The distribution of plants exhibits a degree of variability, probably resulting from differences in fill material or underlying differences in soil quality and topography across the Project Area.
- 2.5.4 Within the Project Area, the dominant plant species within the grassland habitats is *Brachiaria mutica*, which accounts for over 60% of the plant coverage within this habitat. This is an invasive alien species, which tends to become dominant in habitats where it is able to establish. It is common on fishpond bunds in the Deep Bay area. Other common

plant species in this habitat include the herbs *Bidens alba*, *Conyza bonariensis* and *Sesbania cannabina*, the climber *Ipomoea cairica*, and the grasses *Cynodon dactylon* and *Eleusine indica*. All are very common in early-successional habitats throughout Hong Kong, and most are considered to be invasive weed species.

Seasonal marsh

- 2.5.5 Within the grassland mosaic, some areas (totally 0.69ha in five separate locations) are lower-lying and retain water during the wet season, permitting the establishment of a seasonal wetland habitat. The extent of these habitat patches varies between years, according to rainfall levels. Within these patches a number of wetland plant species tolerant of periodic dry conditions have become established, including *Phragmites australis*, *Paspalum paspaloides*, *Cyperus imbricatus*, *Ludwigia octovalvis*, *Rumex trisetifer* and *Alternanthera philoxeroides*. All are common, widespread species found in wetland habitats throughout Hong Kong and are of no particular conservation importance.

Freshwater marsh/reedbed

- 2.5.6 Towards the west of the Project Area, an area of approximately 4ha is lower and retains rainwater for most of the year, allowing the establishment of a freshwater marsh. There appears to be some pollution of water in this freshwater marsh, due to domestic waste from nearby village areas.
- 2.5.7 dominant plant species in this part of the Project Area is *Phragmites australis*, which covers approximately 70% of the habitat. Other wetland plant species present include *Ipomoea aquatica* and *Panicum repens*, as well as smaller areas of *Alternanthera philoxeroides*, *Cyclosorus interruptus*, *Ludwigia octovalvis* and *Murdannia nudiflora*. Some shallow open water is also present.
- 2.5.8 As with other parts of the Project Area, the freshwater marsh has been subject to routine maintenance, including vegetation cutting and spraying with mosquito insecticide, in response to concern from adjacent residential areas. These activities have limited the development of vegetation in the area (especially *Phragmites*, which typically grows taller and denser than is the case on this Project Area), as well as limiting the potential for use by wetland fauna. In the absence of regular cutting, it is anticipated that the *Phragmites* would become more dominant, causing the freshwater marsh on site to develop into reedbed. This would increase the ecological value of the Project Area, especially for birds, including several reedbed-dependent species of conservation importance.

Drainage channels and ditches

- 2.5.9 Drainage channels are located around the perimeter of the Project Area. These are narrow, and the water within is shallow and relatively polluted by domestic discharge and surface run-off. Smaller drainage ditches within the Project Area dry out for a period of several weeks during the dry season. Riparian vegetation along the channels was structurally simple and dominated by species typical of disturbed habitats around Deep Bay, including *Brachiaria mutica*, *Panicum* spp., *Paspalum* spp., *Eleusine indica* and *Bidens alba*.

Developed area and Bare ground

2.5.10 The north-eastern corner of the Project Area is currently developed land used for open storage and is therefore subject to regular human disturbance. The access track into the Project Area and land surrounding the open storage has been cleared of vegetation and regularly disturbance limits the regrowth of vegetation into this habitat, creating an area of bare soil. No significant vegetative community is established, the only plants present being common roadside weeds such as *Rhynchelytrum repens*, *Panicum maximum* and *Brachiaria mutica*.

Table H2-1 Habitats present in the Wo Shang Wai Project Area.

Habitat type	Project Area	
	Area (ha)	%
Grassland	11.05	51.73
Seasonal Marsh	0.69	3.23
Freshwater Marsh/Reedbed	4.00	18.73
Drainage Ditches/Channels	0.81	3.79
Developed Land & Bare Ground	4.81	22.52
Total	21.36	100

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 created within the WRA. The wetland areas will comprise a mixture of micro-habitats designed to provide the habitat requirements for a number of wetland-dependent or associated birds, herpetofauna and dragonflies which are of conservation concern; these target species have been selected after a review of the existing ecological interest of the Project Area 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 Project Area.

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.

3.2 Guiding Concepts

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

- (a) Recognition of the value of the Deep Bay Wetlands especially the nearby WCA and Mai Po Inner Deep Bay Ramsar Site.
- (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 Project Area (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 basin users.
- (f) Requirement that the wetland habitats should be largely self-sustaining: once the recreated 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 Project Area 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 created.
- (h) Recognition of the ecological value of any existing habitats on site, whilst acknowledging that wetland restoration 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.

4 TARGET SPECIES FOR THE REHABILITATED WETLANDS

4.1 Overview

4.1.1 Following a review of the baseline data, target species for the rehabilitated wetlands have been identified as those species of conservation importance (as defined in Section 4.2.1) which were recorded in significant numbers during the baseline ecological surveys and will therefore be impacted by the proposed development.

4.2 Target Species

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

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

4.2.2 In addition to this, all data from the baseline ecological 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 Hong Kong context. The aim of this review was to determine whether or not the Project Area 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 Annex 2 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 listed in Annex 2.1 of Annex 2, Little Egret, Cattle Egret and Chinese Pond Heron were regularly recorded and in numbers deemed to be of significance. Most of the other species were recorded infrequently and/or in very low numbers with a mean of less than one individual per visit and were treated as not occurring in significant numbers.

4.2.4 Five other species (three of conservation importance, two which are wetland-dependent) that had a mean of more than one individual per visit 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. These five species were Black-crowned Night Heron *Nycticorax nycticorax*, Black Kite *Milvus migrans*, Grey Wagtail *Motacilla cinerea*, Yellow Wagtail *Motacilla flava* and Red-billed Starling *Sturnus sericeus*.

Butterflies

4.2.5 Only one individual of a species of butterfly of conservation importance, a Danaid Egg-fly *Hypolimnas misippus*, was recorded during the baseline ecological surveys. On this basis no butterflies were considered to qualify as targets during the review process.

Dragonflies

- 4.2.6 Only one species of dragonfly of conservation importance, Scarlet Basker *Urothemis signata*, was recorded during the baseline ecological surveys, with a total of three individuals noted on two dates. On this basis no dragonflies were considered to qualify as targets during the review process

Other fauna

- 4.2.7 Following a review of all other fauna recorded during the baseline ecological surveys it was concluded that none qualified as target species.
- 4.2.8 Based upon this assessment, three species were identified as Target Species. These are shown in **Table H4-1**

Table H4-1 Target Species for the Wo Shang Wai Rehabilitated Wetlands.

Species	Status	Reference
Little Egret <i>Egretta garzetta</i>	Potential Regional Concern (Regional Concern)	Fellowes <i>et al.</i> (2002).
Cattle Egret <i>Bubulcus ibis</i>	Local Concern	Fellowes <i>et al.</i> (2002).
Chinese Pond Heron <i>Ardeola bacchus</i>	Potential Regional Concern (Regional Concern)	Fellowes <i>et al.</i> (2002).

4.3 Habitat Requirements for the Target Species

- 4.3.1 Habitat requirements for each of the three Target Species are given below and summarised in **Table H4-2**.

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, and is therefore considered a highly suitable target species for the restored wetlands.
- 4.3.4 Little Egret was recorded in the Project Area on nine out of 17 surveys. Numbers in the Project Area in most months were comparatively small (up to six), although flocks of 48 in November 2005 and 20 in May 2006 were recorded. Habitats used in the Project Area were freshwater marsh/reedbed, seasonal marsh and drainage ditches. Up to 123 were recorded on a single count around fishponds in the Assessment Area.

Cattle Egret

- 4.3.5 Cattle Egret is a scarce in Hong Kong with migrants occurring in spring and autumn. It is a widespread species, although records are mainly from the northwest and northeast New Territories, especially during the breeding season. In Hong Kong, Cattle Egrets tend to forage in areas of short vegetation often around cattle and water buffalo, on the bunds of fish ponds, on landfills and on golf courses and football pitches (Carey *et al.* 2001). They feed largely on insects and amphibians (Voisin 1991) and, unlike other ardeids, rarely eat fish, feeding more often on insects disturbed by grazing animals, maggots and flies around dead fish, and earthworms (Carey *et al.* 2001).
- 4.3.6 This is a localised species and there is strong evidence to suggest that it has declined significantly in recent years in the Deep Bay area due to land use changes.
- 4.3.7 Cattle Egret was recorded in the Project Area on four spring/summer counts, the maximum count in the Project Area being of 14 birds during June 2006. Up to 60 birds were recorded in the Assessment Area, mostly during spring/summer. Birds were recorded foraging in the Project Area in the freshwater marsh and seasonal marsh.

Chinese Pond Heron

- 4.3.8 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).
- 4.3.9 Chinese Pond Heron breeds close to the Project Area in the Mai Po Village and Tam Kon Chau egrettries, but appears to be declining in the Deep Bay area, which has been attributed to wetland loss in the Deep Bay area.
- 4.3.10 Small numbers of Chinese Pond Herons were recorded in the Project Area on nine surveys, mostly during spring/summer, and birds in the Project Area were found foraging in the freshwater marsh/reedbed, seasonal marsh, and drainage ditches. The highest count in the Project Area was seven during June 2006, although greater numbers were recorded in the Assessment Area, especially during the evening, with up to 27 individuals observed heading towards roost sites.

Table H4-2 Summary of the Habitat to be provided for the Target Species at Wo Shang Wai.

Species	Short grass	Tall trees and shrubs	Open water	Reedbed	Non-vegetated islands
Targets					
Little Egret		R	F	F	F, R
Cattle Egret	F, R	R			
Chinese Pond Heron		R		F	

Key: habitat important for F = Foraging; R = Roosting.

Target levels

- 4.3.11 The target level for each of the Target Species will be an exceedance of the density across the Project Area as a whole recorded during the baseline ecological data collection period. The baseline will be based upon data collected during Baseline Ecological Monitoring and will be discussed and agreed with EPD and AFCD prior to operation of the WRA, as detailed in section 7.1. The list of target species will be expanded as required during the Operational Phase Monitoring to accommodate species of conservation importance which may colonise the recreated wetlands. The management of the wetland will be revised on an annual basis to reflect any such changes. It should be noted, however, that the design of the restored wetland has taken into account the habitat requirements of other species of conservation importance that are considered likely to utilise the area, based on experience of creating similar habitats elsewhere (AEC 2007). Details of these species are included in Annex 3.

4.4 Proposed design for the Restored Wetland

- 4.4.1 The size of the recreated wetland will be 4.74 ha. This is based on the area of wetland currently on site (4.69 ha) and the need for the development to avoid a net loss of wetland habitat. The wetland area is consolidated into a single unit to reduce fragmentation, lessen the effects of disturbance and maximise connectivity with existing wetland habitats. The layout of the recreated wetland is designed to maximise the extent to which it is directly adjacent to existing wetlands, at the same time preventing a direct interface between residential development and existing wetland habitats outside the Project Area. The wetland area will thus also serve to buffer the existing wetlands from potential impacts created by the residential component of the proposed scheme. Within the recreated wetland there will be a gradation in vegetation height, with the tallest vegetation at the interface between the residential and wetland components of the proposed scheme (to soften the interface between these components) grading into very short vegetation at the interface between the existing and recreated wetland area (to increase connectivity and maintain an open aspect between these wetlands).
- 4.4.2 The proposed habitat conditions that will provide all the requirements for the species listed in **Table H4-2** and Annex 3 are as follows:
- Open water up to 2.5 m in depth with shallow water margins (0-20 cm depth);
 - reedbed with shallow water margins (0-20 cm depth) and deeper water areas up to 1 m depth);
 - vegetated and non-vegetated islands and shallow water margins (0-20 cm depth);
 - trees/tall shrubs overhanging parts of the main water body;
 - short grass; and
 - a mixture of tall grass and shrubs.

Open water

- 4.4.3 The site will be formed to create a freshwater wetland comprising of four cells in order to facilitate water management, increase shallow water margins and allow access for management and monitoring. Maximum operational water depths will be approximately 2.5

m, and about 75% of the open water areas will be less than 1.5 m.

Reedbed

- 4.4.4 Reedbed on the site will form the majority of the vegetated area and will comprise areas with a maximum water depth of 1 m and extensive areas where water depths are less than 20 cm; these areas will be adjacent to, and continuous with, areas of open water which will have a maximum water depth on 2.5 m. The distribution of reeds on site will be controlled to prevent the entire wetland body becoming a single reedbed. This will be achieved by a rapid increase in water depth at the margins of the reeds to achieve a water depth of approximately 1.5 m – the depth at which reeds fail to grow. Without such deeper areas reeds would rapidly colonise the entire wetland at the expense of area open water, which would reduce habitat diversity.

Vegetated and non-vegetated islands

- 4.4.5 Four islands will be constructed, one in each of the cells; two of these will be planted with tall trees and shrubs and two will be lined and covered with gravel to create non-vegetated islands (and to reduce colonisation by terrestrial vegetation). These will be gently sloping and surrounded by shallow water less than 20 cm deep.

Trees/tall shrubs

- 4.4.6 Woodland areas will largely be located along the southern boundary of the wetland to form a buffer along the edge of the development area; these areas will be planted with tree and shrub species which are adapted to flooded conditions and waterlogged soils.

Tall grass/shrubs

- 4.4.7 Such areas will be hydro-seeded and planted with low shrubs. The grasses will be cut on a regular basis to maintain vegetation height at a suitably low level (< 0.5 m) and to prevent the colonisation of unwanted exotics.

Short grass

- 4.4.8 Such areas will be hydro-seeded and planted with low shrubs. The grasses will be cut on a regular basis to maintain vegetation height at a suitably low level (< 0.2 m) and to prevent the colonisation of unwanted exotics.

Planting Lists

- 4.4.9 Proposed planting lists for the different habitat types are provided in Annex 1 of this document.

4.5 Habitat Utilisation by the target species

Little Egret

- 4.5.1 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 typical roost sites for this species.

4.5.2 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 within the reedbed areas. The wetlands will be stocked with small fish and shrimp which are preferred prey of Little Egrets.

4.5.3 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.

Cattle Egret

4.5.4 This species shows a strong preference for areas of short grass and the provision of this on the bund areas within the restored wetlands will be a key aspect of the management of the wetlands. In addition, roosting habitat will be provided in the form of tall trees.

Chinese Pond Heron

4.5.5 Chinese Pond Herons tends to forage in areas of shallow water with aquatic vegetation which will be provided within the fringes of the reedbed areas. This species feeds primarily upon shrimps and small fish and these will be stocked in the restored wetlands to ensure that suitable food items are available for this species. Suitable roosting habitat will also be provided in the form of tall trees.

4.6 Habitat Change under the Current Master Layout Plan

Table H4-3 Comparison of Habitats lost and created due to the Proposed Development.

Habitat	Existing (ha)	Created (ha)
Grassland	11.05	0.33
Seasonal Marsh	0.69	-
Freshwater Marsh/Reedbed	4.00	-
Drainage Ditches/Channels	0.81	-
Developed Land/ Bare Ground	4.81	16.62
Reedbed	-	1.12
Open water	-	2.37
Tall grass/shrubs	-	0.12
Tall trees/shrubs	-	0.66
Non-vegetated islands		0.14
Total	21.36	21.36

5 MANAGEMENT STRATEGY

5.1 Responsibility for Habitat Creation, Management and Enhancement

5.1.1 The Project Proponent will be responsible for the creation, enhancement and management of the rehabilitated wetland area during the construction phase and shall provide an undertaking to take sole responsibility for management until a successor can be found to the satisfaction of EPD or its agents. An appropriately qualified ecologist with wetland design and management experience will be responsible for supervising implementation of the WRP and for long term monitoring; 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) 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. There 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 management.

Open water

- >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%.

Vegetated islands

- >70% tree canopy cover, with at least 20% overhanging water;
- undesirable flora species < 10 % of vegetation cover;

Non-vegetated islands

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

Tall trees/shrubs

- planted area > 80%;
- undesirable flora species < 10 % cover.

Tall grass/shrubs

- 80% of grass < 0.5 m high;
- planted area > 80% cover;
- undesirable flora species < 10 % vegetation cover.

Short grass

- 80% of grass < 0.3 m high
- planted area > 80% cover;
- undesirable flora species < 10 % vegetation cover.

In addition to this habitat the needs of dragonflies and amphibians will be met by providing ponds which will not be linked to the main water bodies and will be rain-fed and maintained fish free (these are shown in **Figure H1**). This will mitigate for impacts to these communities arising from habitat loss, although no individual species qualified as targets. These ponds will be 1.5-2m deep in the middle. At the edge, a 1m wide shelf should be created at a depth of 0.3-0.5m. Dense submerged and emergent aquatic macrophytes will be planted along this shelf. Beyond this shelf, the pond profile will slope fairly steeply down to the recommended depth of 1.5-2m. In the deeper water, floating macrophytes such as lotus / lilies will be planted. The ponds will be kept free of fish, with a recommended pH range of 4.5-7.5. The ponds will be close to shrubby and/or woody vegetation which will provide roosting / refugia areas for adult dragonflies. If these conditions are maintained, the ponds will provide suitable habitat for a broad range of dragonfly species (25+), including some which are uncommon in Hong Kong and 5-10 species of amphibian.

5.3 Hydrological Management

- 5.3.1 Rainfall during the wet season will be the only regular source of water for the WRP. However, as shown in **Table H5-1**, there is likely to be a deficit during the months of November to March. Since the annual rainfall is significantly higher than annual evaporation, seasonal reductions in water levels could be tolerated as the wetland would be replenished during each wet season.

Table H5-1 Water Budget for the Wo Shang Wai recreated wetland (Source: Hong Kong Observatory data climatological means 1971 – 2000).*

Month	Rainfall (mm)	Evaporation (mm)	Surplus/deficit(mm)
January	24.9	80.7	- 55.8
February	52.3	67.6	-15.3
March	71.4	78.1	-6.7
April	188.5	93.2	+95.3
May	329.5	118.4	+211.1
June	388.1	129.0	+259.1
July	374.4	155.5	+218.9
August	444.6	143.2	+301.4
September	287.5	134.2	+153.3
October	151.9	136.4	+15.5
November	35.1	112.5	-77.4
December	34.5	94.5	-60.0
Year	2382.7	1343.4	+1039.3

* Note that rainfall at Wo Sang Wai is lower (by c. 25%) and evaporation higher than the HKO data. This is balanced to some extent by evapotranspiration from a vegetated area being lower (by c. 20%) than evaporation from an open water body.

- 5.3.2 As there will be areas 2.5 m deep within each cell, these will remain wet throughout the dry season. This will be important in maintaining fish stocks and a healthy reedbed. In addition, 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. Such an approach to water management requires that all rainfall is stored on site and that water levels are permitted to reach the maximum operational level before water is discharged from the wetland. 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 cells and larger sluice(s) at the discharge point to permit the rapid discharge of water when the cells are full or following heavy rainfall events. Indicative locations of water control structures are shown in **Figure H2**.
- 5.3.3 Water depth markers will be placed in the deepest part of each of the sections of open water (deeper than 1.5 m, as shown in **Figure H1**). As such there will be six water depth markers, allowing water depths to be accurately measured throughout the restored wetland and especially in the deep water areas, which will function as refugia for fish and shrimps during period of low water levels.
- 5.3.4 There may be occasions when additional water is required, either due to low water levels as a consequence of prolonged drought or when poor water quality requires the replacement or dilution of the water within the wetland. At times of drought water will either be imported, or the cells will be hydrologically isolated from each other using the uPVC pipe and sluice

system and water pumped between cells to ensure the entire wetland does not dry out. One or more of the cells could be permitted to dry out, provided that sufficient water remains within at least one of the cells to facilitate recolonisation of the other cell(s) by fish, shrimp and other wetland fauna once water levels rise across the wetland. Imported water could be pumped in from nearby fishponds, pumped from mains water supply or imported via a tanker (either fishpond or mains water). The exact source would depend on conditions at the time, although water quality and availability will inevitably drive the decision making process. The preferred source is most likely to be fish pond water, however, either pumped in from nearby ponds or imported by tanker. The project proponent would enter into commercial agreements with pond operators if required.

5.3.5 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 into the adjacent Mai Po River once maximum operational levels are reached and water will be added before levels drop below 1.5 m. Adjacent streams are tidal and grossly polluted; as such they 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).

5.3.6 Regular checking of water quality will be required to ensure that water quality remains within the limits acceptable to fish, dragonflies and amphibians. In general, water pH is a frequent management issue within created wetlands as most such wetlands are formed on acid sulphate soils and as such have a natural tendency to become more acidic over time. This is especially the case when wetlands soils are exposed and then reflooded. The addition of lime or peanut residue is frequently used to combat this issue. Other issues which may be an issue are low dissolved oxygen levels (which can be resolved through pumping water around the WRA) or high salinity (which can be resolved through water exchange)..

5.4 Fish stocking

5.4.1 Fish stocks will fulfill three complementary functions: provision of food for birds, control of vegetation and maintenance of water quality. Fish can be effective predators of amphibian eggs and tadpoles and of dragonfly larvae (AEC 2005), however, and in recognition that wetland-dependent dragonflies and amphibians were recorded within the Project Area during baseline surveys (albeit with no species qualifying as targets), the habitat needs of dragonflies and amphibians will be met by providing ponds which will not be linked to the main water bodies, will be rain-fed and maintained fish free. The locations of these are shown in **Figure H1**. With the inclusion of these fish-free areas, it is not anticipated that dragonflies and amphibians would be adversely affected by the proposed development.

5.4.2 In addition, the shrimp species *Macrobrachium nipponese* 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 wetland. An initial stocking as part of the wetland restoration process will be required because the wetland will be devoid of fish following construction. Following this, fish and shrimp stocks will be monitored regularly and additional stocking will only be undertaken if these are found to be low. Although this may be required on an annual basis regular stocking of 'trash fish' to attract large waterbirds will not be part of the routine management of the restored wetland.

5.4.4 Stocking 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;
- *Macrobranchium nipponense* to provide food for birds;
- Small native fish (exact 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 recreated wetlands.

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 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 cells is sufficiently deep for this species.

5.5.3 The control of vegetation on the bunds and islands 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 *Echinochloa crusgalli*, pantropical weeds such as *Bidens alba* and *B. pilosa* and exotic creepers such as *Mikania micrantha* will 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. Such frequent vegetation management is also required to minimise disturbance as it is preferable to have low levels of regular disturbance than intermittent high levels of disturbance.

- 5.5.4 Frequent cutting of the areas of short grass (as shown in **Figure H1**) will be required to maintain the required height and to prevent unwanted grass species and exotics becoming established. This would be undertaken at a minimum frequency of one 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 build up 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 will 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. This will be required on an annual basis and will be undertaken at the end of the wet season. Wherever possible, dead trees, branches and shrubs will be retained. 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 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 to the wetland. Accordingly, the wetland requires to be secured to prevent unauthorized access and actual and visual barriers will be required to prevent disturbance.
- 5.6.2 Along the eastern, southern and western sides the wetland will directly abut onto areas of residential development. Along these boundaries it is proposed to erect a 2 m high solid wall. 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 solid wall would be buffered from the wetland by the planting of tall trees and shrubs along the southern perimeter of the wetland as shown in **Figure H1**. The aim of tree and shrub planting would be to minimise the visual impact of the wall to the wetland and areas to the north. It would also provide habitat for less disturbance-sensitive species utilising the wetland.
- 5.6.3 Access will be required, however, to facilitate monitoring and management. As far as possible monitoring activities not required to be undertaken during the morning (for example monitoring of water quality and fish stocks) will be undertaken during the early afternoon, with only those activities that must be undertaken during the morning (for example bird monitoring) being scheduled for the early morning in order to reduce disturbance during the period when bird activity is typically highest. 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 northern side of the wetland, which is contiguous with the Deep Bay fishpond system, a low chain link fence 1 m high will be erected to delineate the site boundary and to prevent access and disturbance from outside the site whilst maintaining ecological linkages with the Deep Bay fishpond system. It is noted that such a fence may exclude larger wild mammals, however the need to exclude dogs from the site (which cause extensive disturbance to wildlife and may prey upon waterbirds) override 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 H5-2**.

Table H5-2 Regular management actions for the Wo Shang Wai WRA.

Action	Frequency	Notes
Water Control		
Measure water levels and adjust sluice heights/other water control structures or pump accordingly 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 courses and repair / maintain as necessary	Monthly or more frequently if required.	Also to be inspected after lowering of Typhoon Signal 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 and weeding across the entire site.	
Removal of exotic / undesirable invasive plants (including	Monthly checking with removal to be scheduled for subsequent	Aggressive exotics such as Water Hyacinth to be removed

Action	Frequency	Notes
algae) (weeding)	30 days.	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		
Monitoring of fish numbers and species	Quarterly, with sampling techniques to allow for different behaviour of large fish, small fish and crustaceans.	
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 upon approval of the Section 16 Application 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 wetland restoration area 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 recreated wetland.
- Reuse Substrate: If suitable, substrate (pond mud) within the Project Area will be retained and will form the base of some or all of the wetland area. Mud depth of 6cm to 10cm 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 Project Area.
- Re-contour the wetland area.
- Install water control features: this will enable 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 recreated wetlands, 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 this will require replacing through supplemental planting.

6.2 Implementation Programme

- 6.2.1 It is expected that from commencement of construction of the wetland to it being fully operational will take approximately 2.5 years. This is based on the assumption that site clearance and site formation works would be undertaken during the wet season to avoid disturbance to birds during the dry season. During the subsequent wet season, planting and initial plant maintenance would be undertaken, in addition to retention of rainwater within the wetland. During the second dry season, plant maintenance and control of unwanted plants would be required. Any replacement planting would be undertaken during early stages of the second wet season and further plant maintenance would be undertaken during this period. By the start of the third dry season all plants would be established and water levels would be at the operational maximum; at this point the wetland itself should be established and fully functional:
- 6.2.2 Because the proposed wetland restoration site and the area proposed for residential development is of such limited ecological value, it is not considered that construction period ecological mitigation measures are required. Accordingly the wetland restoration works will be implemented in parallel with the residential development. Works will be completed and the wetland will be established prior to occupancy of the residential units.

7 ECOLOGICAL MONITORING

7.1 Baseline Ecological Monitoring

7.1.1 Baseline Ecological Monitoring was conducted during the preparation of the EcolIA for the proposed development, data collected during these surveys will provide the baseline for evaluation of the success in achieving numerical targets for the Target Species. Target levels will be discussed and agreed with EPD and AFCO prior to the operation of the WRA. As a minimum, the target levels will be determined so that the mean number of individuals of each species recorded in the Project Area during a twelve-month period will be no lower than the mean number recorded during baseline surveys. The mean used for this calculation will be number of individuals recorded on surveys, divided by the number of surveys; baseline data collected for this EIA would provide a mean number of 5.5 Little Egret, 1.3 Cattle Egret and 1.3 Chinese Pond Heron (i.e. a total of at least 66 Little Egret, 16 Cattle Egret and 16 Chinese Pond Heron during monthly surveys over a 12-month period. These will be used as the minimum target levels for these three target species.

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 H7-1** and the methodology for each survey is detailed below under Operational Phase Monitoring. Identification of impacts from construction activity, and required response, will be based on action and limit levels in Table H7-2.

7.3 Operational Phase Ecological Monitoring

7.3.1 Monitoring will be conducted to cover the ecological attributes detailed below:

Monitoring of target bird species

7.3.2 Monitoring of the 3 target bird species listed in **Table H4-1** is required in order to demonstrate success in reaching the target of the recreated wetland supporting, as a minimum, the number of birds recorded during the Baseline Ecological Survey.

Site transects

7.3.3 Surveys will be undertaken monthly. During each survey visit, the surveyor will walk slower around the perimeter of the wetland and along each bund, and identify all birds to species level. Surveys will commence within one hour of sunrise and last for approximately two hours. Surveys covering the Assessment Area will follow a transect that includes all habitats potentially impacted, and will survey each fishpond within this area.

Monitoring of Dragonflies and Butterflies

7.3.4 Transect surveys for dragonflies and butterflies will be undertaken once per month during March and September to November and twice per month during the peak period of adult

emergence in April to August, at which time the number of individual adults observed varies considerably according to prevailing weather, and monthly surveys may not cover the range of variability. Survey duration will be approximately 2 hours, commencing at 08.00 hours, and both groups will be surveyed during the same survey.

- 7.3.5 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. Dragonfly exuviae will be recorded qualitatively. Habitat use and breeding activity is recorded, as well as evidence of breeding success in the form of final instar larval exuviae, which are collected and identified. All butterfly species will be identified and numbers estimated quantitatively or semi-quantitatively.
- 7.3.6 For dragonflies, transect surveys will be supplemented by quantitative monitoring of emergence using of exuviae emergence traps, six traps will be used and inspected once per week during March to August. Emergence traps are highly effective in detecting breeding activity of dragonflies. The frequency and on-going requirement for this monitoring will be reviewed on an annual basis.

Monitoring of Herpetofauna

- 7.3.7 Herpetofauna surveys focus on breeding amphibians and the reptile community. One half-day day-time survey (primarily aimed at detecting reptiles) will be conducted each month during April to November. Surveys will take place during 10.00 – 14.00 hours, the peak period of reptile activity. One half-day night-time survey (primarily aimed at detecting breeding amphibians) will be conducted each month during the period from March to August. Night time surveys will be undertaken during 18.00 – 22.00 hours and focus on the detection of vocalising amphibians. During the surveys a fixed survey route will be walked. All reptiles and amphibians observed or heard will be identified, and their abundance estimated. Habitat use and breeding activity are recorded.

Monitoring of aquatic invertebrates

- 7.3.8 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 will be used to sample aquatic species in the water column and clinging to vegetation at the water-bund interface. The sweep-net will be a D-shaped net of 30 cm diameter with a 1 mm mesh. Each sample will comprise two 2-metre sweeps of the net from which all captured specimens are removed. The first sweep will be carried out at the water surface and the second as close to the wetland bed as possible. Each set of sweeps will be taken along the water-bund interface. Two randomly located replicate samples will be taken from each cell (giving eight samples in total).
- 7.3.9 Samples will be placed in labelled containers together with preservative for transporting to the laboratory. Once in the laboratory, specimens will be rinsed in water, placed on a white sorting tray and sorted for identification to species level using a binocular microscope. Where partial body parts are identified, only heads will be counted.
- 7.3.10 The number of each macro-invertebrate species will be ascertained for each replicate sample for all taxa groups. A total dry weight biomass will be determined for each of the

above groups.

- 7.3.11 The number and species of any fish captured incidentally during the sampling will be recorded.

Methodology for monitoring benthic invertebrates

- 7.3.12 Monitoring of benthic invertebrates 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 cell (with a total of 20 cores samples being collected). Core contents will be bagged and stored in a cooler for subsequent sorting. Samples will analysed in the same way as for sweep netting.

Methodology for monitoring freshwater fish and crustaceans

- 7.3.13 Monitoring of freshwater fish and crustaceans will be conducted at six monthly intervals at the end of the wet season (September) and the end of the dry season (March). Throw and drag-netting will be undertaken once every two months in each cell. 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 are conducted in each cell. 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.

Monitoring of habitats types

- 7.3.14 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).

Monitoring of vegetation cover

- 7.3.15 Detailed floristic surveys will be conducted in each habitat type (reedbed, vegetated islands, tall trees/shrubs, tall grass/shrubs and short grass) at six monthly intervals at the end of the wet season (September) and the end of the dry season (March). Transects will run through each habitat area with a fixed number of quadrats in each. 10m x 10m quadrats will be used vegetated islands, in areas of tall trees/shrubs and tall grass/shrubs, while 2m x 2m quadrats in the habitats of reedbed and short grass.
- 7.3.16 Within each 10m x 10m quadrat, all plant species, including both planted and naturally invaded species, will be identified to species level. Height, growth form and conditions of all woody plants will be measured and recorded. Any rare or protected species will also be identified.
- 7.3.17 Within each 2m x 2m quadrat, all plant species and their densities will be identified to species-level and estimated respectively. 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.

Pedology Monitoring

7.3.18 Sediment in each cell will monitored yearly in the early wet season. Three sediment samples will be collected from each 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

7.3.19 In-situ water quality will be measured in each cell once per month. The following parameters will be monitored:

- Temperature
- pH
- Salinity
- Turbidity
- Dissolved oxygen

7.3.20 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).

7.3.21 In addition, every six months (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 H7-1 Summary of Construction and Operational Phase Ecological Monitoring for the Wo Shang Wai WRA.

	Construction Phase Ecological Monitoring	Operational Phase Ecological Monitoring
Birds	Weekly (including Assessment Area).	Monthly (excluding Assessment Area).

	Construction Phase Ecological Monitoring	Operational Phase Ecological Monitoring
Dragonflies and Butterflies	Once per month during March and September to November and twice per month during April to August.	Once per month during March and September to November and twice per month during April to August.
Herpetofauna	Once per month during April to November.	Once per month during April to November.
Aquatic invertebrates	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.	At six monthly intervals at the end of the wet season (September) and the end of the dry season (March).
Freshwater fish	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.	At six monthly intervals at the end of the wet season (September) and the end of the dry season (March).
Vegetation cover	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.	Yearly in the early wet season.
Water Quality	Following filling with water monthly for in situ water quality and every six months (end of the wet season and end of the dry season) for laboratory testing.	Monthly for in situ water quality and every six months (end of the wet season and end of the dry season) for laboratory testing.
Site Inspections	Weekly.	Twice per month.

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

- 7.4.1 Findings of the wildlife and habitat monitoring programme detailed above will be reviewed on a monthly basis (or more frequently if species' or habitat targets are not being met) by a Wetland Ecologist to identify necessary adjustments to the management regime.
- 7.4.2 In addition, weekly inspections of the WRA and adjacent areas will be conducted during the construction and establishment phase, any events detrimental to the operation of the wetlands highlighted and suitable remedial action taken.
- 7.4.3 The monitoring programme will be sufficiently flexible to allow additional inspections in the event 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 certain criteria (e.g. number of target species, area of preferred habitats) are not being met; actions will be conducted to improve the habitats. **Table H7-2** describes the action and limit levels and the action plan.

Table H7-2 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 open water pond – wet season levels	< 70 & > 95%	< 60 & 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 to reinstate the area/ re-profiling/ other measures.
Area of water in the open water pond – dry season levels	< 50 & >95%	<40 & 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 to reinstate the area/ re-profiling/ other measures.
Emergent or floating vegetation in the open water pond (although it is not proposed to plant emergent or floating vegetation as part of the restoration process, it is to be expected that these will colonise the wetland over time)	> 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).
Wooded island tree 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.
Gravel island 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.
Reedbed reed cover	< 80%	< 60%	Action level exceedance: double the

Parameters	Action Level	Limit Level	Action
			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% & > 80%	<15% & > 95%	Action level exceedance: pump to restore water levels. Limit level exceedance: pump to restore water levels; review water management regime in medium term..
Undesirable plant species (all wetland)	> 10% of vegetation in WRA or in any cell	> 20% of vegetation in WRA or in any 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 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

Parameters	Action Level	Limit Level	Action
			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/ erect buffering screen (short-term)/ increase buffer planting (long-term)/ other measures

7.6 Resources Requirement for Wetland Construction and Operating

Construction

- 7.6.1 The resources requirement given in **Table H7-3** below 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 (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 H7-3 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 2 ha planting area, mainly of reeds
Tree/shrub/grasses planting	Approx. 1.1 ha planting, trees planted as whips, pot grown shrubs and hydroseeding of grasses required.
Sluices/ weirs	As shown in Figure H2 ,
Pipework	Material and installation cost. Dependent upon detailed design.
Tracks	Grasscrete or similar finish.

Annual Management and Maintenance Resources Requirement

7.6.2 The estimated Annual Management and Maintenance Resources Requirement is shown in **Table H7-4**. 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 Project Area. If the same contractor is employed some equipment may be utilized in both the wetland and for landscape maintenance on the residential site.

7.6.3 Annual Monitoring Resource Requirements are stated in **Table H7-1**.

Table H7-4 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.
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	1000 m ²	Replacement planting

Fencing repairs	As required	Annual budget required.
Sluice repairs	As required	
Misc. materials	As required	Annual budget required.

7.7 Trust management system, financial arrangements and management agents

Issues to Consider

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

7.8 Management and Maintenance Options – 3 different approaches

- 7.8.1 One option would be for the Wetland Restoration Area to be placed in the ownership of an independent Trust which would be established to own, manage and maintain the distinctive portion of the Project Area 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 Wetland Restoration Area 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.
- 7.8.2 The second option would be for the Project Proponent to retain that part of the Project Area demarcated as Wetland Restoration Area 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.
- 7.8.3 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 Wetland Restoration Area 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.
- 7.8.4 Irrespective of which option is selected, the Project Proponent shall be responsible for the construction of the Wetland Restoration Area as part of the development and shall provide an undertaking to take sole responsibility for management until a successor can be found to the satisfaction of EPD or its agents.

8 REPORTING

8.1 Monitoring Reports

- 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, i.e. the stakeholders and relevant Government Departments e.g. AFCD and EPD. The frequency of reporting will conform to the requirements of the Environmental Permit.

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ANNEX 1. PROPOSED PLANTING LIST FOR WO SHANG WAI WETLAND RESTORATION AREA.

Plant mixes for the habitat types shown in **Figure H1** of this report are as follows:

Mix 1 (For reedbed areas)

Reedbed species	Percentage of individuals
<i>Phragmites</i> spp. (e.g. <i>Phragmites australis</i>) (Herb)	100
Total	100%

Mix 2 (For Vegetated islands and areas of Tall trees/shrubs)

Tree/tall shrub mix	Percentage of individuals
<i>Ficus hispida</i> (Tree)	10
<i>Ficus microcarpa</i> (Tree)	15
<i>Ficus variegata</i> var. <i>chlorocarpa</i> (Tree)	10
<i>Macaranga tanarius</i> (Tree)	10
<i>Melia azedarach</i> (Tree)	20
<i>Syzygium jambos</i> (Tree)	10
<i>Bridelia tomentosa</i> (Shrub)	10
<i>Trema orientalis</i> (Tall shrub)	10
<i>Viburnum odoratissimum</i> (Shrub)	5
Total	100%

Mix 3 (For areas of tall grass/shrubs)

Grass and shrub mix	Percentage of individuals
<i>Bridelia tomentosa</i> (Shrub)	5
<i>Gardenia jasminoides</i> (Shrub)	5
<i>Melastoma candidum</i> (Shrub)	5
<i>Rhaphiolepis indica</i> (Shrub)	5
<i>Cynodon dactylon</i> (Grass)	5
<i>Panicum maximum</i> (Grass)	40
<i>Paspalum paspaloides</i> (Grass)	35
Total	100%

Mix 4 (For areas of Short grass)

Short grass mix	Percentage of individuals
<i>Commelina diffusa</i>	50
<i>Cynodon dactylon</i>	40
<i>Eleusine indica</i>	10
Total	100%

Mix 5 (For shallow margins of fish-free ponds)

Marginal vegetation mix	Percentage of individuals
<i>Polygonum barbatum</i>	20
<i>Polygonum glabra</i>	20
<i>Ludwigia octovalvis</i>	15
<i>Ludwigia perennis</i>	20
<i>Cyperus malaccensis</i>	10
<i>Eleocharis spiralis</i>	15
Total	100%

Note:

- 1) The proposed tree/shrub species are suitable for planting near permanent or in seasonally damp areas.
- 2) No vegetation will be planted in the areas of Open water and on Non-vegetated islands

ANNEX 2. SUMMARY OF STATUS OF SPECIES WITHIN THE PROJECT AREA.

Annex 2.1. Mean number of individuals and maximum number of individuals of bird species of conservation importance recorded on morning transect counts in Project Area (PA), April 2005-June 2006. (Level of importance based on Fellowes et al. 2002).

Species	Wetland-dependent	Level of Concern	Mean in PA	Maximum in PA
Great Cormorant <i>Phalacrocorax carbo</i>	Y	PRC	0.5	5
Grey Heron <i>Ardea cinerea</i>	Y	PRC	0.1	2
Little Egret <i>Egretta garzetta</i>	Y	PRC (RC)	5.5	48
Cattle Egret <i>Bubulcus ibis</i>	Y	(LC)	1.3	14
Chinese Pond Heron <i>Ardeola bacchus</i>	Y	PRC (RC)	1.3	4
Black-crowned Night Heron <i>Nycticorax nycticorax</i>	Y	(LC)	0.2	4
Black Kite <i>Milvus migrans</i>	N	(RC)	1.2	5
White-breasted Waterhen <i>Amaurornis phoenicurus</i>	Y	-	0.2	2
Little Ringed Plover <i>Charadrius dubius</i>	Y	(LC)	0.1	1
Common Sandpiper <i>Actitis hypoleucos</i>	Y	-	0.2	1
Common Snipe <i>Gallinago gallinago</i>	Y	-	0.1	1
White Wagtail <i>Motacilla alba</i>	(Y)	-	0.9	3
Grey Wagtail <i>Motacilla cinerea</i>	Y	-	2.2	3
Yellow Wagtail <i>Motacilla flava</i>	Y	-	10.0	151
Zitting Cisticola <i>Cisticola juncidis</i>	(Y)	LC	0.1	1
Oriental Reed Warbler <i>Acrocephalus orientalis</i>	Y	-	0.1	1
Red-billed Starling <i>Sturnus sericeus</i>	(Y)	(RC)*	0.9	15
White-shouldered Starling <i>Sturnus sinensis</i>	(Y)	(LC)	0.1	2

* Red-billed Starling is considered by Fellowes *et al.* (2002) to be of Global Concern. Since publication, however, the global population estimate has been revised and the species is not now considered threatened. A listing of Regional Concern (RC), based on the importance of the large roosts present near Deep Bay, is considered to be more appropriate.

Annex 2.2. Butterfly species recorded in the Project Area (PA) during surveys, May 2005 – June 2006.

Species	Level of concern	Mean in PA	Maximum in PA
Formosan Swift <i>Borbo cinnara</i>		0.1	1
Common Jay <i>Graphium doson</i>		0.1	1
Common Mime <i>Chilasa clytia</i>		0.1	1
Great Mormon <i>Papilio memnon</i>		0.1	1
Paris Peacock <i>Papilio paris</i>		0.2	1
Red-base Jezebel <i>Delias pasithoe</i>		0.1	1
Indian Cabbage White <i>Pieris canidia</i>		7.7	33
Yellow Orange Tip <i>Ixias pyrene</i>		0.1	1
Mottled Emigrant <i>Catopsilia pyranthe</i>		0.3	1
Lemon Emigrant <i>Catopsilia pomona</i>		0.2	2
Common Grass Yellow <i>Eurema hecabe</i>		3.1	18
Pale Grass Blue <i>Zizeeria maha</i>		0.3	3
Lime Blue <i>Chilades lajus</i>		0.3	4
Dark-brand Bush Brown <i>Mycalesis mineus</i>		0.2	2
Straight Five-ring <i>Ypthima lisandra</i>		0.1	1
Large Faun <i>Faunis eumeus</i>		0.2	1
Angled Castor <i>Ariadne ariadne</i>		0.1	1
Great Egg-fly <i>Hypolimnas bolina</i>		0.1	1
Danaid Egg-fly <i>Hypolimnas misippus</i>	LC	0.1	1
White-edged BlueBaron <i>Euthalia phemius</i>		0.1	1
Blue-spotted Crow <i>Euploea midamus</i>		0.1	1

Annex 2.3. Dragonfly species recorded in Project Area (PA) during surveys, May 2005 – June 2006.

Species	Level of concern	Mean in PA	Maximum in PA
Orange-tailed Midget <i>Agiocnemis femina</i>		0.7	4
Orange-tailed Sprite <i>Ceriagrion auranticum</i>		0.4	3
Common Bluetail <i>Ischnura senegalensis</i>		3.0	13
Black Threadtail <i>Prodasineura autumnalis</i>		0.5	5
Lesser Emperor <i>Anax parthenope</i>		0.2	2
Asian Widow <i>Palpopleura sexmaculata</i>		0.2	1
Asian Amberwing <i>Brachythemis contaminata</i>		4.5	41
Crimson Darter <i>Crocothemis servilia</i>		1.1	7
Blue Percher <i>Diplacodes trivialis</i>		0.3	3
Pied Percher <i>Neurothemis tullia</i>		8.1	67
Blue Skimmer sp.* <i>Orthetrum</i> sp.		1.4	12
Common Red Skimmer <i>Orthetrum pruinosum</i>		1.5	6
Green Skimmer <i>Orthetrum sabina</i>		4.5	15
Wandering Glider <i>Pantala flavescens</i>		4.5	29
Variegated Flutterer <i>Rhyothemis variegata</i>		5.5	17
Evening Skimmer <i>Tholymis tillarga</i>		0.1	1
Crimson Dropwing <i>Trithemis aurora</i>		0.9	6
Scarlet Basker <i>Urothemis signata</i>	LC	0.3	2

* Three species of blue skimmer may occur on site: Common Blue Skimmer *Orthetrum glaucum*, Lesser Blue Skimmer *Orthetrum triangulare* and Marsh Skimmer *Orthetrum luzonicum*.

ANNEX 3. ADDITIONAL SPECIES OF WETLAND RESTORATION PLAN

A3.1 Additional Species of Conservation Importance

A3.1.1 Under the terms of the EIAO the recreated wetlands are required as mitigation for the species to be significantly impacted by the proposed development (see Section 4 for target species selection). However, it is recognised that in addition to the target species many other species, including species of conservation importance, could also utilise the wetlands if suitable habitat were provided.

A3.1.2 This Annex details Species of Conservation Importance which are expected to utilise the site based on the following:

- They are recognized as being of Conservation Importance based upon criteria provided by BirdLife International (2006 and web updates), IUCN Species Survival Commission (2001) and Fellowes *et al.* (2002);
- It is realistic to expect them to use the rehabilitated wetlands given the size, location and expected level of human activity within the Project Area;
- They are either present on Project Area, in the nearby wetland system or are sufficiently vagile to locate and utilize the Project Area;
- The design of the wetland can accommodate each species without reducing the overall value of the Project Area for the Target Species.

A3.1.3 Based upon this selection process 18 species have been identified; these are detailed in Table A3.1.

Table A3.1. Additional Species of Conservation Importance expected to utilise the recreated Wetlands.

Species	Status	Reference
<i>Birds</i>		
Great Cormorant <i>Phalacrocorax carbo</i> *	Potential Regional Concern	Fellowes <i>et al.</i> (2002)
Night Heron <i>Nycticorax nycticorax</i> *	Local Concern	Fellowes <i>et al.</i> (2002)
Grey Heron <i>Ardea cinerea</i> *	Potential Regional Concern	Fellowes <i>et al.</i> (2002)
Purple Heron <i>Ardea purpurea</i>	Regional Concern	Fellowes <i>et al.</i> (2002)
Great Bittern <i>Botaurus stellaris</i>	Regional Concern	Fellowes <i>et al.</i> (2002)
Great Egret <i>Egretta alba</i> *	Potential Regional Concern	Fellowes <i>et al.</i> (2002)
Yellow Bittern <i>Ixobrychus sinensis</i>	Local Concern	Fellowes <i>et al.</i> (2002)
Black Kite <i>Milvus migrans</i> *	Regional Concern	Fellowes <i>et al.</i> (2002)
White-throated Kingfisher <i>Halycon smyrnensis</i> *	Local Concern	Fellowes <i>et al.</i> (2002)
Zitting Cisticola <i>Cisticola juncidis</i> *	Local Concern	Fellowes <i>et al.</i> (2002)
Pallas's Grasshopper Warbler <i>Locustella certhiola</i>	Local Concern	Fellowes <i>et al.</i> (2002)
Red-throated Pipit <i>Anthus cervinus</i>	Local Concern	Fellowes <i>et al.</i> (2002)
Bluethroat <i>Luscinia svecica</i>	Local Concern	Fellowes <i>et al.</i> (2002)
Chinese Penduline Tit <i>Remiz consobrinus</i>	Regional Concern	Fellowes <i>et al.</i> (2002)
Red-billed Starling <i>Sturnus sericeus</i> *	Global Concern**	Fellowes <i>et al.</i> (2002)
White-cheeked Starling <i>Sturnus cineraceus</i>	Potential Regional Concern	Fellowes <i>et al.</i> (2002)
White-shouldered Starling <i>Sturnus sinensis</i> *	Local Concern	Fellowes <i>et al.</i> (2002)

Species	Status	Reference
Yellow-breasted Bunting <i>Emberiza aureola</i>	Near-threatened	BirdLife International (2006)
<i>Dragonflies</i>		
Coastal Glider <i>Macrodiplox cora</i>	Local Concern	Fellowes <i>et al.</i> (2002)
Scarlet Basker <i>Urothemis signata</i> *	Local Concern	Fellowes <i>et al.</i> (2002)

* Recorded within the Assessment Area during the baseline ecological surveys

** Red-billed Starling is considered by Fellowes *et al.* (2002) to be of Global Concern. Since publication, however, the global population estimate has been revised and the species is not now considered threatened. A listing of Regional Concern (RC), based on the importance of the large roosts present near Deep Bay, is considered to be more appropriate.

A3.2 Habitat Requirements for Additional Species of Conservation Importance

Great Cormorant

A3.2.1 Great Cormorants are winter visitors to Hong Kong. They roost communally and disperse to feed, either in Deep Bay or on fishponds. They use both active and inactive ponds, but avoid small ponds, especially those completely surrounded by trees or adjacent to human activity. They feed by catching fish whilst swimming (usually underwater). Accordingly, they will utilise ponds when they are full or partly full of water, but not drained. During the day, when not feeding, some birds return to the night time roosts whilst others use daytime loafing sites, which are usually in isolated trees or tree lines or on bare bunds or banks, especially those which are isolated from disturbance and ground predators by being surrounded by water (AEC 2007, Carey *et al.* 2001).

A3.2.2 Foraging opportunities will be provided in the deeper open water areas, which will be stocked with fish suitable for this species. Suitable areas for roosting will be available on the non-vegetated islands and the areas of tall trees and shrubs.

Grey Heron

A3.2.3 Grey Heron is an abundant winter visitor to Deep Bay but is rare at other times of year and elsewhere in Hong Kong (Carey *et al.* 2001). Habitat utilisation has been studied in Hong Kong by Young (1994) who noted that this species is predominantly a crepuscular feeder and primarily uses *gei wai* as a daytime roost; but also utilises fish ponds for feeding. Grey Herons usually feed on fish, preferentially selecting those 10 – 16 cm in length (Cramp and Simmons 1977) and usually hunt by wading in water up to c. 70 cm depth. If undisturbed, they loaf during the day on bunds and islands.

A3.2.4 Foraging opportunities will be provided in the shallower open water areas and on the fringes of the reedbed. The wetland will be stocked with fish suitable for this species. Suitable areas for roosting will be available on the non-vegetated islands and the areas of tall trees and shrubs.

Black-crowned Night Heron

A3.2.5 Black-crowned Night Heron is a widespread resident and winter visitor to Hong Kong. It occurs in most wetland habitats, including fishponds, marshes, reedbeds, streams, etc. This is a predominantly nocturnal species which regularly roosts communally during the day,

especially in trees and bamboo next to or overhanging water. They feed mainly on small fish (Carey *et al.* 2001, Voisin 1991).

A3.2.6 Black-crowned Night Heron is thought to have declined as a breeding species in the Deep Bay area in recent years although it is present there throughout the year.

A3.2.7 Day time roosting sites will be provided in the form of tall trees, which on parts of the site will be overhanging water, a combination which seems extremely attractive to roosting Black-crowned Night Herons.

A3.2.8 This species forages mainly at night in areas of shallow water with aquatic vegetation, which will be provided within the fringes of the reedbed areas. This species feeds primarily upon small fish and these will be stocked in the restored wetlands to ensure that suitable food items are available for this species.

Purple Heron

A3.2.9 Purple Heron is an uncommon autumn passage migrant, is scarce in spring and winter, and probably also breeds in the Deep Bay area. Most Hong Kong records are from the Deep Bay area and the highest numbers occur in reedbeds (Carey *et al.* 2001). Purple Herons feed mostly on small fish. They also take amphibians, snakes, lizards, birds, small mammals and insects (Voisin 1991).

A3.2.10 Foraging and roosting opportunities for this species will provided within and on the fringes of the reed bed.

Great Bittern

A3.2.11 Great Bittern is a scarce winter visitor and passage migrant to Deep Bay, with the highest numbers occurring in spring, especially late March. This species has a strong preference for reedbeds, an association which is found throughout most of its range (Voisin 1991). They feed predominantly on fish, eels and amphibians (Cramp and Simmons 1977).

A3.2.12 Foraging and roosting opportunities for this species will be provided within and on the fringes of the reed bed.

Great Egret

A3.2.13 Great Egret is a common to abundant bird in Hong Kong with small numbers breeding. It is largely found in the Deep Bay area, at Starling Inlet and at Shuen Wan. Habitat utilisation has previously been studied in Hong Kong by Young (1994) who showed that whilst this species regularly fed on drained ponds and *gei wai*, intertidal mudflats are typically more important as feeding habitat. They feed mainly on fish, but also on small mammals, birds, amphibians, crustaceans, molluscs, worms and insects (Voisin 1991).

A3.2.14 Foraging opportunities will be provided in the shallower open water areas and on the fringes of the reedbed. The wetland will be stocked with fish suitable for this species. Suitable areas for roosting will be available on the non-vegetated islands and the areas of tall trees and shrubs.

Yellow Bittern

- A3.2.15 Yellow Bittern is an uncommon summer visitor and passage migrant to Hong Kong and has greatly declined in numbers in recent years. In Hong Kong it occurs in a variety of wetland habitats but especially mangroves (particularly during the breeding season), reedbeds, and freshwater marshes. It requires areas with extensive emergent vegetation. Yellow Bitterns forage primarily on small fish and amphibians (Carey *et al.* 2001).
- A3.2.16 Foraging and roosting opportunities for this species will provided within and on the fringes of the reed bed.

Black Kite

- A3.2.17 Black Kite is a winter visitor and scarce breeding bird in Hong. It is far more widespread and numerous in winter than in summer, especially in the Deep Bay area where it is largely absent during the summer months. It occurs across a wide variety of coastal and inland habitats including fishponds where it consumes dead fish and little else. Day time roosts are regularly noted, especially in groups of tall trees close to water.
- A3.2.18 Day time roosting habitat will be provided for this species in the areas of tall trees and shrubs.

White-throated Kingfisher

- A3.2.19 White-throated Kingfisher is a resident bird in Hong Kong which is locally common in autumn and winter. It occurs in a variety of wetland and non-wetland habitats but especially mudflats, mangroves, fishponds and wet agriculture. It feeds on small fish, crustaceans, invertebrates, lizards and small snakes (Carey *et al.* 2001).
- A3.2.20 Day time roosting habitat will be provided for this species in the areas of tall trees and shrubs, and suitable foraging habitat in areas of shallow water.

Zitting Cisticola

- A3.2.21 Zitting Cisticola is a common winter visitor and passage migrant in Hong Kong and a rare breeding species. It favours areas of grass, especially in lowland wetland areas such as active and disused fishponds. Small numbers breed in Hong Kong, primarily in the Deep Bay area (Carey *et al.* 2001).
- A3.2.22 Areas of tall grass and shrubs and reedbed will provide suitable foraging habitat for this species.

Pallas's Grasshopper Warbler

- A3.2.23 Pallas's Grasshopper Warbler is primarily an autumn passage migrant to Hong Kong, with occasional winter and spring records. It occurs in most wetland habitats but most notably in areas of abandoned or inactive wet agriculture, along the bunds of fishponds and in reedbeds. It is insectivorous (Carey *et al.* 2001).

- A3.2.24 Areas of tall grass and shrubs and reedbed will provide suitable foraging habitat for this species.

Red-throated Pipit

- A3.2.25 Red-throated Pipit is a common winter visitor and passage migrant to Hong Kong. It is found in low lying marshes or open grassy areas, wet and dry agriculture and, especially during migration, on bunds between fishponds. Most records are from the northwest New Territories.

- A3.2.26 Areas of short grass will provide suitable foraging habitat for this species.

Bluethroat

- A3.2.27 Bluethroat is a winter visitor and spring migrant to Hong Kong; it is largely restricted to the northwest New Territories, where it frequents wet agricultural areas, well vegetated fishponds, freshwater ditches and reedbeds. It is insectivorous (Carey *et al.* 2001).

- A3.2.28 The areas of reedbed will provide suitable foraging areas for this species.

Chinese Penduline Tit

- A3.2.29 Chinese Penduline Tit is a fairly common passage migrant and winter visitor to the Deep Bay area. It is insectivorous and forages almost exclusively in reedbeds (Carey *et al.* 2001).

- A3.2.30 The areas of reedbed will provide optimum foraging habitat for this species.

Red-billed Starling

- A3.2.31 Red-billed Starling is a winter visitor to Hong Kong, occurring in large flocks in the northwest New Territories. The wintering population in Hong Kong is considered probably to be of international importance for this species (Carey *et al.* 2001). Red-billed Starlings are omnivores and feed around fishponds, wet agricultural areas (especially where these are contaminated by effluent from pig farms), edges of reedbeds and both natural and artificial drainage channels. They readily take advantage of spilled food provided for fish or ducks. Much food is obtained on the ground but they also frequently feed in trees where they consume insects and fruit.

- A3.2.32 The areas of tall trees and shrubs will provide suitable foraging habitat for this species.

White-cheeked Starling

- A3.2.33 White-cheeked Starling is a common but localised winter visitor which is most common in the Deep Bay area and in other nearby wetland areas such as Kam Tin. It often scavenges on food waste around fishponds and pig and poultry farms and is especially fond of the fruit of Persian Lilac *Melia azaderach* (Carey *et al.* 2001).

- A3.2.34 The areas of tall trees and shrubs will provide suitable foraging habitat for this species.

White-shouldered Starling

- A3.2.35 White-shouldered Starling is a common passage migrant and scarce and localised breeding summer visitor and winter visitor. The breeding population is considered to be less than 50 pairs (Carey *et al.* 2001). Whilst historically this species nested in old buildings or village houses it has adapted in recent years and has, very recently, been successfully attracted to artificial nest boxes at Lok Ma Chau (AEC 2007).
- A3.2.36 The areas of tall trees and shrubs will provide suitable foraging habitat for this species; in addition nest boxes suitable for this species will be placed in taller trees around the site to encourage this species to breed on site.

Yellow-breasted Bunting

- A3.2.37 Yellow-breasted Bunting is an uncommon to common passage migrant with small numbers occurring in winter. It occurs in a wide variety of habitats in Hong Kong, including wet and dry farmland, grassland, the edges of reedbeds and fishpond bunds. It is largely granivorous, but will also take small insects (Carey *et al.* 2001).
- A3.2.38 Areas of tall grass and shrubs and reedbed will provide suitable foraging habitat for this species.

Coastal Glider

- A3.2.39 This species is considered to be of 'Local Concern' by Fellowes *et al.* (2002). It was first discovered in Hong Kong in 1997. It is known to occur at Mai Po marshes, Kam Tin, San Tin and Lok Ma Chau. The species breeds in brackish lagoons and estuaries, but adults will utilise nearby ponds and marshes for foraging.
- A3.2.40 The fish-free ponds and reedbed area will provide suitable foraging habitat for adults of this species.

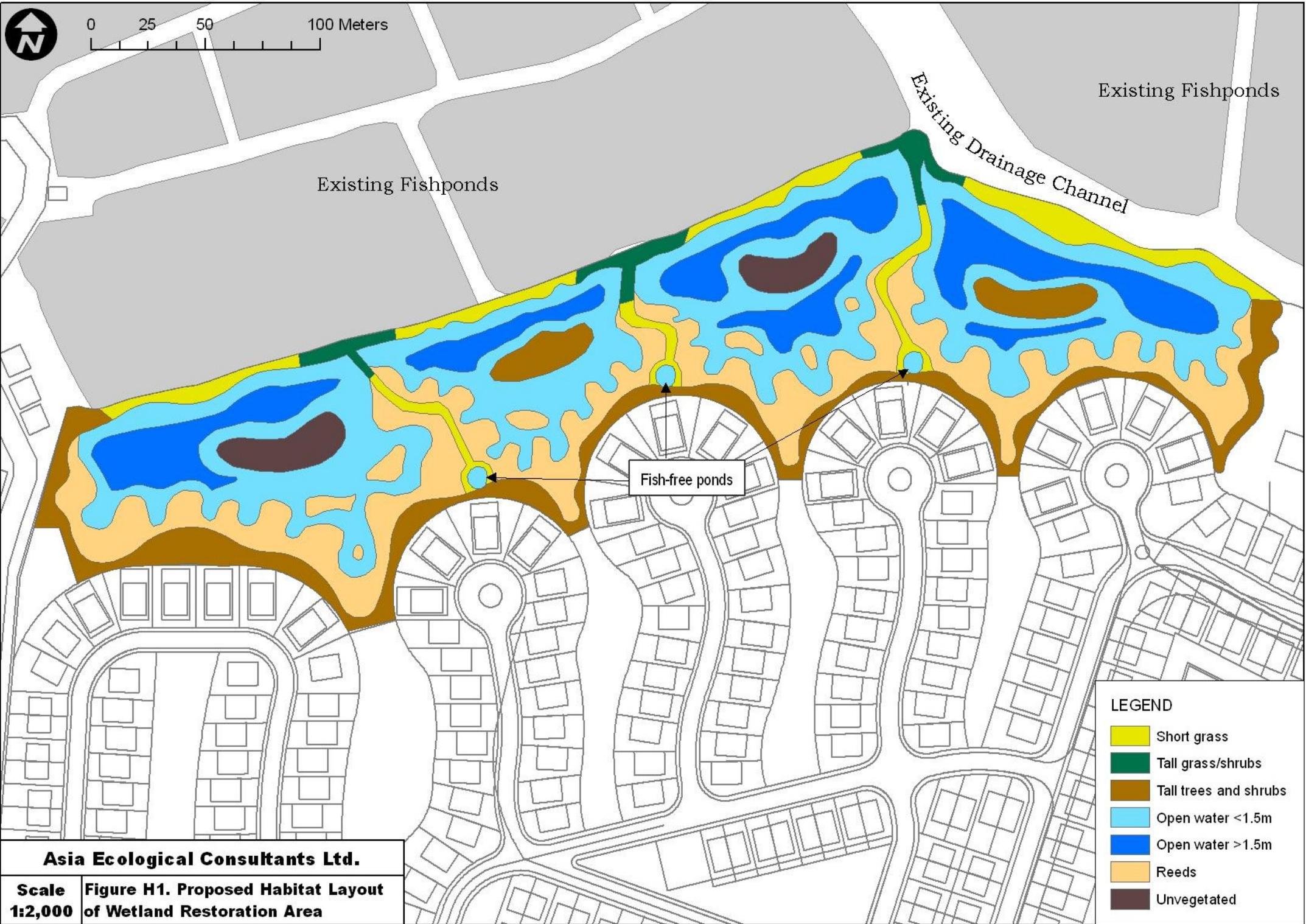
Scarlet Basker

- A3.2.41 This species is considered to be of 'Local Concern' by Fellowes *et al.* (2002). It is quite widespread in the New Territories, and has been recorded at Mai Po, Lok Ma Chau and Kam Tin.
- A3.2.42 The fish free ponds will provide suitable breeding habitat for this species.

Table A3.2 . Summary of the Habitat to be provided for Additional Species of Conservation Importance.

Species	Short grass	Tall Grass and shrubs	Tall trees and shrubs	Open water	Reedbed	Non-vegetated islands	Fish-free ponds
Great Cormorant			R	F		R	
Grey Heron			R	F	F	R	
Black-crowned Night Heron			R		F, R		
Purple Heron					F, R		
Great Bittern					F, R		
Great Egret			R		F	R	
Yellow Bittern					F, R		
Black Kite			R				
White-throated Kingfisher			R	F			
Zitting Cisticola		F			F		
Pallas's Grasshopper Warbler		F			F		
Red-throated Pipit	F						
Bluethroat					F		
Chinese Penduline Tit					F		
Red-billed Starling			F				
White-cheeked Starling			F				
White-shouldered Starling			F, B				
Yellow-breasted Bunting		F			F		
Coastal Glider <i>Macrodiplax cora</i>				F	F, B		F,R,B
Scarlet Basker <i>Urothemis signata</i>				F	F		F,R,B

Key: habitat important for F = Foraging; R = Roosting; B = Breeding.

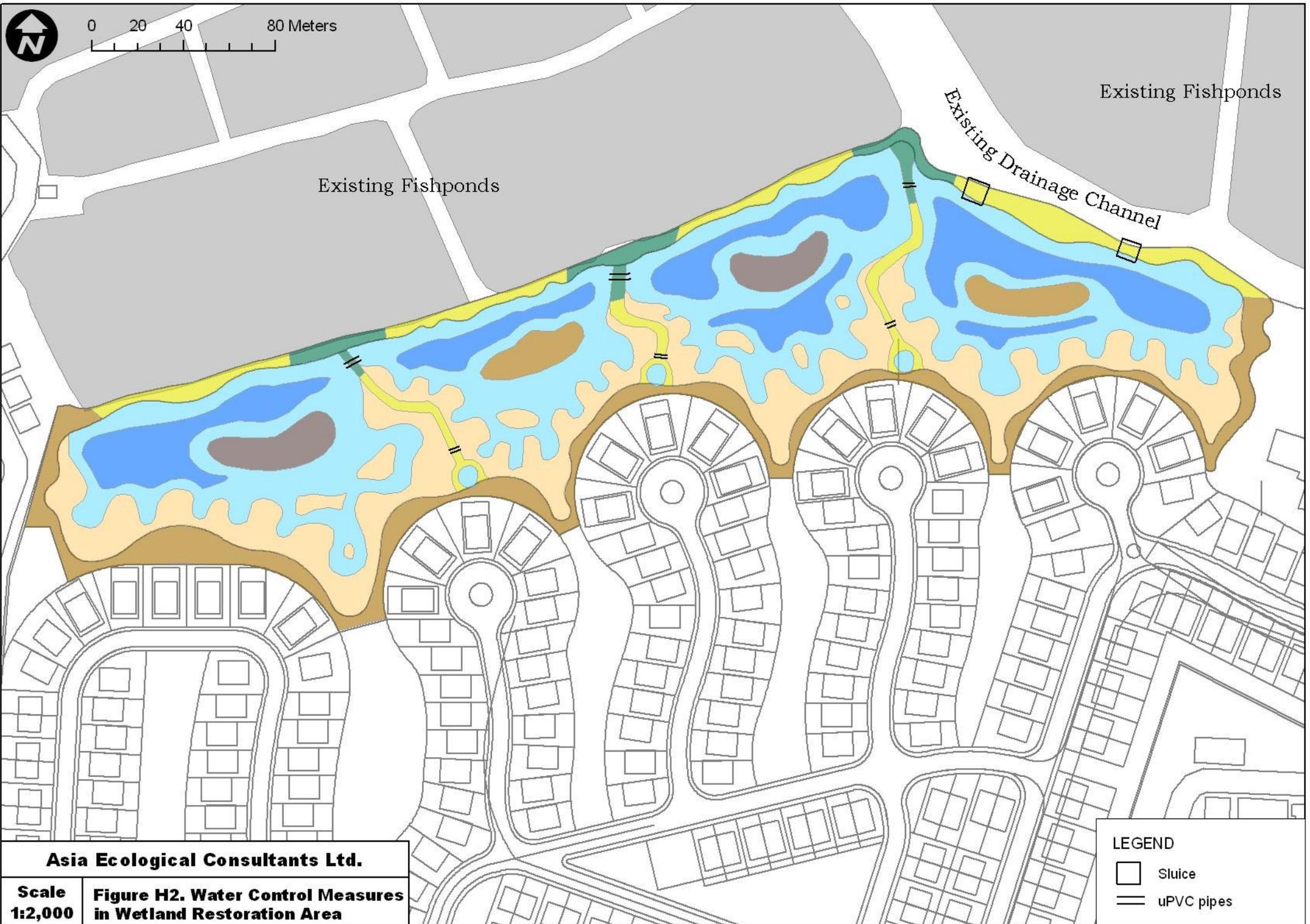


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Scale 1:2,000 **Figure H1. Proposed Habitat Layout of Wetland Restoration Area**



0 20 40 80 Meters



Existing Fishponds

Existing Fishponds

Existing Drainage Channel

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**Scale
1:2,000**

**Figure H2. Water Control Measures
in Wetland Restoration Area**

LEGEND

-  Sluice
-  uPVC pipes