

8 terrestrial ecology

8.1 Introduction

8.1.1 The Hong Kong Jockey Club proposes to construct and operate an 18 hole public golf course and associated facilities on the east side of Kau Sai Chau island as an extension of the existing 36-hole golf course. The project proponent submitted a project profile to EPD, and an Environmental Impact Assessment (EIA) Study Brief was issued for the project proponent to carry out an EIA. The purpose of this section of the EIA is to provide an ecological baseline of the Assessment Area and assess potential impacts of the proposed project on ecological resources. This section includes results of literature review, field surveys, and impact assessment based on the Technical Memorandum on Environmental Impact Assessment Process (the "TMEIAP").

8.1.2 Government legislation and guidelines relevant to the consideration of terrestrial ecology under this study include the following:

- Forests and Countryside Ordinance (Cap. 96) and its subsidiary legislation the Forestry Regulations;
- Town Planning Ordinance (Cap. 131);
- Wild Animals Protection Ordinance (Cap. 170);
- Country Parks Ordinance (Cap. 208) and associated subsidiary legislation;
- Environmental Impact Assessment Ordinance (Cap. 499) and associated Technical Memorandum on Environmental Impact Assessment Process (the "TMEIAP").
- TMEIAP, particularly Annexes 8 and 16.

8.1.3 This study also takes note of the following Guidelines and the international agreements :

- Hong Kong Planning Standards and Guidelines, Chapter 10 "Conservation";
- Guidelines for Implementing the Policy on Off-Site Ecological Mitigation Measures (PELB Technical Circular 1/97, Works Branch Technical Circular 4/97, dated 17 February 1997);
- Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the "Ramsar Convention");
- Convention on International Trade in Endangered Species of Wild Flora and Fauna ("CITES");
- The Convention on Biological Diversity; and
- PRC Regulations and Guidelines.

8.1.4 The Forests and Countryside Ordinance prohibits to all but authorised permit holders the felling, cutting, burning or destroying of trees or growing plants in forests and/or plantations on government land (Kau Sai Chau is entirely government land). Related subsidiary regulations prohibit the picking, felling or possession of listed rare and protected plant species. The list of species protected under the Forestry Regulations was last amended on 11 June 1993 under the Forestry (Amendment) Regulation 1993 of Section 3 of the Forests and Countryside Ordinance. Some trees on the Project Area would be felled, for which a felling permit is required.

8.1.5 The recently amended Town Planning Ordinance provides for the designation of coastal protection areas, Sites of Special Scientific Interest (SSSIs), Green Belt or other specified uses that promote conservation or protection of the environment, e.g. conservation areas. The authority responsible for administering the Town Planning Ordinance is the Town Planning Board. There are no known plans to designate an such areas on Kau Sai Chau.

8.1.6 Under the Wild Animals Protection Ordinance, designated wild animals are protected from being hunted and their nests and eggs are protected from destruction and removal. All birds and most mammals are protected under this Ordinance. The Second Schedule of the Ordinance that lists all protected animals was last revised in June 1992. Listed animals have been recorded on Kau Sai Chau and measures will be required to protect them.

8.1.7 The Country Parks Ordinance (Cap. 208) provides for the designation and management of Country Parks and Special Areas. Country Parks are designated for the purpose of nature conservation, countryside recreation and outdoor education. Special Areas are created mainly for the purpose of nature conservation. No country parks or special areas have been designated on Kau Sai Chau and neither is planned.

8.1.8 Annex 16 of the TMEIA sets out the general approach and methodology for assessments of ecological impacts arising from a project or proposal, to allow a complete and objective identification, prediction and evaluation of the potential ecological impacts. Annex 8 recommends the criteria that can be used for evaluating ecological impacts.

8.1.9 Chapter 10 of the HKPSG covers planning considerations relevant to conservation. This chapter details the principles of conservation, the conservation of natural landscape

and habitats, historic buildings, archaeological sites and other antiquities. It also addresses the issue of enforcement. The appendices list the legislation and administrative controls for conservation, other conservation related measures in Hong Kong and Government departments involved in conservation.

8.1.10 "Guidelines for Implementing the Policy on Off-site Ecological Mitigation Measures" (PELB Technical Circular 1/97, Works Branch Technical Circular 4/97, dated 17 February 1997) sets out guidelines for implementation of Government policy on off-site ecological mitigation measures.

8.1.11 The Convention on Wetlands of International Importance Especially as Waterfowl Habitat (the Ramsar Convention) applies to HKSAR. The Convention requires parties to conserve and make wise use of wetlands. Article 1 of the Convention defines wetlands as "areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed six meters." The ponds, streams, marshes and coastal marine waters at Kau Sai Chau are considered wetlands under this definition, and the Ramsar wise use guidelines apply to their conservation and management.

8.1.12 CITES was ratified in 1975 and remains the only global convention whose focus is the protection of plant and animal species from unregulated international trade. The species covered by CITES are listed in three appendices according to the degree of protection afforded. Appendix I includes species threatened with extinction. Trade in these species is generally not permitted. Appendix II includes "species not necessarily threatened with extinction, but in which trade must be controlled in order to avoid utilization incompatible with their survival". Appendix II species may only be traded under authority of a CITES permit. Appendix III contains species that are protected in at least one country that has asked other CITES Parties for assistance in controlling the trade. Trade agreements are negotiated between the affected countries.

8.1.13 The Peoples' Republic of China (PRC) is a Contracting Party to the United Nations Convention on Biological Diversity (CBD) of 1992. The Convention requires signatories to protect and manage their biodiversity resources. The Government of the Hong Kong Special Administrative Region has stated that it is committed to meeting the environmental objectives of the Convention (PELB 1996).

8.2 Study Methodology

8.2.1 The Project Area covers the boundary of the proposed golf course extension and associated works areas while the Assessment Area covers areas of land and sea within 500 m of the boundary of the Project Area (**Figure 8.1**).

8.2.2 Literature was reviewed to locate and compile ecological data for the assessment area. The review included Government and private sector reports, as well as unpublished information. In addition to the references cited in **Section 8.10** of this chapter, the following sources were reviewed:

- | Environmental impact assessments for the original golf course project at Kau Sai Chau
- | Ecological monitoring reports of The Jockey Club Kau Sai Chau Public Golf Course Ltd. between 1995 and 2005
- | Results of biodiversity surveys of Hong Kong flora carried out by University of Hong Kong (Xing *et al.* 2000 and Siu 2000)
- | Porcupine! (Newsletters of Department of Ecology and Biodiversity, University of Hong Kong) for sightings of flora and fauna
- | Hong Kong Bird Reports (1995-1997)
- | Hong Kong dragonflies (Wilson 2004)
- | Hong Kong amphibian fauna (Lau and Dudgeon 1999)

8.2.3 Field studies were undertaken over separate time periods: October-April 2000-1 (7 months); and October-June 2004-5 (9 months). During the 4-year interval there were no development or works project to be conducted within the Assessment Area for this study. Therefore there were no major natural changes and few anthropogenic disturbances such as fire. Vegetation cover of the Project and Assessment Areas did not change significantly from 2000-1 to 2004-5. Shrubs and trees around the existing golf course matured, and vegetation became denser in the absence of hillfire. However, the boundaries and species compositions of habitat types remained largely unchanged. Similarly, streams and freshwater ponds did not change appreciably from 2000-1 to 2004-5. All waterbodies on the golf course in 2004-5 were the same in number and location as in 2000-1. Thus, in terms of habitat for terrestrial and freshwater fauna, the condition of the Project and Assessment Areas in 2004-5 was similar to that found in 2000-1. Therefore the baseline data collected in 2000-1 remain valid in 2004-5. The following text combines the two datasets to describe flora and fauna on the Project and Assessment Areas prior to construction of the proposed Project.

Habitat/Vegetation

8.2.4 Habitats within the Assessment Area were mapped based on ground truthing of government aerial photographs dated 2004. Field surveys were carried out on 18 October,

10 November, 17 November, 2000, 13 February and 26 April, 2001, 29 October and 30 December 2004, and 28 April and 26 May 2005 to describe the vegetation within the Assessment Area. The October and December 2004 surveys also served as verification surveys to identify any major changes in terms of habitats and species composition since previous field surveys in 2001. Representative areas of each habitat type were surveyed on foot. Plant species were recorded in each habitat type and their relative abundance was estimated. Special attention was given to rare or protected species. Photographs were taken of representatives of each habitat type. Nomenclature and conservation status of plant species were updated according to Xing *et al.* (2000).

Avifauna

8.2.5 The bird communities in the Project and Assessment Areas were surveyed using the transect count method between November 2000 and April 2001, and between October 2004 and June 2005. Monthly surveys were carried out between November 2000 and April 2001, and between March and June 2005. Surveys were carried out once every two months between October 2004 and February 2005. Night surveys were carried out in December 2000, April 2001, December 2004 and April 2005. The locations of survey transects are shown in Figure 8.2. All birds seen or heard within 30 m either side of the centerline of the transects were identified and counted. Bird species observed outside sampling transects but within the Project Area were recorded in order to produce a complete bird species list for the Project Area. Signs of breeding were recorded. Ornithological nomenclature in this report follows Carey *et al.* (2001). Bird densities were calculated as birds per hectare. Birds on coastal habitats (including inter-tidal and open sea) were surveyed from a boat four times between November 2000 and April 2001, and between October 2004 and June 2005.

8.2.6 Part of the existing golf course fall into the Assessment Area of the proposed project. Birds on the existing golf course were surveyed systematically and quantitatively from 1995-2005 as part of the long-term ecological monitoring programme for the operation phase of the golf course. The monitoring reports for the period 1995-2005 were reviewed for impact assessment of both construction and operation phases of the proposed project.

Other Terrestrial Fauna

8.2.7 Dragonflies and butterflies within the Project and Assessment Areas were surveyed using the transect count method between November 2000 and April 2001, and between October 2004 and June 2005 (Figure 8.2). The locations of survey transects are shown in Figure 8.2. Dragonflies and butterflies seen within 10 m of the centreline of transects were recorded and identified to species. Dragonfly and butterfly species observed outside sampling transects but within the Project Area were recorded in order to produce complete species lists. Relative abundance of dragonflies and butterflies are expressed as numbers per hectare. Nomenclature for dragonflies follows Wilson (2004); nomenclature for butterflies follows Yiu (2004).

8.2.8 Surveys of mammals, reptiles and amphibians in the Project and Assessment Areas were performed between November 2000 and April 2001, and between October 2004 and June 2005. Night surveys were carried out in April 2005. Reptiles and amphibians were recorded by visual and acoustic survey and identified to species. All sightings, tracks, and signs of mammals were recorded. Nomenclature used in this report for amphibians follows Lau and Dudgeon (1999), for reptiles Karsen *et al.* (1998) and for mammals Wilson and Reeder (1992).

8.2.9 Mammals, herpetofauna and dragonflies were surveyed from 1995-2005 as part of the long-term ecological monitoring programme of the operation phase of the golf course. Surveys of butterflies on the existing golf course started in 1999 and continued thereafter. Information collected since 1995 on dragonflies, butterflies, herpetofauna and mammals was reviewed for impact assessment of construction and operation phases of the proposed project.

Aquatic fauna

8.2.10 Field surveys for aquatic fauna were performed during 2000 to 2001 (7 month period, on 18 October, 10 November, 17 November, 2000, 13 February and 26 April, 2001), and during 2004 to 2005 (9 month period, on 29 October and 30 December 2004, 13 February and 28 April, 26 May and 20 June 2005) to cover both wet and dry seasons. The surveys covered natural stream courses within the assessment area (Stream A to D), and aquatic fauna were studied by various sampling methods depending upon site conditions. Methods included direct observation, active searching, and sample collection using hand-nets. Hand nets were used to collect swimming organisms such as shrimps and fish. Where necessary boulders on the stream beds were overturned to locate aquatic organisms such as crabs. Snorkel diving was also used to observe stream fish in estuaries. Aquatic species encountered and their relative abundance was recorded, with special attention to rare or protected species.

8.3 Literature Review

Habitat & Vegetation

8.3.1 Ecological surveys were conducted in 1993 and 1994 on northern Kau Sai Chau for construction of the existing golf course (AXIS Environmental Consultants Ltd. 1994a).

Habitats recorded included tall shrub/woodland, scrubland, grassland, eroded areas and mangroves. None of the recorded plant species were rare in Hong Kong or in South China. Two plant species protected under the Forestry Regulations were recorded: *Enkianthus quinqueflorus* and *Arundina chinensis*. One coastal species, *Scaevola hainanensis*, which has restricted distribution in Hong Kong, was also found at a mangrove habitat.

Avifauna

8.3.2 Twenty-eight bird species were recorded on north Kau Sai Chau between September 1993 and May 1994 in the initial EIA (App. 8.1a & 8.1b) (AXIS Environmental Consultants Ltd. 1994a, 1994b). Most of the recorded species are habitat generalists (e.g., Chinese Bulbul *Pycnonotus sinensis* and Black Drongo *Dicrurus macrocercus*). Both bird abundance and species richness were considered low (AXIS Environmental Consultants Ltd. 1994a). This was attributed to the degraded habitat conditions on the island due to decades of recurring hillfires and use of the island as an artillery range from 1939-1975.

8.3.3 Avifauna in the existing golf course was monitored quarterly each year from 1995-2005. Four transect samples and 3 point counts were undertaken four times per quarter, for a total of 16 sampling replications per year. In total 160 surveys were carried out over the last 10 years of each of the transects and two of the points (one point could not be sampled in summer 1995 due to dam construction so it was sampled a total of 156 times). A total of 135 species of birds was recorded, 120 species during systematic transect and point counts and 15 species during non-systematic surveys (App. 8.2) (Ecosystems Ltd. 2005). This accounts for 30% of the total number of species recorded in Hong Kong (450 species), and includes all 28 species recorded during the pre-golf EIA study of September 1993 through May 1994. Twenty species have been recorded breeding on Kau Sai Chau. Retention of all recorded pre-golf bird species indicates that bird niches were not lost due to conversion of the former grassland-shrubland to a golf course. The large number of recorded bird species reflects long-term intensive monitoring over 10 years, but it also shows that habitat creation due to golf course development has provided niches for species that did not occur pre-golf. For example, Little Grebe *Tachybaptus ruficollis*, Cattle Egret *Bubulcus ibis*, and Moorhen *Gallinula chloropus* do not typically occur in grassland-shrubland habitat such as that found on north Kau Sai Chau in 1993 or on the Project Area today. The high bird species richness on the golf course is also due in part to habitat restoration/creation through tree planting and elimination of hillfire as an agent of habitat degradation. Diversity of avifauna would have remained low had the land use on the island remained as it was in 1993.

8.3.4 The bird community of the golf course is similar to that of agricultural lands or urban parks. It is dominated by species that favor open habitats such as Crested Myna *Acridotheres cristatellus*, Black-necked Starling *Sturnus nigricollis*, and Magpie *Pica pica*. The recorded species include 46 waterbirds (e.g., Yellow Bittern *Ixobrychus sinensis*, Moorhen), which were recorded most often in the retained wetland (marsh), created freshwater wetlands (golf course ponds and reservoir) or restored wetlands (mangrove plantation below the reservoir). The presence of numerous waterbird species was due mainly to the retention, creation, and restoration of wetland habitats on the existing golf course.

8.3.5 Mean density of birds on the golf course in 1995-2005 was 3.8 birds ha⁻¹ (Ecosystems Ltd. unpubli. data). This is low compared to other terrestrial habitats in Hong Kong such as cultivated land (33 birds ha⁻¹), urban parks (43-80 birds ha⁻¹), forest (37.8 birds ha⁻¹) and young plantation (12.4 birds ha⁻¹), but comparable to shrubland (4.0 – 7.4 birds ha⁻¹) and higher than hillfire-maintained grassland (2.0 birds ha⁻¹) (Kwok and Corlett 1999, 2000, Leven 2000, Lock 2000, Kwok and Dahmer 2001, Kwok and Dahmer 2002).

8.3.6 Bird species that are regionally or globally protected or locally rare are considered of conservation concern. Regionally or globally protected species recorded on the existing golf course include:

- Reef Egret *Egretta sacra*
- Buzzard *Buteo buteo*
- Black-shouldered Kite *Elanus caeruleus*
- White-bellied Sea Eagle *Haliaeetus leucogaster*
- Black Kite *Milvus lineatus*
- Osprey *Pandion haliaetus*
- Peregrine Falcon *Falco peregrinus*
- Kestrel *F. tinnunculus*
- Little Whimbrel *Numenius phaeopus*
- Greater Coucal *Centropus sinensis*
- Lesser Coucal *C. bengalensis*
- Collared Scops Owl *Otus lempiji*
- Eagle Owl *Bubo bubo*
- Hwamei *Garrulax canorus*.

8.3.7 All of the above are State Class 2 Protected Animals in China. Peregrine Falcon is listed in Appendix I of CITES. All other raptors (buzzards, kites, falcons, eagles and allies) and Hwamei are listed in Appendix II of CITES (Wang 1998). Rare species on the existing golf course include:

- Purple Heron *Ardea purpurea*
- Intermedia Egret *Mesophoyx intermedia*
- Grey-headed Lapwing *Vanellus cinereus*
- Sharp-tailed Sandpiper *Calidris acuminata*
- Sanderling *C. alba*
- Curlew *Numenius arquata*
- Eurasian Woodcock *Scolopax rusticola*
- Emerald Dove *Chalcophaps indica*
- Red Turtle Dove *Streptopelia tranquebarica*
- Savannah Nightjar *Caprimulgus affinis*
- Black-browed Reed Warbler *Acrocephalus bistrigiceps*
- Russet Bush Warbler *Bradypterus seebohmi*
- Yellow-browed Bunting *Emberiza chrysophrys* and
- Grey Treepie *Dendrocitta formosa*.

8.3.8 Some of these species, however, were recorded only occasionally during the 160 surveys in 1995-2005. Bird species recorded 8 or fewer times (on 5% of total surveys) are considered to be infrequent users of the golf course area. Bird species of conservation concern and frequently utilizing the existing golf course area include:

- Reef Egret;
- Black Kite;
- Peregrine Falcon;
- Kestrel; and
- Greater Coucal.

8.3.9 The above 5 species are State Class 2 Protected Animals of China (Wang 1998). Peregrine Falcon is listed in Appendix I of CITES and Black Kite and Kestrel are listed in Appendix II of CITES (*ibid.*). Reef Egret is commonly found in coastal areas in HKSAR. The others can be found in many types of habitats. Black Kite, Peregrine Falcon and Kestrel are raptors, which usually have large home ranges spanning several tens of square kilometres (Hammond and Pearson 1993, McGowan 1997), and usually occur at low densities.

Butterfly and Dragonfly

8.3.10 Butterfly biodiversity was not identified as a key issue and was therefore not addressed during the golf course EIA in 1994. Monitoring of butterflies on the golf course started in July 1999 and continues to date as a component of the long-term ecology monitoring program. In total 31 species were recorded during qualitative surveys between 1999 and 2005 (App. 8.3). Apart from Bush Hopper *Ampittia dioscorides*, all recorded species are common or very common in Hong Kong (e.g., Great Eggfly *Hypolimnas bolina* and Paris Peacock *Papilio paris* (Walthew 1997). The number of butterfly species on the golf course continues to increase annually, from 5 species in 1997 to 28 species in 2005. This is probably related to the increase in vegetation cover, plant diversity, and habitat complexity after hillfire was effectively eliminated by the golf course in 1995 (Ecosystems 2005).

8.3.11 Twenty-three dragonfly species were recorded on Kau Sai Chau in June 1994 during the EIA studies (AXIS Environmental Consultants Ltd. 1994b) (App. 8.4). Most of these were recorded in the marsh on northeast Kau Sai Chau, wetland habitats that were retained during construction of the project (AXIS Environmental Consultants Ltd. 1994b). One uncommon species, Scarlet Dwarf *Nannophya pygmaea*, was recorded from the marsh near Hole N-15 (Hyder 1996). A large breeding colony of Scarlet Dwarf was found on Kau Sai Chau, and Kau Sai Chau is the first known breeding site of this species in Hong Kong (*ibid.*). The presence of Scarlet Dwarfs in the same marsh in 1995 (post-construction) shows that construction of the golf course did not adversely affect these species.

8.3.12 Thirty-seven dragonfly species were recorded on Kau Sai Chau during qualitative surveys in 1995-2005, mostly around the golf course ponds (Ecosystems Ltd. 2005). All dragonfly species recorded during the EIA study in June 1994 except Blue Forest Damsel *Coeliccia cyanomelas* were recorded during the operation phase in 1995-2005. Blue Forest

Damsel is abundant in Hong Kong and found mainly in forest streams (Wilson 2004). It was probably recorded in a deep and wooded ravine on the west side of the island, an area not surveyed as part of the ecological monitoring programme. There was an increase of 14 species on Kau Sai Chau after construction of the golf course. Apart from the long duration of the monitoring period, the increase is probably related to the creation of wetland habitats on the existing golf course. The Dancing Dropwing *Trithemis pallidinervis* recorded in 1999 is an uncommon species, and is only recorded at Tin Shui Wai and Kam Tin in Hong Kong. It was recorded on the golf course ponds. Two uncommon species were recorded, Blue Sprite *Pseudagrion microcephalum*, and Common Evening Hawker *Anaciaeschna jaspidea*. Blue Sprite inhabits lowland stream and pond habitats (Wilson 2004). Common Evening Hawker inhabits wet abandoned fields. Common Evening Hawker was recorded at Pond 1 west of the administration building of the existing golf course.

Herpetofauna

8.3.13 Three-striped Grass Frog *Rana macrodactyla* and Gunther's Frog *R. guentheri* were the only amphibian species reported in the EIA study for the existing golf course (AXIS Environmental Consultants Ltd. 1994a). One juvenile Three-striped Grass Frog was found in the abandoned farmland on north Kau Sai Chau (*ibid.*). Three-striped Grass Frog is widely distributed in the New Territories, but is mainly confined to lowlands (Karsen *et al.* 1998). Gunther's Frog is common and widespread, and can be found from sea level to summit of the highest hills (*ibid.*).

8.3.14 Six species of amphibians were recorded on the existing golf course during the 1995-2005 ecology monitoring programme (Ecosystems Ltd. 2001):

- Asian Common Toad *Bufo melanostictus*
- Gunther's Frog
- Three-striped Grass Frog
- Two-striped Grass Frog *Rana taipehensis*
- Brown Tree Frog *Polypedates megacephalus* and
- Asiatic Painted Frog *Kaloula pulchra*.

8.3.15 Frogs were found only at the ponds and marsh but not in the reservoir. This may be due to the presence of Tilapia in the reservoir that prey on frogs, tadpoles and eggs. Tilapia is an exotic species of fish that is now naturalised in HKSAR. It was almost certainly introduced to the reservoir by people. Apart from Two-striped Grass Frog, all species are common in Hong Kong. Two-striped Grass Frog is uncommon and only recorded from a few localities in Hong Kong (Lau and Dudgeon 1999). It inhabits grassy areas near streams, ponds and reservoirs (*ibid.*). It was recorded on the golf course fairways during nocturnal surveys.

8.3.16 Only two reptiles were recorded on Kau Sai Chau prior to the golf development. Bowring's Gecko *Hemidactylus bowringii* and Garnot's Gecko *Hemidactylus garnotii* were recorded on northern Kau Sai Chau during the 1993-4 EIA study of the existing golf course (AXIS Environmental Consultants Ltd. 1994a). Garnot's Gecko is generally uncommon, but widely distributed in Hong Kong (Karsen *et al.* 1998). Bowring's Gecko is very common throughout Hong Kong (*ibid.*). These two species continue to occupy the island during golf course operation. Both are common around buildings and golf facilities.

8.3.17 Eight species of snake, one terrapin and three species of lizard were recorded on the existing golf course during the operational phase ecological monitoring since July 1995 (App. 8.5). Five of these are of conservation concern:

- Garnot's Gecko
- Grass Lizard *Takydromus sexlineatus*
- Burmese Python *Python molurus*
- Chinese Cobra *Naja atra* and
- King Cobra *Ophiophagus hanna*

8.3.18 Garnot's Gecko and Grass Lizard are uncommon in Hong Kong (Karsen *et al.* 1998). These two species are found in grassland and shrubland. Both Chinese Cobra and King Cobra are listed in Appendix II of CITES (Zhao 1998), and occur in a wide range of habitats (Karsen *et al.* 1998). The Burmese Python was first recorded in 2000 after it apparently swam to Kau Sai Chau. One adult Burmese Python has been seen on and around the golf courses since then. A young Burmese Python (around 2 m in length) was seen at the administration building of the existing golf course in June 2005. This suggests that Burmese Python is now a resident breeding species on Kau Sai Chau. This may be a response to hillfire suppression, and consequent increases in mammalian prey (e.g. rodents, wild boar, civets). Burmese Python is protected under The Wild Animals Protection Ordinance (Cap. 170), is a State Class I Protected Animal in China and is listed in Appendix II of CITES (Zhao 1998). It occurs in many types of habitats in Hong Kong (Karsen *et al.* 1998, Melville 1999).

8.3.19 The only terrapin recorded in the operational monitoring of the existing golf course is the exotic Red-eared Slider *Trachemys scripta*. It is now common in the ponds on the

golf course. Because it did not occur prior to golf development and because it is common in the pet trade in Hong Kong, Red-eared Slider was probably introduced to the island by people. Red-eared Sliders are also well established in several reservoirs in Hong Kong (Karsen *et al.* 1998).

Mammals

8.3.20 During the pre-golf period, evidence of Wild Boar *Sus scrofa* was recorded on north Kau Sai Chau and scats of one species of civet were found in low shrubland in the center of the island (AXIS Environmental Consultants Ltd. 1994a). No other wild mammals were recorded. Wild Boar is Hong Kong's largest extant wild mammal. Most of the records of Wild Boar in Hong Kong come from areas around Tai Mo Shan (Reels 1996) but the species is widely distributed (Suen 2002). There are many records of Wild Boar on Sai Kung Peninsula. There are two species of civet in Hong Kong – the Masked Palm Civet *Paguma larvata* and Small Indian Civet *Viverricula indica*, both recorded on Sai Kung Peninsula (Pei *et al.* 2002). Considering the generally degraded grassland-shrubland habitat that was present on north Kau Sai Chau in pre-golf years and the general absence of woodland, the species of civet present at that time was probably Small Indian Civet.

8.3.21 Ten mammal species have been recorded on the existing golf course during the operational phase ecological monitoring in 1995-2005 (App. 8.6). This list includes the two mammal species recorded during the EIA study by AXIS Environmental Consultants Ltd. (1994a). Two species of civets have been recorded during golf course operation. These are the Small Indian Civet and Masked Palm Civet (both killed by feral dogs) (Dahmer 2001a, 2002a). Both are protected under the WAPO. Small Indian Civet is a State Class 2 Protected Animal in China (Wang 1998). The population size of Small Indian Civets on Kau Sai Chau has not been estimated, but the species is known to breed on the island. Another recorded medium-sized mammal is the Chinese Porcupine *Hystrix hodgsoni*, which is also protected under the WAPO. It was found dead on the golf course with injuries suggesting it was killed by feral dogs. Masked Palm Civet and Chinese Porcupine occur in shrubland and woodland. Small Indian Civet occurs in farmland, shrubland and woodland. Habitats of these mammals are present in the location of the proposed golf course.

8.3.22 Bats were not recorded on the island prior to golf course construction. Two species of bats were recorded on the existing golf course between July 2000 and June 2001, the Pipistrelle *Pipistrellus sp.* and Himalayan Leaf-nosed Bat *Hipposideros armiger*. Both species are insectivores and forage over the entire golf course area, focusing on the wetlands. Both species feed on flying insects that are attracted to floodlights. There are two species of Pipistrelles in Hong Kong, the more common being the Japanese Pipistrelle (*P. abramus*) (Ades 1999). The Chinese Pipistrelle is relatively uncommon and not well studied in Hong Kong. The identity of the Pipistrelle on Kau Sai Chau can only be confirmed by observing a captured individual. The Himalayan Leaf-nosed Bat is the largest insectivorous bat in Hong Kong, and is widely distributed. Because of its body size it is readily seen and identified.

Aquatic fauna

8.3.23 Streams on Kau Sai Chau, including Stream A to D in the present EIA study, were not previously considered to be of special conservation importance and are not listed by government among the 33 ecologically important streams/rivers (EISs) in HKSAR (ETWB(W) 655/14/01).

8.3.24 Few studies of the streams on Kau Sai Chau have been conducted. Chong and Dudgeon (1992) performed an inventory of Hong Kong stream fishes, but streams at Kau Sai Chau were not surveyed. Similarly, a second territory-wide survey on fish fauna (Chan 2001; DEB 2002) did not include Kau Sai Chau.

8.3.25 Four species of freshwater fishes including both stream and pond culture species were recorded in Kau Sai Chau by AFCD (2004). These were Big Head Carp *Aristichthys nobilis*, Grass Carp *Ctenopharyngodon idellus*, *Nicholsicypris normalis*, Chinese Barb *Puntius semifasciolatus*.

8.3.26 The cyprinid fish *Nicholsicypris normalis* was misidentified during the review process of the 1993-4 EIA as *Yaoshanicus arcus*, an endemic to the Yaoshan area of Guangxi. It was reported to have been found on Kau Sai Chau before the existing golf course was proposed, thus became a concern during preparation of the EIA for the existing golf course. The species was later correctly identified as *Nicholsicypris normalis* (Chan 1999) which is widespread in Guangdong, southern Guangxi and Hainan. *N. normalis* is now considered common in Hong Kong (AFCD 2004) where it can be found in different localities including Sai Kung, North District and Lantau.

8.3.27 One species of Atyid shrimp *Caridina trifasciata* was first found at Tsak Yue Wu (near Pak Tam Chung), Sai Kung in September 2000 and was described as a species new to science (Yam and Cai 2003). Kau Sai Chau is the second area of occurrence for this species (*ibid*). Recently a specimen resembling *C. trifasciata* was collected in Macau (Leung Va personal communication) and sent for identification by a shrimp specialist. Besides the morphological differences that distinguish *C. trifasciata* from other *Caridina* species, *C. trifasciata* also has three distinctive dark transverse bands on the body. These bands are readily visible on all specimens including the shrimp from Macau.

8.4 Baseline Condition

Sites of Conservation Importance

8.4.1 No recognized sites of conservation importance, including country parks, SSSIs or marine parks lie within the Assessment Area. The closest Country Parks are Kiu Tsui

Country Park on Sharp Island about 1 km west of Kau Sai Chau, and Sai Kung East Country Park on the mainland about 1 km east of Kau Sai Chau (Figure 8.1). The proposed project would not encroach on or cause any impact to either of these Country Parks. There is no statutory zoning plan for the island. The marine waters surrounding the island have been considered as a prospective marine conservation area.

Habitat/Vegetation

8.4.2 Habitats recorded within the Assessment Area include shrubland, stream/ravine, coastal/backshore and reservoir/pond/marsh (Figure 8.3, Table 8.4-1). Photos of the representative habitat types and plant of ecological importance encountered during the current study are presented in Figure 8.4. Species lists for flora are given in Appendix 8.7.

Table 8.4-1. Habitats recorded within the Assessment Area

Habitat	Area (ha)/Length (km)
Shrubland	324.4
Stream/Ravine	2.6 (km)
Stream A	0.2
Stream B	0.6
Stream C	0.8
Stream D	1.0
Coastal/backshore	9.2 (km)
Reservoir/Pond/Marsh	6.8
Developed	3.3

Shrubland

8.4.3 Shrubland is the dominant habitat type within the Assessment Area. Shrublands of various heights, ranging from 0.5-2 m, covered the exposed hillsides of the island and the non-play area of the existing golf course. They were dominated by *Rhodomyrtus tomentosa*, *Baeckea frutescens*, *Lepidosperma chinense*, and *Dicranopteris pedata*. Shrubland habitat had simple structure and low to moderate diversity. The habitat is a fire-maintained disclimax (or plagioclimax) that results from historic deforestation (Dudgeon and Corlett 1994, 2004; Corlett and Turner 1997), subsequent use of the island as a firing range, and semi-annual hillfires. Prior to development of the golf course hillfires caused by grave cleaning destroyed much of the vegetation on the island twice each year. This prevented natural succession of grassland to shrubland to woodland. Scars on eroded hillsides and bare grounds are not uncommon in this habitat. In total 85 plant species were recorded, one of which is protected, the Chinese New Year Flower *Enkianthus quinqueflorus*. This species is common locally in shrubland and young forest (Xing *et al.* 2000) but is protected by Forestry Regulations due to previous over-harvesting for Chinese New Year celebrations. It was quite common on hillsides and ravines on Kau Sai Chau.

8.4.4 Isolated tree stands were found in shrubland habitats and were mapped as shrubland with trees. This was mostly found in the ravines and occasionally on coastal slopes. Plant species were recorded under Stream/Ravine (see below).

Stream/Ravine

8.4.5 Four perennial streams (Stream A-D) with a combined length of 2.6 km were found within the Assessment Area. Stream D is the main stream draining the west side of the Assessment Area while the other three streams were located within the Project Area. Stream A was heavily silted all year round by sediment eroded from nearby hillsides. Streams B, C and D had clear water and little sediment in the stream beds. Streams B and D had moderate flow during the wet season, while Streams A and C had low flow. Except Stream D, water depth was less than 0.3 m in most the stream reaches. No distinct riparian zone had developed due to the limited size of the ravines and young age of the vegetation. Vegetation dominance and composition resembled that of shrubland, except that more tree species with greater heights (mostly less than 4-5m) were found. Examples of trees include *Schefflera heptaphylla*, *Machilus chekiangensis*, and *Gordonia axillaris* and *Ormosia emarginata*. Due to the presence of water and probably the disturbance-shelter effect of the ravine, the plant diversity was slightly higher than in shrubland. A total of 110 species of vegetation were recorded.

8.4.6 Three protected species were recorded in the ravines (**Figure 8.3**). These include 2 terrestrial orchids, Bamboo Orchid *Arundina graminifolia* (*A. chinense*) and Beardedly Orchid *Peristylus tentaculatus*, and Chinese New Year Flower *Enkianthus quinqueflorus*. The orchid family (Orchidaceae) is protected under the Forestry Regulations. Both orchid species are very common locally and can be found in grasslands and at streamsides (Xing *et al.* 2000). During the verification surveys *Peristylus tentaculatus* was not seen again. This was probably because of natural mortality or erosion of the stream banks.

8.4.7 In addition to these locally protected species, two additional tree species of conservation concern were recorded during the tree survey: 1 *Artocarpus hypargyreus* and 3

Ixonanthes reticulata. Their approximate locations are shown on **Figure 8.3** and are plotted in detail in the landscape chapter. *Artocarpus hypargyreus* is common in Hong Kong but listed as “Near Threatened” by IUCN and as rare and endangered in Guangdong Province in the China Plant Red Data Book. *Ixonanthes reticulata* is common in Hong Kong, listed as “Vulnerable” by (IUCN) and as rare and endangered in Guangdong Province in the China Plant Red Data Book. Neither of these species is protected in Hong Kong.

Coastal/Backshore

8.4.8 The natural coastline within the Assessment Area is about 9.2 km in length and mostly formed of rocky shore. Isolated sandy beaches and sandflats were also recorded in sheltered inlets. Small isolated stands of mangroves were found along the sheltered bays and estuaries. Most of these mangals are a combination of naturally colonised mangrove and stands planted during 1995-6 as a mitigation measure for construction of the existing golf course. Although the trees occurred in low numbers, the mangals were composed of many representative species including *Kandelia obovata*, *Avicennia marina*, *Bruguiera gymnorhiza*, *Excoecaria agallocha*, and *Lumnitzera racemosa*. The backshore was also colonised by mangrove associates and upland species, including *Scaevola taccada*, *Hibiscus tiliaceus*, *Pandanus tectorius*, *Atalantia buxifolia*, and *Lepidosperma chinense*. One restricted climber, *Scaevola hainanensis*, was recorded along the west coast of the island and north of the reservoir dam within the Assessment Area. This species occurs mainly on outlying islands in Hong Kong (Xing *et al.* 2000). In total 43 plant species were recorded in the coastal/backshore habitat.

Reservoir/Pond/Marsh

8.4.9 On the existing golf course artificial waterbodies were created including one reservoir and five ponds. One natural marsh was retained in the existing golf course alongside golf hole North 15. The ponds and reservoir were created for collection and storage of irrigation water and as landscape features and golf water-hazards. The reservoir is located in Kwat Tau Tam inlet, which was dammed to create water storage capacity. The marsh is fed by a small drainage flowing from south to north along the eastern side of the island within the existing golf course. The marsh was formed by construction of a small dam at the shoreline that was constructed years before the golf course. Fresh water stored behind the dam was used by local fishermen and farmers. The fringe of the marsh was dominated by tree species including *Symplocos cochinchinensis*, *Cleistocalyx operculata*, *Glochidion zeylanicum*, *Schefflera heptaphylla*, and *Rhus succedanea*. These stands of trees provided a roosting site for Night Herons (see bird section). Near the standing water, freshwater plants including *Panicum repens*, *Commelina nudiflora*, *Isachne globosa*, *Polygonum* species, and *Melastoma candidum* were recorded. The ponds and reservoir were maintained and were clear of vegetation. Pond bunds were hydroseeded, while the reservoir was surrounded by a narrow belt of remnants of natural shrubland vegetation.

Other habitats

8.4.10 Most of the existing golf course lies within the Assessment Area. It is composed of planted turfgrass (“Grassed Area”), administration and maintenance buildings, access roads and paths (“Developed”), and planted and retained shrubland and woodland habitats in the non-play areas. Landscaping species including *Plumeria rubra*, *Livistona chinensis*, *Spathodea campanulata*, and *Bauhinia blakeana* were planted around the administration building, at the pier and along footpaths. The grassed area of about 84 ha was hydroseeded with grass species, mainly *Cynodon dactylon*. The golf play area is regularly mowed, while the seeded non-play areas support ruderal vegetation dominated by *Mikania micrantha*.

Avifauna

Project Area

8.4.11 A Black-crowned Night Heron roost was discovered during the surveys between October 2000 and April 2001. It supported 72 birds in the shrubland above the marsh near Hole N-15 of the existing golf course. The size of the roost was considered of local importance because the mean number of Black-crowned Night Herons counted in the Deep Bay area and at Starling Inlet (which together account for most of the local inland wetland habitats) between October 2000 and April 2001 was 336.4 birds (data from Hong Kong Bird Watching Society 2001). Adding the Kau Sai Chau roost to this total yields 408 birds for the total area, of which 18% roosted at Kau Sai Chau. The same shrubland was visited during the verification surveys and it was found that the roosting site had been abandoned. Changing of nesting and roosting sites of ardeids is a common phenomenon in Hong Kong. There was no apparent change in the environment at the roost and it was some 50-75 m from the nearest area of golf play.

8.4.12 135 species of birds have been recorded during the long-term ecological monitoring programme for the existing golf course. Some of these species, however, were recorded infrequently during the 40 seasons of surveys between 1995 and 2005 (10 years, 4 seasons per year). To focus on those species that were frequently recorded we disregarded those seen in 8 or fewer seasons (less than 20% of all seasons). Bird species of conservation concern that frequently utilized the existing golf course included the following State Class 2 Protected Animals of China (Wang 1998):

- Reef Egret
- Black Kite
- Peregrine Falcon
- Kestrel and

- Greater Coucal.

8.4.13 Peregrine Falcon is listed in Appendix I of CITES while Black Kite, and Kestrel are listed in Appendix II of CITES (*ibid.*). Reef Egret is commonly found in coastal areas in Hong Kong. The other species can be found in many types of habitats. Black Kite, Peregrine Falcon and Kestrel are known as raptors, carnivorous birds that usually occupy large home ranges spanning several tens of square kilometres (Hammond and Pearson 1993, McGowan 1997), and occur at low densities.

8.4.14 Eight bird species were recorded on sampling transects in shrubland within the Project Area (App. 8.8). Nine additional species (e.g., Common Tailorbird *Orthotomus sutorius*) were recorded between transects in shrubland (App. 8.9). All bird species recorded in shrubland are common and widespread in Hong Kong (Carey *et al.* 2001). Species richness of shrubland in the Project Area was considered very low. The four transects sampled in the ecology monitoring programme can be used for comparison. They cover equal portions of golf turfgrass and adjacent shrubland or open woodland and sampling methods are similar to those used on the Project Area. Mean seasonal species richness on the transects covering the existing golf course (averaged over 40 sampling sessions per season) ranged from 16 to 20 species. This is 200-250% greater than the 8 species recorded on the Project Area transects. The higher species richness on the golf course transects reflects the greater habitat diversity and the availability of freshwater on the golf course.

8.4.15 Bird density in shrublands on the Project Area was 0.45 bird ha⁻¹ (Table 2), very low by Hong Kong standards. This is less than one-eighth of the bird density on the existing golf course (3.8 bird ha⁻¹). Unusually low bird density is due to many years of habitat degradation that has removed trees, eroded soils, and maintained grass-shrub cover over most of the island. Kau Sai Chau has seen prolonged disturbance by semi-annual hillfires and nearly 4 decades of use as a firing range. Topsoil on most of the Project Area is highly eroded and there is little vegetation cover except in the ravines. The dominant plant species *Rhodomyrtus tomentosa*, *Baeckea frutescens*, *Lepidosperma chinense*, and *Dicranopteris linearis* provide poor feeding and nesting habitat for birds. Within the Assessment Area habitat conditions have begun to improve especially in and around the golf course. Trees and shrubs are colonising the native shrublands separating the turfgrass areas. This is due mainly to the fire-break effect of the golf course, which confines hillfires to the northeastern tip of Kau Sai Chau where graves remain and visitors continue to burn the surrounding vegetation (the firing range was not used after 1975). Other factors causing habitat conditions to improve are (i) planting of native trees by golf course personnel and (ii) greater water availability at the edges of the irrigated turfgrass areas.

8.4.16 Bird abundance and species richness were very low in the ravine habitats of the 3 surveyed streams (Table 8.4-2, App. 8.10). All recorded species (e.g., Spotted Dove *Streptopelia chinensis*, Black Drongo *Dicrurus macrocercus*) are common and widespread in Hong Kong (Carey *et al.* 2001).

Table 8.4-2. Bird communities in the Project Area

		Density (birds ha ⁻¹)	Total number of species
Existing Golf Course		3.8	135
Project Area			
Shrubland		0.45	17
Stream	A	0.9	5
	B	2.0	8
	C	2.0	6
Assessment Area			
Shrubland		0.38	3
Stream D		4.7	11

8.4.17 The territorial calls/songs of 3 species were heard in the Project Area, and these species are considered probable breeders. No bird nest was found in the Project Area throughout the study. Chinese Francolin *Francolinus pintadeanus* and Yellow-bellied Prinia are probable breeding species in shrubland. Blue Whistling Thrushes *Myiophonus caeruleus* is a probable breeding species in ravine habitats. All these species are common in Hong Kong (Carey *et al.* 2001). Chinese Francolin is usually found in grassland and shrubland, and is very common as a breeding species around the existing golf course. Yellow-bellied Prinia is found in many types of habitats except woodland and is common on the existing golf course. Blue Whistling Thrush is usually found in locations near running water including concrete culverts in urban areas. It is found in ravines on the existing golf course.

8.4.18 Bird species of conservation concern within Project Area included Black Kite, Buzzard, Greater Coucal and Hwamei *Garrulax canorus*. All except Greater Coucal are listed in Appendix II of CITES and all are State Class II Protected Animals in China (Zheng and Wang 1998). All are widespread in Hong Kong (Carey *et al.* 2001). Black Kite, Buzzard and Greater Coucal are found in many types of habitats in Hong Kong (*ibid.*). Hwamei is mainly found in thick shrubland (*ibid.*). Black Kite and Buzzard are raptors, which usually

have large home ranges spanning several tens of square kilometres (Hammond and Pearson 1993, McGowan 1997) and occur at low densities except at roosts.

Assessment Area

8.4.19 Only three species were recorded on shrubland of the Assessment Area (Table 8.4-2, App. 8.11). All are common and widespread in Hong Kong (Carey *et al.* 2001). Bird density was 0.34 birds ha⁻¹, similar to that in the Project Area. The factors contributing to this low bird diversity were similar to those of the Project Area. Both bird density and species richness in Assessment Area shrublands are considered very low.

8.4.20 Both bird density and species richness in the ravine habitat of Stream D were low, but higher than those in the other 3 surveyed streams in the Project Area. This was related to the more dense vegetation cover and resulting greater habitat complexity. Greater vegetation density and complexity enhances habitat quality for birds, and results in higher bird abundance (Fuller 1995). Ravines typically support more dense and diverse vegetation cover in fire-disclimax landscapes because of their higher moisture levels that ameliorate fire impacts.

8.4.21 Fifteen bird species were recorded in the shallow coastal waters, mostly as solitary birds. Most of the birds utilizing coastal areas were recorded in the channel between north Kau Sai Chau and Tai Tau Chau. Abundance and species richness were considered low, which is typical of hard shores (Morton and Morton 1983).

8.4.22 There was no evidence of bird breeding in the Assessment Area. Bird species of conservation concern in the Assessment Area included:

- Reef Egret
- Black Kite
- Crested Goshawk
- Crested Serpent Eagle
- Peregrine Falcon
- Osprey
- White-bellied Sea Eagle and
- Greater Coucal.

8.4.23 Peregrine Falcon is listed in Appendix I of CITES. All others except Greater Coucal and Reef Egret are listed in Appendix II of CITES. All seven species are State Class II Protected Animals in China (Zheng and Wang 1998).

8.4.24 Reef Egret is commonly found in coastal areas in Hong Kong (Carey *et al.* 2001). It also nests on rocky shores. Black Kite, Peregrine Falcon and Greater Coucal are found in many types of habitats (*ibid.*). Crested Goshawk and Crested Serpent Eagle *Spilornis cheela* are mainly found in wooded areas in Hong Kong (*ibid.*). The sightings of these two species in the ravine of Stream D were considered unusual and the birds were probably vagrants because these two species normally inhabit well-wooded areas. The Crested Serpent Eagle and Crested Goshawk seen in Stream D are the only records of these species on Kau Sai Chau.

8.4.25 Osprey and White-bellied Sea Eagle are mainly maritime species. Osprey is a winter visitor and most records come from the Deep Bay area of northwest Hong Kong. Osprey has been seen in 5 of 10 years of ecology monitoring on the existing golf course. White-bellied Sea Eagle is resident species, and most breeding pairs are located in eastern waters of Hong Kong (Tsim *et al.* 2004). Sheltered coastal area with numerous bays and small islands are considered prime habitats of White-bellied Sea Eagle (Tsim *et al.* 2004, Griffiths and Tsim 2004). A pair of White-bellied Sea Eagles has nested in Yeung Chau in Port Shelter for many years. Tsim *et al.* (2004) noted that the White-bellied Sea Eagles nesting at Yeung Chau have tolerated considerable disturbance from vessels and helicopters. The maximum foraging range of the pair of White-bellied Sea Eagles nesting at Yeung Chau (during incubation period) was estimated to be 2 km in radius (Tsim *et al.* 2004). If the birds seen over Kau Sai Chau are those from Yeung Chau, this would mean the foraging radius would be over 3 km. The sea around Kau Sai Chau may be less important as foraging habitat for White-bellied Sea Eagles compared to those near Yeung Chau. White-bellied Sea Eagle has been seen in 4 of 10 years during ecological monitoring of the golf course.

Butterfly and Dragonfly

Project Area

8.4.26 Ten species of butterfly were recorded in shrubland in the Project Area, and species richness was considered very low (App. 8.12). This compares with 28 species recorded on the existing golf course. All shrubland butterfly species are common or very common in Hong Kong (Yiu 2004). Butterfly density in shrublands within the Project Area was 5.3

butterflies ha⁻¹, and was also very low (Table 8.4-3).

8.4.27 A total of 16 species of butterfly were recorded in the ravine habitats of the three surveyed streams in the Project Area (App. 8.13). Abundance and species richness of butterflies was very low in all 3 surveyed streams, and was lowest in Stream A (Table 8.4-3). All the recorded species except Bush Hopper are common and widespread in Hong Kong (Yiu 2004). Bush Hopper was recorded in the ravine of Stream C. This species is uncommon in Hong Kong, and inhabits marshy grassland, disused paddy fields and gardens (Bascombe *et al.* 1999).

Table 8.4-3. Butterfly communities in the Project Area

		Abundance (butterflies ha ⁻¹)	Total number of species
Existing Golf Course			28
Project Area			
Shrubland		5.3	6
Streams	A	2.9	5
	B	3.5	7
	C	3.5	8
Assessment Area			
Shrubland		1.0	2
Stream D		3.5	9

8.4.28 Wandering Glider *Pantala flavescens* (6 individuals) was the only dragonfly recorded in shrubland within the Project Area (Table 8.4-4). Wandering Glider is the commonest dragonfly in Hong Kong, and occurs in many habitats (Wilson 1997). Adult Wandering Gliders are on the wing throughout the year. Abundance and species richness of dragonflies in shrubland were considered very low.

8.4.29 In total 9 species were recorded in the ravine habitats of the 3 surveyed streams, and all are common or abundant in Hong Kong (App. 8.14). Abundance and species richness of dragonflies were very low in all 3 surveyed streams, and were lowest at Stream A. This was due to the sedimentation in this stream that covered the natural streambed. Sedimentation caused destruction of habitats for larval dragonflies. Soil erosion is a widespread agent of habitat degradation on the Project Area because of past land uses that removed or degraded protective vegetation. In addition, these 3 streams are not large and flow volume is highly seasonal. Maturation of larvae of some species of dragonflies spans more than a year, but these 3 streams are often dry when rainfall is low. This may restrict the uses of these 3 streams as breeding habitat for dragonflies.

Table 8.4-4. Dragonfly communities in Project Area

		Abundance (dragonfly ha ⁻¹)	Total number of species
Existing Golf Course			37
Project Area			
Shrubland		< 0.01	1
Streams	A	2.4	2
	B	4.1	3
	C	9.9	8
Assessment Area			
Shrubland		<0.01	1
Stream D		8.8	9

Assessment Area

8.4.30 Only two butterfly species were recorded in shrubland on the Assessment Area during field surveys (App. 8.15). These were the Common White *Artogeia canidia* and

Common Grass Yellow *Eurema hecabe*. Both are very common in Hong Kong (Walthew 1997). Density of butterflies in shrublands in the Assessment Area was 1.0 ha⁻¹, which is very low (Table 8.4-3).

8.4.31 15 species of butterfly were recorded in the ravine habitat of Stream D (App. 8.16). Abundance and species richness of butterflies in Stream D were low (Table 8.4-3). All except the Green Flash *Artipe eryx* are common or very common in Hong Kong. Green Flash is uncommon in Hong Kong (Yiu 2004) and it typically inhabits woodland and shrubland (*ibid.*).

8.4.32 Only one species of dragonfly was recorded in shrubland in the Assessment Area. This was Wandering Glider, which is the commonest dragonfly species in Hong Kong. Abundance and species richness of dragonflies in shrubland of Assessment Area was considered very low (Table 8.4-4).

8.4.33 Abundance and species richness of dragonflies were low in the ravine habitat of Stream D (Table 8.4-4). All the dragonfly species recorded in Stream D are common and widespread in Hong Kong (App. 13).

Herpetofauna

8.4.34 Three reptile species were recorded in the Project Area Red-eared Slider (a terrapin), Chinese Cobra and King Cobra (snakes). Red-eared Sliders were found in Stream B during the surveys. This is an exotic species in Hong Kong, and is of no conservation interest except as a potential threat to native fauna. King Cobra was recorded in shrubland near Stream A and Chinese Cobra in Stream C. King Cobra is uncommon while Chinese Cobra is fairly common (Karsen *et al.* 1998). Both Chinese Cobra and King Cobra are listed in Appendix II of CITES (Zhao 1998), and both inhabit a wide range of habitats (Karsen *et al.* 1998).

8.4.35 No amphibians were recorded in shrubland in the Project Area. Frogs are usually found at habitats with some moisture but the shrubland in the Project Area may be too dry for amphibians to survive. Eggs of Brown Tree Frog were observed in Stream C in April 2001. This species is common and widespread in Hong Kong (Karsen *et al.* 1998, Lau and Dudgeon 1999). Croaking of Asian Common Toads and Gunther's Frogs was heard at Streams A and B in April 2005. Both are common and widespread in Hong Kong (Karsen *et al.* 1998, Lau and Dudgeon 1999).

8.4.36 No herpetofauna was recorded in shrubland or ravine on the Assessment Area.

Mammal

8.4.37 Hoof-prints and evidence of rooting by Wild Boar were found in shrubland on the Project Area. Rooting by Wild Boar was also found in the ravine of Stream D of the Assessment Area. Dead civets have been periodically found on the existing golf course (Dahmer 2001a, 2002a). These civets were probably foraging or dispersing from habitats on the rest of Kau Sai Chau, but no track, scats or any other evidence was found in Project or Assessment Areas. Civets tend to defecate in open places (e.g., on large rocks, along frequently travelled trails) (Dudgeon and Corlett 2004), so it is unlikely that any scats were overlooked. Abundance of these animals on Kau Sai Chau may be very low, if they are present. This may be due to the fact that terrestrial habitats on Kau Sai Chau are highly degraded. In addition, abundance of civets on this island may be highly depleted by predation by humans (in the past) and feral dogs (currently). Mortality of medium sized mammals due to predation by dogs is not likely to be confined to the existing golf course as dog dung was also found in the Project and Assessment Areas. Depredation by dogs is probably more threatening to civets than the limitation of habitats.

Aquatic Fauna

8.4.38 Four perennial streams (Streams A-D) with a total length of 2.6 km were found within the Assessment Area. Streams on Kau Sia Chau were not previously considered to be of special conservation importance by local ecologists and are not listed by government among the 33 ecologically important streams/rivers (EISs) in HKSAR.

8.4.39 Although the streams have not been affected by developments or pollution sources, they are relatively small: Water depth was less than 0.3m in most of the stream reaches.

8.4.40 Stream A is located within the Project Area. It includes two main tributaries (A1 and A2 in **Figure 8.2**). Stream A was heavily silted with sediments from eroded hillsides all year round, particularly downstream of the confluence of the two main tributaries. The stream had low flow.

8.4.41 Stream B is located within the Project Area. It had clear flow of moderate volume during the wet season. This stream has two main tributaries, B1 and B2 (see **Figure 8.2**). Comparing the maps published in 1998 and 2004 (Countryside Series: Sai Kung & Clear Water Bay), it was found that B2 has become a tributary of Stream B for a few years only. Another branch (B3 in **Figure 8.2**) was shown on the 1998 version of the map, but has been replaced by a new branch (i.e. B2) in the 2004 version. Field survey during the present EIA study also confirmed that B2 is a current tributary while B3 no longer flows. Stream B also contains a long estuarine section of muddy sandy substrate.

8.4.42 Stream C is located within the Project Area. It has had low but clear flow. In contrast to Stream B, Stream C drains to a sandy beach at Kau Chung Wan, and therefore lacks a clear estuarine zone.

8.4.43 Stream D is located outside the Project Area and is the main stream draining the west side of the Assessment Area. It had clear water and moderate flow levels.

8.4.44 A total of eleven fish species were recorded (**Table 8.4.5**). None of them is rare or protected under Hong Kong legislation or CITES.

8.4.45 Stream B is the most diverse and abundant in terms of freshwater fish species among the surveyed streams. Eleven species were recorded here, including all species recorded during the survey. But most species were found in brackish water. The intact estuarine area at the mouth of Stream B has greater habitat complexity, which probably contributes to the high species richness recorded there.

8.4.46 No freshwater fish were recorded in Stream A, where vegetation cover was the least dense and the stream bed was covered by mud from nearby eroded hill slopes. Abundance and diversity of aquatic invertebrates was also low, contributing to the low fish diversity and abundance in Stream A.

Table 8.4.5 Fish Species Recorded in stream habitat

Species	Common name	Habitat	Local status	No. Recorded			
				A	B	C	D
<i>Chelon</i> sp.	Mullet	Marine Brackish	NA	\	> 30	> 5	> 30
<i>Eleotris acanthopoma</i>	Spinecheek Gudgeon	Brackish	Uncommon	\	3	\	\
<i>Eleotris melanosoma</i>	Black Sleeper	Freshwater and Brackish	Records from Sai Kung District and on Lantau Island	\	3	\	\
<i>Glossogobius giuris</i>	Fork Tongue Goby	Brackish	Common	\	< 5	\	\
<i>Glossogobius olivaceus</i>	Spotty Band Goby	Brackish	Uncommon	\	< 5	\	\
<i>Leiognathus brevirostris</i>	Pony	Marine/Brackish	NA	\	> 20	> 20	\
<i>Lutjanus argentimaculatus</i>	Mangrove Red Snapper	Brackish	Common	\	< 5	< 5	> 20
<i>Mugilogobius abei</i>	Goby	Brackish	Common	\	> 15	\	\
<i>Pseudogobius javanicus</i>	Goby	Brackish	Common	\	> 20	\	\
<i>Periophthalmus modestus</i>	Common Mudskipper	Brackish	Common	\	> 20	\	\
<i>Rhinogobius duospilus</i>	Goby	Freshwater	Common	\	< 10	< 10	< 10
Total number of species				0	11	4	3

8.4.47 Although all species are native, only one species of fish (i.e. *Rhinogobius duospilus*) was a typical freshwater fish, while the others were more or less estuarine species.

8.4.48 Besides fishes, diverse aquatic invertebrates are also found (**Table 8.4.6**). Except for Stream A, which was heavily silted and supported only one common shrimp species, Streams B, C and D had moderate aquatic invertebrate diversity and abundance.

Table 8.4.6 Aquatic Invertebrates Recorded in the Stream Habitats

Species	Stream A	Stream B	Stream C	Stream D
<i>Brotia</i>	\	Common	Occasional	Occasional
<i>Caridina cantonensis</i>	Occasional	Abundant	Abundant	Abundant
<i>Caridina elongapoda</i>	\	Abundant	Abundant	Occasional

<i>Caridina trifasciata</i>	\	Common	Abundant	Abundant
<i>Macrobrachium</i> sp.	Occasional	Common	Common	Common
<i>Nanhaipotamon hongkongense</i>	\	\	Occasional	Occasional
<i>Pseudosesarma patshuni</i>	\	Occasional	\	\
<i>Varuna litterata</i>	\	Occasional	\	\

Occasional = less than 10; Common = 10-100; Abundant = more than 100

8.4.49 Three species of Atyid shrimp were recorded on Kau Sai Chau, i.e. *Caridina cantonensis*, *Caridina elongata*, and *Caridina trifasciata*.

8.4.50 The first two pereopods (walking legs) of atyid shrimp are chelate and are characterized by well-developed tufts of setae for the collection of food. They are all detritivores feeding mainly on leaf litter from riparian vegetation. Members of this genus are often found in pools of mountain streams with clean water where flow rates are low and leaf litter accumulates. They are all tiny animals (with carapace length less than 1 cm). Hong Kong atyids generally have an annual life cycle (Dudgeon 1985) and direct development. In Hong Kong four species of this genus have been reported, namely, *Caridina cantonensis*, *C. apodosis*, *C. trifasciata* and *C. serrata* (Yam 2003). Among these, *C. serrata* is endemic to Hong Kong Island. It is therefore considered of conservation concern due to its restricted distribution (Fellowes *et al.* 2001).

8.4.51 *Caridina cantonensis* is the most widespread and abundant species of the four. Body size is usually larger, up to 1 cm in carapace length. Although a truly freshwater species, it can be found in some less optimum conditions. In the present survey, they were recorded in all four streams on Kau Sai Chau, including stream A which is heavily silted and where only two aquatic species were found.

8.4.52 *Caridina elongata* was not reported in previous studies of *Caridina* in Hong Kong, but is a widespread species from China, and Tai Wan to Africa. It can be found in some streams in Hong Kong, in particular near estuaries. On Kau Sai Chau *C. elongata* occupied the lower stream reaches while *C. cantonensis* occupied the upper reaches.

8.4.53 One unknown species of *Caridina* shrimp was found in the middle reaches of Stream C and the upper to middle reaches of Stream D during surveys conducted for the present EIA study in November 2000. Specimens of this shrimp were sent for identification and were confirmed as *Caridina trifasciata*. This species was first found at Tsak Yue Wu (near Pak Tam Chung), Sai Kung in September 2000 and was described as a species new to science (Yam and Cai 2003). Kau Sai Chau constitutes the second area of occurrence for this species. Specimens collected in Macau were sent for identification based on similarity to the confirmed *C. trifasciata* (Leung Va personal communication). If confirmed, this would be the third known site for *C. trifasciata*. Besides morphological differences by which this species was distinguished from other *Caridina* species, this shrimp has three distinctive deep colour transverse bands on the body. In 2005, this shrimp was also found at the middle reaches of Stream B.

8.4.54 The endemic freshwater crab *Nanhaipotamon hongkongense* was recorded in streams C and D. All three species of freshwater crabs recorded in Hong Kong (*Cryptopotamon anacoluthon*, *N. hongkongense*, and *Sommaniathelphusa zanklon*) are endemic. Among them, *N. hongkongense* is usually found at higher elevations and sometimes at locations distant from water sources. It is therefore also referred to as Mountain Crab. Though generally uncommon, this species is widespread throughout Hong Kong. Although all are relatively common and widespread in Hong Kong, these three freshwater crabs are considered of potential global concern by some local ecologists (Fellowes *et al.* 2001).

8.4.55 *Pseudosesarma patshuni* is a sesarminae crab and can be found near streams in some regions of Hong Kong including Lantau (its type locality) and Sai Kung.

8.4.56 An estuarine crab *Varuna* sp. was seen at the lower reach of Stream B. It is a common aquatic invertebrate in lowland reaches of Hong Kong streams.

8.4.57 Palaemonid shrimp (or Long-armed shrimp) *Macrobrachium* sp. (Family Palaemonidae) were collected in the pools along the streams. *Macrobrachium* sp. is commonly found in streams throughout Hong Kong. It is predatory and active at night. It was found in all streams surveyed.

8.4.58 Freshwater snail *Brotia hainanensis*, which is usually found in streams with good water quality, was found at both tributaries of Stream B, and at Streams C and D.

8.5 Evaluation of habitats and species of conservation interest

8.5.1 The ecological importance of the habitats on the Project and Assessment Areas has been evaluated against the criteria recommended in Annex 8 of the TMEIA. This evaluation is presented below in Table 8.5-1.

8.5.2 The conservation status of the rare/endangered/protected flora and fauna species is evaluated based on Table 3 of Annex 8 of the EIATM in Tables 8.5-2 & 8.5-32.

Table 8.5-1. Evaluation of ecological importance of habitats in the Project Area and Assessment Area

Criterion	Habitat			
	Shrubland	Stream/Ravine	Existing golf course	Coastal/Backshore
Naturalness	Natural but subject to frequent fire disturbance	Natural except presence of some old dams along streams	Man-made	Natural
Size	324.4 ha	2.6 km total Stream A: 0.2 km Stream B: 0.6 km Stream C: 0.8 km Stream D: 1.0 km	188.4 ha	9.2 km
Diversity	Low to moderate plant diversity; diversity of fauna very low	Moderate plant diversity; diversity of ravine terrestrial fauna very low. Stream fish and aquatic invertebrates of moderate diversity (except Stream A which is of very low diversity).	Low plant diversity at turfgrass and developed area, low to moderate plant diversity at marsh and remaining shrubland, high for avifauna, moderate for amphibian, reptile and dragonfly; low for butterfly and mammal	Low plant and avifauna diversity
Rarity	1 locally protected but common plant species: <i>Enkianthus quinqueflorus</i> ; 3 protected but common bird species: Black-eared Kite, Greater Coucal and Hwamei	3 locally protected but common plant species: <i>Enkianthus quinqueflorus</i> , <i>Peristylus tentaculatus</i> , <i>Arundina graminifolia</i> 2 tree species protected in China: <i>Ixonanthes reticulata</i> and <i>Artocarpus hypargyreus</i> , 3 protected and rare bird species: Crested Goshawk, Crested Serpent Eagle and Peregrine Falcon 1 endemic freshwater crab <i>Nanhaipotamon hongkonensis</i> . 1 atyid shrimp <i>Caridina trifasciata</i> found in Stream B, C & D. Kau Sai Chau is the second known area of occurrence for this species.	Regionally/globally protected bird species utilizing the golf course frequently included Reef Egret, Black Kite, Peregrine Falcon, Kestrel and Greater Coucal; regional/global protected snake: Burmese Python, Chinese Cobra and King Cobra; Uncommon gecko: Garnot's Gecko and Grass Lizard; local/regional protected mammal: Small Indian Civet, Masked Palm Civet and Chinese Porcupine. Uncommon amphibian species: Two-striped Grass Frog; Uncommon/rare dragonfly: Scarlet Dwarf, Dancing Dropwing and Sapphire Flutterer	1 restricted plant species: <i>Scaevola hainanensis</i> ; 1 regional protected bird species: Reef Egret <i>Egretta sacra</i> , 2 regional and global protected bird species: Osprey <i>Pandion haliaetus</i> and White-bellied sea Eagle <i>Haliaeetus leucogaster</i>
Re-creatability	readily re-creatable but may not have the same species diversity and composition	difficult to re-create	readily re-creatable but may not have the same species diversity and composition	difficult to re-create
Fragmentation	continuous patch with little fragmentation	N/A	continuous patch with little fragmentation	continuous shoreline with little fragmentation
Ecological linkage	not functionally linked to any highly valued habitat in close proximity	not functionally linked to any highly valued habitat in close proximity	not functionally linked to any highly valued habitat in close proximity	not functionally linked to any highly valued habitat in close proximity
Potential value	Will develop into mature woodland given time and in the absence of disturbance	Will have increase in species diversity and canopy coverage given time and in the absence of disturbance	Moderate with habitat management	-
Nursery/breeding ground	Limited due to low vegetation cover.	No significant record but can provide breeding habitats for freshwater fish amphibian and dragonfly (upstream and lowland sections), as well as marine species (estuarine section)	Records of breeding of avifauna, amphibians and dragonfly	No significant record but may provide nesting habitat for some coastal birds
Age	Young of its type	N/A	Young	N/A
Abundance/ richness of wildlife	Very low for fauna	Very low for ravine fauna Moderate for stream fish aquatic invertebrates (except Stream A which is of very low abundance).	Low for fauna	Low for avifauna

Summary	Low to moderate	Moderate for Stream B, C and D Low for Stream A	moderate: higher than surrounding natural habitats	moderate
---------	-----------------	--	---	----------

Table 8.5-2. Evaluation of flora species of conservation concern within the Project Area

Species	Common Name	Growth Form	Location	Protection Status	Distribution	Rarity	Potential Impacts
<i>Enkianthus quinqueflorus</i>	Chinese New Year Flower	Shrub	Ravine at Stream B and C, and D shrubland above Stream C	Protected by Forestry Regulations	Pat Sin Range, Sai Kung, Peak	Common	Minor to no impact during construction because ravine habitats at streams B and C will be protected by buffer zones. Stream D will be unaffected because it lies outside the Project Area. Shrubland habitat where this species were recorded will also lie outside the site formation boundary.
<i>Arundina chinense</i>	Bamboo Orchid	Herb	Stream D ravine	Protected by Forestry Regulations		Very common	No impact as Stream D will be unaffected because it lies outside the Project Area.
<i>Peristylus tentaculatus</i> *	Beardly Orchid	Shrub	Stream C ravine	Protected by Forestry Regulations		Very common	Minor to no impact during construction because ravine habitats at streams C will be protected by buffer zones.
<i>Scaevola hainanensis</i>	Hainan Naupaka	Climber	Coastal	Not protected	Outlying Islands	Restricted	No impact as no coastal habitat will be affected.
<i>Artocarpus hypargyreus</i> **		Tree	Stream B ravine	Not protected locally, but a Category III nationally protected species in China and listed as vulnerable in the China Plant Red Data Book		Common	Minor to no impact as because ravine habitats at stream B will be protected by buffer zones and will be retained on site.
<i>Ixonanthes reticulata</i> **		Tree	Ravine at Stream A, B and hillside shrubland	Not protected locally, but a Category III nationally protected species in China, and listed as vulnerable in the IUCN World List of Threatened Trees and in the China Plant Red Data Book.		Common	Minor to no impact as individuals will be protected by stream buffer zone or lie outside the site formation boundary and will be retained on site.

*not seen during verification surveys; ** recorded by tree surveys

Table 8.5-3. Evaluation of fauna species of conservation concern within the Project and Assessment Areas

Common Name	Latin names	Location recorded	Protection Status	Distribution	Rarity	Potential Impacts
Reef Egret	<i>Egretta sacra</i>	Rocky shore on the west of Kau Sai Chau; Mangrove plantation of existing golf course	All birds are protected under WAPO; Class II Protected Animal of PRC	Widespread; mainly occurs in coastal areas	Common	Minimal impact due to habitat loss. The affected area accounts for an insignificant proportion of the daily home range of this species.
Black Kite	<i>Milvus lineatus</i>	Shrubland of Project Area, ravine of Stream D; Existing golf course	All birds are protected under WAPO; Appendix II of CITES, Class II Protected Animal of PRC	Widespread; can be found in many types of habitats	Common	Minimal impact due to habitat loss. 20-50 Black Kites are routinely seen roosting on or soaring over the existing golf course. Over 20 Black Kites roost daily on power lines at the western fringe of the existing golf course.
Crested Goshawk	<i>Accipiter trivirgatus</i>	Ravine of Stream D	All birds are protected under WAPO; Appendix II of CITES, Class II Protected Animal of PRC	Widespread; mainly found in wooded area	Rare	No preferred habitat of this species will be affected by the proposed project.
Crested Serpent Eagle	<i>Spilornis cheela</i>	Ravine of Stream D	All birds are protected under WAPO; Appendix II of CITES, Class II Protected Animal of PRC	Sporadically distributed in well-wooded area	Rare	No preferred habitat of this species will be affected by the proposed project.
White-bellied	<i>Haliaeetus leucogaster</i>	Coastal area on the west of Kau Sai Chau	Appendix II of CITES, Class II Protected Animal of PRC	Widespread; mainly maritime	Rare; estimated	Minimal impact due to potential habitat loss, but the affected coastal and inland

Sea Eagle					nesting population is 8-10 pairs	foraging area only accounts for a small proportion of the daily home range of this species. Species is routinely seen soaring over the existing golf course and the northern shoreline of Kau Sai Chau during the 10 years of golf operation.
Osprey	<i>Pandion haliaetus</i>	Coastal area on the west of Kau Sai Chau;	All birds are protected under WAPO; Appendix II of CITES, Class II Protected Animal of PRC	Mainly in Deep Bay area; mainly maritime	Uncommon/rare	No impact. Osprey is regularly observed foraging over the golf course reservoir and below the dam. Proposed golf course ponds could provide additional foraging habitat for Osprey if stocked with fish.
Buzzard	<i>Buteo buteo</i>	Shrubland of Project Area	All birds are protected under WAPO; Appendix II of CITES, Class II Protected Animal of PRC	Widespread; can be found in many types of habitats	Common	Minimal shrubland habitat loss, but affected area only accounts for a small proportion of the daily home range of this species. Buzzard is seen soaring over the existing golf course.
Greater Coucal	<i>Centropus sinensis</i>	Shrubland of Project Area, Ravine of Stream C & D; Existing golf course	All birds are protected under WAPO; Class II Protected Animal of PRC	Widespread; can be found in many types of habitats	Common	Minimal impact to shrubland habitat loss, but population affected by this impact is probably very low on the Project Area. Greater Coucal appears to have increased in number on and around the existing golf course..
Hwamei	<i>Garrulax canorus</i>	Shrubland of Project Area	All birds are protected under WAPO; Appendix II of CITES, Class II Protected Animal of PRC	Widespread; mainly found in dense shrubland	Common	Minimal impact due to shrubland habitat loss, but population affected by this impact is probably very low. Species has been recorded on the existing golf course shrublands and maturing open-woodlands.
Chinese Cobra	<i>Naja atra</i>	Ravine of Stream C	Appendix II of CITES	Widespread; can be found in many types of habitats	Common/uncommon	Minimal impact due to shrubland habitat loss, but population affected by this impact is probably very low. Species has been recorded on and around the existing golf course.
King Cobra	<i>Ophiophagus hannah</i>	Ravine of Stream A; Existing golf course	Appendix II of CITES	Widespread; can be found in many types of habitats	Locally uncommon	Minimal impact due to shrubland habitat loss, but population affected by this impact is probably very low. A qualitatively assessed increase in snake numbers on the existing golf course increased the prey base for this snake-eating predator. Habitat condition for King Cobra is probably better on the golf course than in surrounding shrublands where snake densities are low.
Bush Hopper	<i>Ampittia dioscorides</i>	Ravine of Stream C; Existing golf course	Not protected	Widespread; can be found in marshy grassland, disused paddy fields and gardens	Uncommon	Population affected by this impact is probably very low. Ravines will be protected by buffer zones.
Green Flash	<i>Artipe eryx</i>	Ravine of Stream D	Not protected	Widespread; mainly found in woodland	Uncommon	No preferred habitat of this species will be affected by the proposed project.
Freshwater crab	<i>Nanhaipotamon hongkongensis</i>	Stream C and D	Not protected	Endemic, but could be found in various regions in Hong Kong	Widespread	Stream C will be protected by buffer zone, Stream D will be unaffected. Impact will be minor.
Atyid shrimp	<i>Caridina trifasciata</i>	Streams B, C and D	Not protected	Found in Tsak Yue Wu in Sai Kung Peninsula and Kau Sai Chau, possibly Macau.	Uncommon	Minor to no impact during construction because streams B and C will be protected by buffer zones. Stream D will

be unaffected because it lies outside the Project Area.

8.6 Impact Identification and Assessment

8.6.1 Ecological impacts of the project were assessed based upon the ecological resources considered at risk from the proposed project. Both negative and positive impacts were taken into account, and cumulative impacts of this and other projects were assessed. Mitigation measures were developed to reduce negative impacts, and residual impacts were predicted assuming implementation of all feasible mitigation measures. Impact assessment and planning of mitigation measures were conducted in accordance with the Technical Memorandum on EIA Process and the PELB Technical Circular 1/97 on Off-Site Mitigation.

8.6.2 The significance of ecological impacts is evaluated based primarily on the criteria set forth in Table 1, Annex 8 of the TM:

- | habitat quality;
- | species affected;
- | size/abundance of habitats/organisms affected;
- | duration of impacts;
- | reversibility of impacts; and
- | magnitude of environmental changes.

8.6.3 Impacts are generally ranked as "minor", "moderate" or "severe", although in a few cases a ranking of "minimal" (less than "minor") may be given. The ranking of a given impact might vary based on the criteria listed above. For example, an impact might be ranked as "minor" if it affected only common species and habitats, or if it affected only small numbers of individuals or small areas, whereas it might be ranked as "severe" if it affected rare species or habitats, large numbers of individuals or large areas. The major factors giving rise to a ranking are explained in the text. As noted in Annex 16 of the TM, a degree of professional judgement is involved in the evaluation of impacts.

Construction Phase

8.6.4 This section of the report considers the potential impacts of project construction on terrestrial and freshwater ecology. The project details are described in Section 2 of the EIA report. The construction works related to ecological impacts include:

- | Bulk site formation works to form the 18 new golf holes, cart paths, site office, golf cart parking building;
- | Construction of 3 new irrigation lakes, water tanks, underground drainage pipes including an overflow pipe to existing reservoir, and associated pumping stations;
- | Construction of desalination plant on the west shoreline and associated saltwater pumping station;
- | Construction of temporary haul roads which will be decommissioned after the construction phase;
- | Erection of temporary barging point on the east shoreline which will be decommissioned after the construction phase; and
- | Reshaping the existing S4, S6 to accommodate formation of the new lake and recontouring of practice green, extension of the existing administration building and maintenance building.

8.6.5 Potential sources of construction impact include:

- | Site formation;
- | Noise and disturbance; and
- | Surface runoff.

Site Formation

Shrubland

8.6.6 The proposed project would cause a permanent loss of 56.1 ha of shrubland, 32.7 ha of which would be in the golf course extension area while 23.4 ha would be in the southeast sector of the existing golf course that adjoins the new extension area (Figure 8.5). Plant species to be impacted are all common and typically found in this habitat type. Impacts to plant species of conservation concern are considered minimal as these species and most of their ravine habitats (see below sections on direct impacts on streams) will be preserved during site formation. Although inside the Project Area, the Chinese New Year Flower recorded in the upland habitats was located outside the site formation boundary and therefore will not be affected. The trees of conservation concern recorded during tree surveys (*Artocarpus hypargyreus* and *Ixonoanthes reticulata*) will be retained on site.

8.6.7 Despite the large area of shrubland habitat to be lost, this type of habitat will still be the dominant habitat on Kau Sai Chau (Figure 8.5) and is considered of low ecological importance because it is a product of previous abuse by deforestation, anthropogenic wildfire and artillery practice. Fauna abundance and species richness in the Project Area shrublands were very low. Shrubland will be converted to golf course, which will provide replacement habitat for wildlife as it has on the existing golf course over the last 10 years. The golf course extension would extend the fire-break effect over a larger area, thus providing greater protection to more of the remaining natural areas on the island. This will encourage natural succession on shrublands and other unaffected habitats. Loss of individual trees will be compensated by tree planting at a ratio of 3:1. Therefore the impact to wildlife due to loss of habitats will be temporary and confined to the construction phase. The impact is considered minor.

8.6.8 The impact to terrestrial fauna of conservation concern due to loss of shrubland is ranked as minor for the following reasons: 1) Shrubland is not a preferred habitat of some of the fauna species of conservation concern (White-bellied Sea Eagle, Osprey, Reef Egret, Crested Goshawk, Crested Serpent Eagle, Green Flash) listed in **Table 4.7**; 2) these species were present in very low numbers in shrubland (Greater Coucal, Hwamei, Chinese Cobra, King Cobra, Bush Hopper); 3) Some of the fauna species of conservation concern recorded in shrubland (Black Kite, Buzzard) typically utilize many types of habitats; 4) The affected habitats also account for a small proportion of the daily home range of some of the fauna of conservation interest (e.g., these species were present in very low numbers (Black Kite, Buzzard); and shrubland will remain on the non-golf areas of the island as well as in the undisturbed portions of the golf course. An additional reason for ranking the habitat loss as a minor impact is that the existing golf course supports many of the species of conservation concern. Notable among these are Black Kite, Buzzard, White-bellied Sea Eagle, Osprey, Reef Egret, Hwamei, Greater Coucal, Chinese Cobra, and King Cobra.

Existing golf course

8.6.9 Construction work will affect 23.4 ha of shrubland habitat of the existing golf course. The area affected at any one time will be small, and will account for a small proportion of the daily home range of the fauna species of conservation concern (e.g., Black Kite, Kestrel). In addition, due to the low abundance of fauna on the existing golf course and the temporary nature of the habitat loss, the impact to terrestrial fauna is considered minimal.

8.6.10 The ponds north of the clubhouse and the marsh near Hole N-15 will not be affected. Impact to fauna utilizing these wetland habitats (e.g., dragonfly, amphibians) will be minimal. The pond at the existing maintenance shop will be filled to accommodate expansion of the maintenance area. This pond is not a natural feature but was dug in 1994-5 during the initial construction project. The surface water drainage for this pond is now an underground pipeline that emerges onto the surface in the former stream channel at a site approximately 150 m NE of the pond. This drainage pipeline will be extended upstream beneath the pond area to be filled, leaving the existing drainage system unchanged. Surface water supply to the lower reaches of the stream and to the marsh will be unaffected. Loss of this pond will temporarily reduce habitat for wetland invertebrates (dragonflies) and waterbirds. No birds are known to nest at the pond. The pond would be filled during the non-breeding season. The lost habitat will be replaced by the 3 new ponds to be constructed in the extension area.

8.6.11 Reshaping of two golf holes, a practice green, and extension of the administration and maintenance buildings would cause minimal ecological impact because the works would occur within the existing golf course footprint, and after construction similar habitats would be reprovided.

Coastal habitat

8.6.12 Construction works at the desalination plant and barging point will only affect small areas of coastal habitats, which account for a small proportion of the daily home range of fauna of conservation concern in the coastal areas (White-bellied Sea Eagle, Osprey, Reef Egret). Bird abundance along the shoreline of Kau Sai Chau was low. The coastal area near the existing ferry pier, where the desalination plant and associated seawater pumping station will be located, is currently subjected to high levels of human disturbance (ferry arrivals at 20 minute intervals, supply boats docking and off-loading). The ecological importance of the coastal area around the ferry pier as habitat for birds and other fauna is low. The impact to fauna in coastal areas is considered minimal.

Stream

8.6.13 Stream D is located outside the Project Area and would not be affected by the Project. Streams A, B, and C lie within the Project Area. Stream A is of low ecological value, while Stream B & C are of moderate ecological value.

8.6.14 During the design process of the golf course layout, direct impacts on these stream courses were avoided as far as possible by modifying the alignment of fairways. Streams B and C, where diverse aquatic fauna including the Atyid shrimp *Caridina trifasciata* were found, would be preserved along their full length. Except construction of crossings (see below sections), no filling, channelisation, diversion, or any other construction works would be conducted in or adjacent to the channels of these two streams. Hole 10 was even intentionally divided into two parts to avoid direct impacts on tributary B2 of Stream B. In addition to avoiding direct impacts, buffer zones would be demarcated and protected along the full length of these two streams. The width of the buffer zones would be 20 m from the stream bank over most of the stream length. The only exception would be the buffer zone in the reach of tributary B2 lying between the two parts of Hole 10. Due to the limitation of space, stream buffer zones at that section of stream would have to be reduced to less than 20 m in some locations. However, the design team still pursued the maximum achievable widths of buffer zone at this section and the minimum width of the buffer zone

would be maintained to no less than 5m.

8.6.15 A section of the former tributary of Stream B (B3) would be converted to underground culvert for natural hill slope drainage during rainfall. As confirmed during field surveys, the function of tributary B3 has been replaced by B2, and B3 no longer supports surface flow (see Paragraph **8.4.41** for details). Culverting a section of B3 would therefore not cause stream habitat loss.

8.6.16 Tributary A1 (Figure **8.2**) and the lower Stream A would also be preserved and protected by a 20 m buffer zone. A section of tributary A2 (about 50 m in length), however, would be converted to underground culvert, causing loss of stream habitat. Stream A, however, is the stream of lowest ecological value among the three within the Project Area. Only two common and widespread aquatic species (*Caridina cantonensis* and *Macrobrachium* sp.) were recorded in this stream, and neither was abundant. The flow of tributary A2 would be maintained by the culvert, even though it is the smaller of the two tributaries and contributes less volume to the flow of Stream A. Based upon the small size of the loss, the heavily silted nature of Stream A, and the absence of species of conservation concern, this impact is ranked as minor.

8.6.17 Crossings would be required at the streams for access to fairways (greenskeeping equipment, golfers, golf buggies). Three permanent bridges are proposed, one at each of the three stream courses (Stream A, B & C, see **Figure 6.6a** and **Figure 8.6**). Two of these permanent bridges (at Streams A and C) would be supported by piers behind the streambanks and thus would not encroach the stream beds or stream banks (Figure 8.6). The bridge at Stream B would be a culvert bridge, the stream passing beneath the bridge in a 450 mm diameter pipe. This bridge would be located at the very upstream reach of Tributary B1, a site that would be dry during most of the year. Two additional crossings in culverts are proposed at the highest reach of tributary B2 of Stream B. In contrast to the underground pipe culvert at tributary A2, these culverts are only to enable passage of golfers and buggies, and therefore are much shorter (less than 2 m in length). They are also located at the highest and steepest stream reach of tributary B2. This reach of the stream would also be dry during most of the year. The impact is thus considered insignificant. A photograph of an existing culvert between holes South 3 and South 8 is shown on Figure 8.6. This culvert is virtually invisible after 10 years of vegetation growth..

Fragmentation

8.6.18 Shrubland on the Project Area will be fragmented. However, remaining patches would remain in close proximity and would not be separated by physical barriers. Fauna would be able to move from patch to patch at will. In addition, most terrestrial species recorded in the Project Area are highly mobile (e.g., Chinese Bulbul), and are not known to be susceptible to habitat fragmentation. Indeed, many are typically found in fragmented or open habitats (Wild Boar, Small Indian Civet). The impact to terrestrial fauna due to habitat fragmentation is ranked as minor.

Noise and Disturbance

8.6.19 Considerable noise and visual disturbance may be generated during site formation and deliveries to the site from both the existing pier and the temporary barging point. This could affect the distribution and behavior of fauna in the adjacent habitats. Fauna will leave the site upon site formation. Due to the temporary and localized nature of the impact, potential impacts to fauna from this source are ranked as minor. Disturbance due to dust generation during construction can be minimized by good site practice.

8.6.20 Construction work on the existing golf course may generate noise and visual disturbance to wildlife. Since the disturbance level in the daily operation of the existing golf course (e.g., golf play, turfgrass maintenance) is not low, wild animals utilizing the existing golf course are to some extent disturbance tolerant. Due to the temporary and localized nature of the impact, potential impacts to fauna from this source are ranked as minor.

Surface Runoff

8.6.21 Potential impacts to aquatic ecology during the construction phase would mainly arise from sedimentation due to surface runoff. Elevated suspended solids levels caused by site runoff could increase concentrations of suspended solids in the water bodies, and could decrease dissolved oxygen levels. A lower oxygen level would affect sessile species, whilst motile species would tend to temporarily avoid the affected areas. The result could be a temporary reduction in abundance of aquatic fauna. Sedimentation will be minimized by concentrating earth works in the 2005-6 dry season. However, based on experience from the 1994-5 construction of the existing golf course, mitigation will be required.

8.6.22 Sedimentation of the stream courses during construction phase is also a major concern for the Project. As stated in the water quality section, temporary drainage systems would be established on different parts of the construction areas. Runoff within the construction areas will be collected, desilted and then re-used for turf grass planting. Furthermore, the full length of Stream B and Stream C, as well as tributary A1 and the main course of Stream A, would be protected by buffer zones. Buffer zones will also help prevent runoff from entering the stream courses.

8.6.23 Although the impacts from construction area runoff are mostly prevented by the temporary drainage system, there is still potential for sedimentation of stream courses where culverts would be installed. This impact is ranked as minor to moderate and mitigation measures are required.

Summary of Construction Impacts

8.6.24 For the fauna of conservation importance, as Stream D is located outside the Project boundary, while Stream B & C would not be impacted by construction works except crossings and protected by buffer zone, freshwater crab *Nanhaipotamon hongkongensis* found in Stream C & D, and *Caridina trifasciata* found in Stream B, C & D would not be affected. As the majority of ravine habitats will also be preserved by the buffer zones, impact to fauna inhabiting of ravine habitat (e.g., Bush Hopper) would be insignificant.

8.6.25 Potential impacts of project construction on terrestrial ecology are summarized in Table 8.6-1.

Table 8.6-1. Construction-stage Impacts

Activity	Receiver	Potential Impacts	Nature of Impacts	Severity	Mitigation Required
Site formation	Habitats (shrubland/ and dependent species)	Total loss of flora and habitats within site formation boundary Loss of habitats for fauna	Permanent, irreversible, limited species affected	Minor	No
Habitat fragmentation	Terrestrial fauna	Changes in distribution, activity patterns	permanent, irreversible	Minimal	No
Construction dust	Adjacent/ remaining habitats	Inhibition of vegetation growth Changes in distribution and activity patterns of fauna	Temporary, reversible, small scale, limited species affected	Minor	No
Noise and disturbance	Sensitive wildlife species on and near the Development Area	Changes in distribution, activity patterns	Temporary, reversible, small scale, limited species affected	Minor	No
Site runoff	Intertidal and subtidal fauna	Changes in salinity, increase suspended solid	Temporary, reversible, small scale	Minor	Yes

Operation Stage

Operation of golf course

8.6.26 Ecological monitoring of the existing golf course over the last ten years showed that the golf course has provided habitats for a diverse array of wildlife including birds, herpetofauna, dragonflies and butterflies. Numbers of species and densities are generally higher on the existing golf course than in surrounding habitats. Apart from Blue Forest Damsel, all species recorded on north Kau Sai Chau during the pre-golf EIA study were subsequently recorded in 1995-2005. This shows that there was no loss of ecological niche due to conversion of highly degraded habitats (shrubland) to golf course. There was no quantitative survey in the EIA study for the existing golf course. However, vegetation cover on north Kau Sai Chau before construction of the golf course was similar to that on the Project Area except for higher percent cover of grasses and lower cover of shrubs. It is therefore reasonable to assume that bird densities at the two sites were similar. Bird density on the existing golf course (3.8 birds ha⁻¹) is 8.4 times that in shrubland on the Project Area (0.45 bird ha⁻¹). Thus the conversion of highly degraded habitats to golf course enhanced avian biodiversity.

8.6.27 The ecological monitoring of the existing golf course also showed that creation of wetland habitats can increase biodiversity. The presence of many wetland birds (e.g., Little Grebe *Tachybaptus ruficollis*, White-winged Black Tern *Chlidonias leucoptera*) on the existing golf course was mainly due to the creations of ponds. These species do not occur in the dry environment of shrubland. Three ponds of combined area 1.6 ha would be created in the proposed golf course for water storage and irrigation supply. These ponds would also provide habitats for wetland birds, dragonflies and amphibians as do the ponds on the existing golf course.

8.6.28 Conservation management has been enhanced on Kau Sai Chau by the commitment of The Kau Sai Chau Public Golf Course Ltd. to ecologically-friendly golf. In recognition for its efforts the golf course has been awarded a certificate from Audubon International for wildlife habitat management. Conservation projects have included hillfire control, installation of bat roost-boxes and bird nest-boxes, planting of trees and bamboos to provide egret habitat, planting of native trees as visual and safety barriers. Outreach programs have included conservation education in local schools and on-site projects involving students in nest-box monitoring, exotic species removal, and formal lectures. These activities would not have happened without the existing golf course.

8.6.29 The operational impact to habitat and flora is considered positive due to protection of habitats from fire. This will accelerate natural succession and will ultimately lead to

greater numbers of trees and more complex habitats in an around the golf course, and also over all of the fire-protected areas of the island. Vegetation density and biomass will increase in response to fire protection. This will increase the amount of organic material reaching the soil surface and later incorporated into the soil-building process. The combination of these effects will have a positive impact on wildlife species and population numbers, as seen over the last decade. The presence of additional freshwater ponds will benefit waterbirds and herpetofauna.

8.6.30 Operation of the low-flow surface runoff re-cycling system will enable re-use of irrigation water. This is positive from the perspective of water conservation because of the long dry-season (October-April) and the fact that irrigation water on Kau Sai Chau is supplied only by rainfall and treated sewage effluent. The potential impacts on wild biota of re-cycling irrigation water are minimal because only the turfgrass areas are irrigated. Flora in the turfgrass areas is almost entirely cultured (except in the roughs and around retained gravesites where some native species have colonised), so there would be little or no impact on native flora. Fauna that occupies the turfgrass areas does so intermittently for foraging (e.g. birds and wild boar) or to move from one point to another (e.g. snakes and civets). Species that forage on turfgrass areas are typically in search of insects or annelids (earthworms) on or in the sod. Beetles, whose grubs are important prey items for some birds and wild boar, lay their eggs seasonally. This means that re-cycling of irrigation water would be of no consequence to either predator or prey because the life cycle of the prey is related to season rather than to the irrigation regime. Annelids may prefer moister soils and could become more numerous if more water were to be applied to turf during the dry season. This would benefit worm-eating birds, which are abundant on the golf course (starlings, mynahs, pipits, wagtails, thrushes), and wild boar, which feed on annelids (Dahmer 2001b).

8.6.31 Over 9 years of monitoring there have been no incidences where turfgrass nutrients or other chemicals were detected in either marine or freshwater bodies on or around the golf course. It is unlikely that these would be detected in the future because management regimes that produced the unblemished performance record to date will continue on the third course. This enables the conclusion that aside from the neutral to positive impacts described above, the low-flow drainage recycling system would have no impact on wild biota on the existing or proposed golf courses. The impact to terrestrial and freshwater fauna from conversion of degraded habitats to golf course and operation of the golf course with the low-flow re-cycling system is considered positive, no mitigation measures are needed.

8.6.32 The proposed golf course can also provide habitats for fauna inhabiting/utilizing the existing golf course, as the two sites will support similar habitats. The impact to terrestrial fauna inhabiting/utilizing the existing golf course due to the operation of the proposed golf course will be positive, no mitigation measures are needed.

Long term noise and disturbance

8.6.33 Human activities, which may result in increase of noise and disturbance to wildlife, in the Project Area will increase with the operation of the proposed golf course. Ecological monitoring in the existing golf over the last 10 years showed that there were increase in biodiversity in north Kau Sai Chau after the construction of golf course, e.g., bird abundance in north Kau Sai Chau increased by 8.4 times. There is no evidence of adverse impact to wildlife due to the operation of golf course. The impact of long term noise and disturbance is ranked as minimal.

Water quality change from surface runoff

8.6.34 As stated in the water quality section of this report, no surface runoff from the fairways would enter any of the existing stream courses. The golf course would have a closed drainage system to collect most of the runoff within the golf course, temporarily store it on-site, and then recycle the stored water for use in irrigation.

8.6.35 To provide sufficient freshwater for irrigation a reservoir was formed in 1994-5 at the north end of the island by constructing a rockfill dam across the Kwat Tau Tam inlet. The overall design for the water management and quality control was based on a concept of self containment and effluent re-cycling both to conserve water and to minimise potential environmental impacts on marine and mariculture areas around the Island. The irrigation and drainage system, together with the golf course lakes, reservoir, and associated catchments were designed as far as practicable as a closed water management system to optimise re-cycling of irrigation run-off within the project area. Treated wastewater and sewage effluent from the clubhouse and maintenance areas are also re-cycled into this system. This approach will be adopted for the proposed third golf course. A closed drainage system will divert surface runoff into surface channels or underground culverts, into constructed ponds, and finally to the existing reservoir (see details in para. 8.6.36). From there the water will be pumped back onto the course to irrigate turfgrass. The current environmentally-friendly turfgrass management practices and the comprehensive monitoring programme will be extended to the proposed third golf course as well. Based on this three-tier approach to environmental protection, water quality impacts are not anticipated.

8.6.36 A closed low flow drainage system is proposed to capture runoff by collecting surface water from the proposed third golf course and pump it back to the existing reservoir for reuse in irrigation (**Figure 6.4**). The drainage system design and concept approach for the proposed third golf course is similar to the existing golf course, which has been seen as successful, to minimize the impacts to nearby sensitive receivers as far as possible. There are three main components for the closed low-flow drainage system which contains a number of collection underground tanks/pumping stations, irrigation buffer lake 1D (first temporary collection of surface runoff from proposed third golf course) and existing reservoir (storage for irrigation purpose). Details are as follows:

- | The closed low flow drainage system involves intercepting runoff from the greens, fairways and tees from all holes, except Hole 5 and part of Hole 6, and recirculating the flow through the irrigation system. Hole 5 and part of Hole 6 would discharge to the existing marsh area.
- | A total of 10 pumping stations coupled with either lake or tank storage would be required to intercept runoff from the course and direct it to the irrigation buffer lake (lake 1D), then it will further divert to the existing reservoir where the runoff would be re-circulated through the irrigation system.
- | It is proposed that the interception system would be designed to retain a 1 in 2 year design flow.
- | The irrigation buffer lake 1D will receive no direct runoff from any areas other than the greens, tees and fairways of the proposed third golf course. It will be served as the first point of discharge prior to overflow to the existing reservoir for storage and irrigation.
- | Under this option irrigation water to the new course would be supplied via the buffer lake (lake 1D) supplemented by the desalination plant during dry periods.

8.6.37 Runoff from greens, tees and fairways will be collected by catchpits or the perforated sub-soil drainage system from where it will be conveyed along pipes to the underground storage tanks or open storage ponds. Each ponds and tanks shall have a set of pumps that are automatically operated by level control and will pump the runoff to the irrigation buffer lake. The storage volume between the pumps on and off levels and their pumping rate has been determined such that overflow shall only occur on events greater than a 1 in 2 year return period. When the irrigation buffer lake is full it overflows to the existing reservoir at Kau Sai Chau.

8.6.38 The permanent drainage system for the proposed third golf course comprises comprehensive networks of drains, lakes and low flow storage tanks/pumping stations, with the following major objectives:

- | To avoid flooding of the proposed golf course and to remove water from the playing areas as soon as possible;
- | To collect runoff from the proposed golf course to the existing reservoir for irrigation and recycle purpose;
- | To prevent low-flow runoff from discharging directly the streams and marine waters; and
- | To maintain flows through existing stream environmental.

8.6.39 The design principles applied in the proposed golf course layout has demonstrated consideration to protect all identified water quality sensitive receivers are shown as follows:

- | No alterations of watercourse in the latest design layout - buffer zones will be provided for all sensitive streams to reduce the disturbance during the construction and operational phase;
- | No developments near existing wetlands (marsh);
- | Avoid disturbance of stream bed during the design phase and construction of the permanent bridges by using precast unit which will be constructed within the construction site but outside stream buffer zones, or transported by barge, and installed to the proposed locations;
- | To protect streams from contamination by keeping high maintenance areas, i.e. tees, greens and fairways, to a minimum, the overall change in runoff quantity and quality can be minimized; and
- | The new lakes are designed to serve as temporary storage point for runoff.

8.6.40 The remaining fairways (Hole 5 and 6) and the overflow water during heavy raining would also go into the sea rather than the existing stream courses. Minimal operational phase water quality impact is anticipated. No mitigation measure is needed.

Summary of Operation Impacts

8.6.41 Potential impacts of project construction on terrestrial ecology are summarized in Table 8.6-2.

Table 8.6-2. Operation-stage Impacts

Activity	Receiver	Potential Impacts	Nature of Impacts	Severity	Mitigation Required
Operation of golf course/ driving range	Terrestrial fauna favours open areas; Fauna in the existing golf course	Provision of habitats; higher feasibility of management plan for conservation purposes.	Restoration of habitat, enhancement of biodiversity, both are positive	Positive effects	No
Long term noise and disturbance	Terrestrial fauna	Changes in distribution, activity patterns	Human activities	Minimal	No

Surface runoff	Stream fauna	Changes in water quality	Input of fertilizers and other chemicals	Minimal	No
----------------	--------------	--------------------------	--	---------	----

8.7 Impact Avoidance and Mitigation Measures

Construction Stage

8.7.1 Despite the steep terrain at the golf course extension area, the required amount of site formation work was minimised during the design stage to avoid excessive cut and fill. About 67% of native habitats in the extension area would be retained. Haul roads would be located on future fairway and cart paths alignments to minimise temporary disturbance of habitats.

8.7.2 Loss of shrubland habitat would be replaced by provision of about 40 ha of turfgrass area. The ecological value of the new golf course habitat would be enhanced by creation of irrigation ponds and tree planting. The ponds with a total area of 1.6 ha would provide breeding habitats for reptiles and amphibians and foraging habitats for waterbirds such as Little Grebes, ardeids, Common Sandpipers, Common Kingfishers. To compensate loss of trees, a total of 42 trees will be transplanted and 967 trees (more than 3:1 ratio) will be planted on the new golf course (Appendix A12.1). 90% of these trees are native, while 76% of these will be light standard trees or larger, which will provide instant breeding and foraging habitats for birds and butterflies. The use of light to heavy standard trees is more preferable to seedlings as bigger trees provide habitats of higher structural complexity. Many of the native trees to be planted will produce fruit that can be eaten by frugivorous birds. Light to heavy standard trees will set fruits (bird food) earlier and in higher abundance.

8.7.3 Impacts to streams have been avoided during the design stage by designating buffer zones. Except Tributary A2 and the old Tributary B3 where short sections would be culverted, other streams and tributaries will remain intact. Except at the crossings, there will be no direct disturbance to the stream bed. To accommodate the construction and golf hole design, the buffer zone of Tributary B2 at Stream B will be reduced to 5m in one area. The buffer zone of this section of Stream B would be temporary disturbed during site formation, but will be reinstated after construction. The buffer zones of Stream C will be totally preserved.

Sedimentation

8.7.4 Potential impacts due to site runoff would be reduced by scheduling most of the bulk site formation works during the dry season of 2005-6 in order to avoid excessive erosion. At locations of existing stream courses where construction works would be conducted, including the underground pipe culvert at tributary A2 and old tributary B3, the two small pipe culverts at the upstream part of Tributary B2, and the Culvert Bridge at the upstream part of Tributary B1, bypass flow channel or pipes would be provided before the commencement of construction and would maintain the stream flow until the crossings and the underground pipe culvert are finished. The two small pipe culverts at Tributary B2 would be constructed in sequence, to further avoid the potential sedimentation impact from their construction. Construction materials must be stored at locations away the stream courses. Site runoff would be desilted in settling ponds to reduce the potential for suspended sediments, organics and other contaminants to enter stream and marine environment.

Operation Phase

8.7.5 Based on 10 years of experience in operation of the existing 36-hole golf course, it is anticipated that the operation of the proposed 18-hole golf course will not cause adverse impacts to the Project Area, the existing golf course, or to the island or surrounding environments in Port Shelter. No mitigation measures are considered necessary other than adherence to the same high-quality operating standards that characterised the first 10 years of golf on Kau Sai Chau.

8.8 Residual Impacts

8.8.1 Residual impacts include net loss of 56.1 ha of shrubland habitat. In compensation, 40 ha of turfgrass and 967 new trees would be planted and 1.6 ha of new pond area would be created within the golf course. Due to the low ecological value of the shrubland habitat, the evidence from the existing golf course that biodiversity was increased where shrubland was replaced, and the range of mitigation measures to be implemented, the residual impacts of shrubland loss are considered acceptable.

8.9 EM&A Requirements

8.9.1 Since no mitigation is required for loss of habitat and vegetation, no monitoring is required for flora. Monitoring of transplanted and newly planted trees will be conducted by the landscape contractors.

8.9.2 Generally, the water quality monitoring programme for the existing course will be adopted for the proposed third course. A comprehensive monitoring manual and

programme will be designed to ensure cost effective monitoring.

8.9.3 Additional EM&A requirements are listed below and described in detail in the Environmental Monitoring and Audit Manual.

- monitoring the effectiveness of demarcated stream buffer zones
- monitoring the aquatic fauna in streams, focusing on *C. trifasciata*.
- monitoring stream protection during bridge construction

8.10 References

- Ades, G.W.J. 1999. The species composition, distribution and population size of Hong Kong bats. *Memoirs of the Hong Kong Natural History Society* 22: 183-209.
- AFCD. 2004. Field Guide to the Freshwater Fish of Hong Kong.
- AXIS Environmental Consultants Ltd. 1994a. *Kau Sai Chau Development – Stage 2 Environmental Impact Assessment*. Hong Kong Jockey Club.
- AXIS Environmental Consultants Ltd. 1994b. *Kau Sai Chau Development – Additional Ecological Survey*. Hong Kong Jockey Club.
- Bascombe, M.J., Johnston, G. and Bascombe, F.S. 1999. *The butterflies of Hong Kong*. Academic Press, London.
- Carey, G.J., Chalmers, M.L., Diskin, D.A., Kennerley, P.R., Leader, P.J., Leven, M.R., Lewthwaite, R.W., Melville, D.S., Turnbull, M. and Young, L. 2001. *The Avifauna of Hong Kong*. Hong Kong Bird Watching Society, Hong Kong.
- Chan, B.P.L. 1999. Yaoshanicus no more, but Nicholsicypris galore! *Porcupine!* 19, page 18.
- Chan, B.P.L. 2001. Sustainability and Biodiversity: the Impact, Alternative Design and Prospects of Restoration of Channelized Lowland Streams in Hong Kong. Unpublished Ph.D. thesis. The University of Hong Kong, Hong Kong.
- Chong, D.-h. and Dudgeon, D. 1992. Hong Kong stream fishes: an annotated checklist with remarks on conservation status. *Memoirs of the Hong Kong Natural History Society* 19: 79-112.
- Corlett, R.T. 1996. Characteristics of vertebrate-dispersed fruits in Hong Kong. *Journal of Tropical Ecology* 12: 819-833.
- Corlett, R.T. 1998. Frugivory and seed dispersal by birds in Hong Kong shrubland. *Forktail* 13: 23-27.
- Corlett, R. T. and I. M. Turner. 1997. Long-term survival in Tropical Forest Remnants in Singapore and Hong Kong. Pages 333-346 in Laurance, W. F. and R. O. Bierregaard, Jr. (eds.) *Tropical Forest Remnants; Ecology, Management, and Conservation of Fragmented Communities*, Univ. of Chicago Press, Chicago & London.
- Dahmer, T. D. 2001a. Feral dogs and civet mortality on Kau Sai Chau, Sai Kung, Hong Kong. *Porcupine!* 24:16-18.
- Dahmer, T. D. 2001b. Morphometrics and food habits of Wild Boar (*Sus scrofa*) in southeast Hong Kong. *Mem. Hong Kong Nat. Hist. Soc.* 24:199-204.
- Dahmer, T. D. 2002a. Feral/stray dogs and civet mortality on Kau Sai Chau, 2001-2. *Porcupine!* 27:7-9.
- Dahmer, T. D. 2002b. Pipistrelles use bat roost boxes on Kau Sai Chau. *Porcupine!* 27:10-11.
- Dudgeon, D. and Corlett, R. 1994. *Hills and Streams - An Ecology of Hong Kong*. Hong Kong University Press, Hong Kong.
- Dudgeon, D. and Corlett, R. 2004. *The Ecology and Biodiversity of Hong Kong*. Friends of the Country Parks & Joint Publishing, Hong Kong.
- Ecosystems Ltd. 2005. *Kau Sai Chau Golf Centre – Ecological Monitoring Report for July 2004 to June 2005*. Hong Kong Jockey Club.
- Hammond, N. and Pearson, B. 1993. *Birds of Prey*. Hamlyn, London.
- Hong Kong Bird Watching Society. 2001. *Monthly Waterfowl Counts Data April 2000 – March 2001: Waterfowl Monitoring at the Mai Po Inner Deep Bay Ramsar Site*. Hong Kong Bird Watching Society, Hong Kong.
- Hyder Environmental Limited. 1996. *Kau Sai Chau Golf Centre Operation Phase Environmental Monitoring and Audit Report: August – October 1996*. Hong Kong Jockey Club, Hong Kong.
- Karsen, S.J., Lau, M.W.N. and Bogadek, A. 1998. Hong Kong Amphibians and Reptiles. Urban Council, Hong Kong.
- Kwok, H.K. and Corlett, R.T. 1999. Seasonality of a Forest Bird Community in Hong Kong, South China. *Ibis* 141: 70-79.
- Kwok, H.K. and Corlett, R.T. 2000. The bird communities of a natural secondary forest and a *Lophostemon confertus* plantation in Hong Kong, South China. *Forest Ecology and Management* 130: 227-234.
- Kwok, H.K. and Dahmer, T.D. 2001. Bird communities on cultivated lands in Hong Kong. *Memoirs of the Hong Kong Natural History Society* 24: 181-188.
- Kwok, H.K. and Dahmer, T.D. 2002. Bird community on hill fire maintained grassland. *Memoirs of the Hong Kong Natural History Society* 25: 111-116.
- Kwok, H.K. 2002. Vertical stratification of forest bird community in Tai Po Kau Nature Reserve. *Memoirs of the Hong Kong Natural History Society* 25: 161-167.
- Kwok, H.K. and Lock, N.Y. 2002. Bird community in a young lowland forest in Hong Kong. *Memoirs of the Hong Kong Natural History Society* 25: 169-174.
- Lau, M.W.N. and Dudgeon, D. 1999. Composition and distribution of Hong Kong Amphibian fauna. *Memoirs of the Hong Kong Natural History Society* 22: 1-80.
- Leven, M.R. 2000. *Shrubland Birds in Hong Kong: Community Structure, Seasonality and Diet*. Unpubl. PhD thesis, University of Hong Kong, Hong Kong.

- Lock, N.Y. 2000. *The Ecology of Urban Birds in Hong Kong*. PhD Thesis of The University of Hong Kong, Hong Kong.
- MacArthur, R.H., MacArthur, J.W. and Preer, J. 1962. On bird species diversity. *The American Naturalist* 96: 167-174.
- McGown, C. 1997. *The Raptor and the Lamb: predators and prey in the living world*. Henry Holt, New York.
- Melville, D. 1999. Alien alert! *About Life* 1999(Summer): 2.
- Morton, B. and Morton, J. 1983. *The Sea Shore Ecology of Hong Kong*. Hong Kong University Press, Hong Kong.
- Pei, J.C.K., Lai, Y.C. and Suen, K.Y. 2002. Present status of larger mammals in Hong Kong's country parks and their conservation concerns. pp. 97-122 in *Proceedings of the Workshop on the Status and Conservation of Hong Kong's Wild Animals and Plants*. The Wildlife Conservation Foundation, Hong Kong.
- Suen Kai-yuen. 2002. Lost Mammals. Guo Liang Hui New Shiye Co. Ltd., Chai Wan, Hong Kong, 361pp.
- Tsim, S.T., Lee, W.H., Cheung, C.F., Chow, K.L., Ma, Y.N. and Liu, K.Y. Population and breeding ecology of White-bellied Sea-Eagles in Hong Kong. p. 248-261 in Turnbull, M. and Ma, C.K.W (eds.) *Hong Kong Bird Report 1999/2000*. The Hong Kong Bird Watching Society, Hong Kong.
- Wang, S. 1998. China Red Data Book of Endangered Animals: Mammalia. Science Press, Beijing.
- Wilson, D.E. and Reeder, D.M. 1992. *Mammal species of the world: A taxonomic and geographic reference*. Smithsonian Institution Press, Washington & London.
- Wilson, K.D.P. 2004. *Field Guide to the Dragonflies of Hong Kong*. Agriculture, Fisheries and Conservation Department, Hong Kong.
- Xing, F. W. S.C. Ng and L.K.C. Chau. 2000. Gymnosperms and angiosperms of Hong Kong. *Memoirs of the Hong Kong Natural History Society*. 23: 21-136.
- Yiu, V. 2004. *Field Guide to Butterfly Watching in Hong Kong*. Hong Kong Lepidopterist's Society, Hong Kong.
- Yam R.S.W. 2003. Atyid Shrimps in Hong Kong Streams. *Porcupine!* 29, pp. 15-16.
- Yam, R.S.W., & Cai, Y. (2003) *Caridina trifasciata*, a new species of freshwater shrimp (Decapoda: Atyidae) from Hong Kong. *Raffles Bulletin of Zoology* 51: 277-282.
- Young, J.J. and Reels, G.T. 1998. A brief note on the distribution and conservation of Birdwing butterflies in Hong Kong. *Porcupine!* 17:10.
- Yue, P. and Chen, Y. (1998). *China Red Data Book of Endangered Animals: Pisces*. Science Press. Beijing.
- Zhao, E.M. 1998. China Red Data Book of Endangered Animals: Amphibia and Reptilia. Science Press, Beijing.
- Zheng, G.M. and Wang, Q. S. 1998. China Red Data Book of Endangered Animals: Aves. Science Press, Beijing.