8 MARINE ECOLOGICAL IMPACT ASSESSMENT

Introduction

8.1 This section of the report identifies and evaluates the nature and extent of potential impacts arising from the construction and operation of the Project on marine ecological resources.

Environmental Legislation, Policies, Plans, Standards and Criteria

8.2 This Section makes reference to the following guidelines, standards, documents and the HKSAR Government ordinances and regulations when identifying habitats and species of ecological importance and evaluating ecological impacts:

- Wild Animals Protection Ordinance (Cap. 170)
- Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586)
- Marine Parks Ordinance (Cap. 476) and subsidiary legislation
- Town Planning Ordinance (Cap. 131)
- Hong Kong Planning Standards and Guidelines (HKPSG) Chapter 10
- Environmental Impact Assessment Ordinance (Cap. 499)
- EIAO Guidance Note Nos. 6/2002, 7/2002
- The IUCN Red List of Threatened Species

Wild Animals Protection Ordinance (Cap. 170)

8.3 Under the Wild Animals Protection Ordinance (Cap. 170), designated wild animals are protected from being hunted, whilst their nests and eggs are protected from injury, destruction and removal. All marine cetaceans and sea turtles are protected under this Ordinance. The Second Schedule of the Ordinance, which lists all the animals protected, was last revised in June 1992.

Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586)

8.4 The Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586) provides protection for certain plant and animal species through controlling or prohibiting trade in the species. Certain types of corals are listed in Schedule 1 of the Ordinance, including Blue coral (*Heliopora coerulea*), Organ pipe corals (family Tubiporidae), Black corals (order Antipatharia), Stony coral (order Scleractinia), Fire corals (family Milleporidae) and Lace corals (family Stylasteridae). Cetacea including whales, dolphins, porpoises, and rorquals are also listed under Schedules 1 & 2 of the Ordinance. The import, export and possession of scheduled corals, no matter dead or living, is restricted.

Marine Parks Ordinance (Cap. 476) and Subsidiary Legislation

8.5 The Marine Parks Ordinance (Cap. 476) and Subsidiary Legislation allows for designation, control and management of marine parks and marine reserves through regulation of activities therein to protect, conserve and enhance the marine environment for the purposes of nature conservation, education, scientific research and recreation. The Ordinance came into effect on 1 June 1995. The Authority administering marine parks and reserves is the Country and Marine Parks Authority.

Town Planning Ordinance (Cap. 131)

8.6 The amended Town Planning Ordinance (Cap. 131) provides for the designation of coastal protection areas, Sites of Special Scientific Interest (SSSIs), Conservation Area, Country Park, Green Belt or other specified uses that promote conservation or protection of the environment. The authority responsible for administering the Town Planning Ordinance is the Town Planning Board.

Hong Kong Planning Standards and Guidelines (HKPSG) Chapter 10

8.7 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 describes enforcement issues. The appendices list the legislation and administrative controls for conservation, other conservation related measures in Hong Kong and government departments involved in conservation.

Environmental Impact Assessment Ordinance (Cap. 499)

8.8 Annex 16 of the TM-EIA sets out the general approach and methodology for assessment 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 habitat and ecological impact.

EIAO Guidance Note Nos. 6/2002, 7/2002

8.9 EIAO Guidance Note No. 6/2002 clarifies the requirements of ecological assessments under the EIAO. EIAO Guidance Note No. 7/2002 provides general guidelines for conducting ecological baseline surveys in order to fulfill requirements stipulated in the TM-EIA.

The IUCN Red List of Threatened Species

8.10 The IUCN Red List of Threatened Species is a comprehensive inventory of the global conservation status of plants and animals. It uses a set of criteria to evaluate the extinction risk of thousands of species and subspecies. These criteria are relevant to all species and all regions of the world. There are seven Categories of Threat in the IUCN Red List System: Extinct, Extinct in the Wild, Critically Endangered, Endangered, Vulnerable, Near Threatened and Least Concern. A species is listed as threatened if it falls in the Critically Endangered, Endangered or Vulnerable categories.

Assessment Methodology

8.11 The marine ecological impact assessment was conducted in accordance with the Technical Memorandum of Environmental Impact Assessment Ordinance (TM EIAO) Annex 8 and Annex 16. In accordance with the EIA Study Brief, the Assessment Area for the purpose of the marine ecological impact assessment should be the same as the Assessment Area for water quality impact assessment.

8.12 For this EIA study, the ecological characteristics of the Assessment Area (covering Northwestern, Western Buffer, Southern, Victoria Harbour, Eastern Buffer and Junk Bay WCZs) were elucidated via a desktop study of literature. A review of the ecological information of the Assessment Area indicates that the existing data is extensive and comprehensive. For the HATS EEFS (Environmental Protection Department (EPD, 2004), a comprehensive literature review as well as ecological surveys to fill in identified data gaps including juvenile fish sampling, subtidal and intertidal survey, and coral survey were conducted. Additionally, more recent relevant journals and publication are used in this EIA report to supplement the marine ecological baseline information in the Assessment Area. Therefore, no information gap is identified and no further field surveys are considered necessary for this EIA study. A list of the key relevant literature is presented at the end of this section.

Description of Environment

8.13 The ecological baseline condition of the Assessment Area is described below, comprising:

- Benthic community
- Coral community
- Intertidal community
- Marine mammals (Chinese White Dolphin, Finless Porpoise), Green Turtle and Horseshoe crab
- Artificial reef (ARs) at Sha Chau and International Airport
- Sha Chau and Lung Kwu Chau Marine Park, Cape D' Aguilar Reserve and SSSIs

8.14 A location map of the ecological resources within the Assessment Area is shown in **Figure 8.1a** and **Figure 8.1b**. Photographs of representative habitats and species of conservation concern are

shown in **Appendix 8.3**.

8.15 Based on the findings from water quality modeling (**Figure 5.9**, **Figure 5.10**, **Figure 5.13** and **Figure 5.14**), the potential zone of influence by this Project would be Victoria Harbour and Western Buffer WCZs. The Key ecological sensitive receivers within these two WCZs would include coral community and Chinese White Dolphin.

Benthic Community

8.16 Recent information on the benthic community in Hong Kong can be found from the Agriculture, Fisheries and Conservation Department (AFCD) study in 2002 conducted by the City University. **Figure 8.2** shows the 120 sampling stations in this AFCD study during both wet season (June-July 2001) and dry season (November-December 2001). A summary of main species in the Assessment Area is presented in **Table 8.1**. The distribution of marine benthic organisms (density $\geq$ 100m^2) is presented in **Table 8.2**. The Assessment Area is separated into Northwestern (NW), Western Buffer (WB), Victoria Harbour (VH), Eastern Buffer (EB), Junk Bay (JB) and Southern (SW) WCZs.

Table 8.1 Occurrence of species recorded of main species in 120 sampling stations in summer and winter survey.

Species	**NW**		**WB**		**VH**		**EB**		**JB**		**SW**	
	S	W	S	W	S	W	S	W	S	W	S	W
Polychaete												
Mediomastus sp.	X	X	X	X	X	X	X	X	X	X	X	X
Sigambra hanaokai	X	X	X	X	X	X	X	X	X	X	X	X
Aglapphamus dibranchis	X	X	X	X	X	X	X	X	X	X	X	X
Sigambra sp.	X		X		X		X		X		X	
Cossurella dimorpha	X		X								X	
Ophiodromus angustifrons	X	X	X	X	X	X	X	X			X	X
Paraprionospio pinnata	X	X	X	X	X			X	X	X	X	X
Prionospio malmgreni	X	X	X	X	X	X	X	X	X		X	X
Prionospio ehlersi		X		X				X		X		X
Otopsis sp.		X		X		X		X				X
Crustacean												
Callianassa japonica	X		X				X		X		X	
Neoxenophthalmus obscurus	X	X	X	X			X	X		X	X	X
Echinoderm												
Amphiodia obecta	X	X	X	X			X	X			X	X
Sipunculan												
Apionsoma trichocephalus	X	X	X	X			X	X			X	X

Key: "X" – present in WCZ; "S" – recorded in summer season; "W" recorded in winter season. Table is summarized from AFCD, 2002

Table 8.2 Distribution of marine benthic organisms (density > 100m^2) in summer and winter survey

Species	NW		WB		VH		EB		JB		SW	
	S	W	S	W	S	W	S	W	S	W	S	W
Polychaete												
Neanthes sp.					X							
Naineris sp					X							
Prionospio malmgreni		X		X				X				X
Schistomeringos rudolphi					X							
Oligochaete												
Thalassordilides gurwitchi					X	X						
Bivalve												
Potamocordbula laevis	X											
Ruditapes philippinarum	X				X							
Crustacean												
Maera serratipalma						X						
Ceradocus capensis					X							

Key: "X" – present in WCZ; "S" – recorded in summer season; "W" recorded in winter season. Table is summarized from AFCD, 2002

8.17 From this AFCD (2002) study, polychaete annelids, crustaceans, and bivalves were the most abundant groups recorded in the Assessment Area comprising 46.9%, 18.2% and 11.1% of the total species respectively and they are well presented components of the soft bottom community (Civil Engineering Department CED, 1995). Most species are common in this region, as they are reported in Huang's (1994) bibliography of marine animals in South China Sea. These species do not contribute significantly to delineation of community pattern (Clarke and Warwick, 2001). A summary of this AFCD (2002) benthic study findings of the Assessment Area are presented below:

- The common, ubiquitous species included the polychaete *Mediomastus* sp., *Sigambra hanaokai, Aglaphamus dibranchis, Prionospio malmgreni, Paraprionospio pinnata, Ophiodromus anustifrons, Prionospio ehlersi* and *Otopsis* sp., the crustacean (crab) *Neoxenophthalmus obscures*, the echinoderm (brittle star) *Amphiodia obtecta*, and the sipunculan *Apionsoma trichocephalus*. Some of these species are known to be adapted well to organic pollution.

- Most of the sediments in the Assessment Area, except the area near the Sha Chau and Lung Kwu Chau Marine Park and areas near Soko Island, are composed of very fine sand and silt or clay (AFCD, 2002) and are unlikely to provide high interstitial niches for benthic infauna (Shin, 1998). Wade (1972) provides an evaluation framework of a diverse community structure in the tropics which have high values in terms of species richness (d) over 10, diversity (H') over 3 and evenness (J) over 0.8. According to AFCD (2002) benthic study, the community diversity is presented in **Table 8.3**.

Table 8.3 Community diversity

WCZs	Station	d		H'		J	
		S	W	S	W	S	W
Northwestern Waters	9	3.45	1.90	0.94	1.43	0.31	0.80
	10	3.67	5.86	1.63	2.51	0.56	0.72
	11	5.18	8.03	1.30	1.94	0.17	0.48
	12	3.43	**10.21**	2.26	3.23	0.88	0.80
	13	5.89	3.52	2.56	2.30	0.80	0.87
	14	5.95	3.83	2.83	2.13	0.86	0.83
	15	6.51	5.91	3.12	3.01	0.93	0.93
	16	6.81	**10.00**	2.73	3.53	0.78	0.89
	17	6.63	6.08	2.25	2.40	0.62	0.67
	18	5.62	8.06	1.53	2.14	0.42	0.54
	19	6.92	9.13	2.64	2.94	0.71	0.74
	20	5.54	4.15	2.69	2.48	0.82	0.97
	21	6.80	7.20	2.66	2.98	0.73	0.83
Southern Waters	22	6.16	5.63	2.61	2.27	0.74	0.62
	23	**11.33**	**10.79**	3.15	3.52	0.74	0.86
	24	**11.54**	**11.43**	3.03	2.96	0.70	0.68
	25	**10.36**	**10.36**	3.13	3.09	0.79	0.76
	26	**10.28**	**10.13**	2.86	2.93	0.67	0.70
	27	9.21	**10.70**	3.29	3.22	0.84	0.79
	28	**10.32**	**10.50**	3.27	3.18	0.80	0.77
	29	9.86	**10.63**	3.10	3.20	0.76	0.76
	30	3.94	4.36	2.43	1.76	0.95	0.58
	31	5.91	7.74	2.85	2.83	0.89	0.77
	32	3.24	7.76	2.24	2.82	0.93	0.76
	33	8.57	**11.00**	2.74	2.77	0.71	0.66
	34	7.64	7.45	2.69	2.61	0.71	0.70
	35	6.46	7.78	2.92	3.00	0.83	0.82
	36	7.87	6.77	2.90	2.85	0.77	0.81
	37	8.03	8.05	3.20	3.01	0.86	0.81
	38	8.27	9.41	3.35	2.75	0.89	0.68
	39	7.67	7.74	3.02	3.27	0.83	0.93
	40	7.84	8.79	2.65	3.35	0.71	0.89
	41	6.02	4.83	2.78	2.56	0.80	0.85
	42	7.32	7.49	3.16	3.14	0.90	0.91
	44	4.80	4.55	2.68	1.93	0.95	0.64
	45	5.45	4.67	2.51	2.57	0.79	0.89
	47	2.91	4.35	1.83	2.59	0.80	0.96
	51	3.60	9.08	1.39	2.82	0.44	0.68
	55	6.59	6.16	2.62	2.79	0.73	0.84
	56	7.95	7.84	2.86	3.10	0.78	0.84
	57	9.11	6.57	3.31	2.94	0.88	0.87
	58	7.64	7.12	3.13	3.10	0.87	0.90
	59	7.23	6.65	2.89	2.84	0.81	0.83
	60	8.26	**10.86**	3.20	3.32	0.89	0.82
	61	9.40	8.20	3.43	3.25	0.91	0.88
	62	8.87	8.51	3.36	3.29	0.88	0.88
	63	6.57	4.44	2.96	2.55	0.88	0.88
	64	9.44	5.85	3.16	2.80	0.82	0.86
	65	5.14	4.79	2.24	2.57	0.70	0.83
	66	6.47	5.40	2.99	2.62	0.90	0.82
	70	8.32	7.68	1.63	1.53	0.42	0.38
Western Buffer	43	4.82	5.53	2.58	2.47	0.88	0.78

WCZs	Station	d		H'		J	
		S	W	S	W	S	W
	46	5.21	6.65	2.65	3.14	0.85	0.97
	48	4.16	3.22	2.19	2.14	0.77	0.97
	49	5.16	6.42	2.66	2.92	0.85	0.88
	50	3.28	4.91	1.82	2.62	0.66	0.91
Eastern Buffer	75	**13.17**	**11.98**	3.50	2.96	0.81	0.68
	80	**12.47**	**12.65**	3.29	3.21	0.75	0.72
Junk Bay	85	5.44	5.04	2.73	2.43	0.87	0.77
Victoria Harbour	52	2.04	3.55	1.14	1.78	0.52	0.67
	53	6.46	5.84	2.35	2.36	0.60	0.63
	54	4.14	4.98	1.23	0.91	0.34	0.25

Key: The bolded value refers to value d>10; the grey shading refers to value>3, the underline value refers to value >0.8. The above data are adapted from AFCD (2002)

- As shown in the table, the Assessment Area generally has d < 10, H' < 3 and J<0.8. Data from this AFCD (2002) study shown that lower species diversity and evenness were observed in Victoria Harbour and Western Buffer WCZs as compared to the eastern and southern waters. The indices thus reflect the response of benthic communities to local hydrographic or water quality conditions. All these areas are thus relatively environmentally disturbed, leading to lower species diversity and evenness in the benthic communities.

- Macro-epifauna comprises larger organisms (typically > 1mm) that tend to live on or in close association with the sediment surface. Trawl surveys were conducted near the Sha Chau and Lung Kwu Chau Marine Park. A total of 69 invertebrate species were recorded including 19 species of crab and 13 shrimp species and the area was considered biologically diverse.

- There were also numerous mollusc species present although in accordance with many other studies conducted in the Northwestern waters, there were few echinoderms.

- For the two WCZs of Southern and Eastern Buffer waters within the Assessment Area, several places such as Soko Islands located to the south of Lantau Island and Tathong Channel have d >10, H' >3 and J> 0.8. These areas support high biodiversity.

- Tathong Channel in Eastern Buffer WCZ, under the strong influence of Victoria Harbour, contained the smallest individuals but had the highest abundance and relatively high species richness. A species, Amphioxus (*Branchiostoma belcheri*), of conservation interest was recorded in this area. In view of ecological importance and zoological interest, amphioxus is now designated as a second priority protection species in China, and an Amphioxus Reserve Area has been established within Xiamen Bay (Yang et al., 1993).

- The Soko Islands in Southern WCZ has the second highest abundance, lower average biomass, but higher overall biomass, and the second highest taxonomic richness. It was also numerically dominated by polychaetes but was supplemented by large numbers of bivalves. The percent of fine sediment particle sizes and Total Organic Carbon values were the lowest.

- A detailed description of the marine species recorded in Sha Chau and Lung Kwu Chau Marine Park has been provided from AFCD (2002). The Sha Chau and Lung Kwu Chau Marine Park had relatively low individuals and biomass compared with the entire Assessment Area. In summer - species 13-33 per 0.5 m^2, individuals 66-220 m^{-2}, biomass 3.66-25.38 g m^{-2}, and winter - species 52-57 per 0.5 m^2, individuals 328-484 m^{-2}, biomass 6.08– 9.88 g m^{-2}. The polychaete *Mediomastus californiensis* was dominant in both seasons. Other species common in summer were the polychaete *Lumbrineris nagae*, *Mediomastus* sp., *Otopsis* sp. and *Aglaophamus dibranchis*, and the bivalve *Potamocorbula laevis*. In the winter, other polychaetes were dominant, including *Paraprionospio pinnata*, *Prionospio malmgreni*, *Prionospio pygmaea*, *Prionospio* sp. and *Sigambra* sp.. However, no rare and protected benthic species were recorded.

- At the SSSI in Sham Wan and Marine Reserve in Cape D' Aguilar, the community diversity of these

areas are considered as low because the species richness d are less than 10.

- All the species recorded from the Assessment Area were common and widespread in Hong Kong.

8.18 Three representative grab samples of the bottom mud were obtained from the southeast of Lung Kwu Chau Island in November 2001 from (CED, 2002). The mud was silty and no macroscopic benthic organisms were encountered.

8.19 "Permanent Aviation Fuel Facility for Hong Kong International Airport, EIA (2002)" by CED has reviewed the findings from "Environmental Monitoring and Auditing for Contaminated Mud Pit IV at East Sha Chau by CED (2001a, 2002) in Northwestern WCZ. The macro-infauna invertebrates surveys were carried out in wet seasons only (May and August, 2001). The results showed that in terms of families present, the annelids (~50%), arthropods (~20%) and molluscs (~15%) were the top three dominant families among the total number of identified families. These three families usually comprised the majority of individuals present. However, the infaunal diversity in this study was low H'<2. These results are consistent with the study findings from AFCD (2002). The benthic macroinvertebrate epi-fauna invertebrates survey was carried out in May, 2001 from "Environmental Monitoring and Auditing for Contaminated Mud Pit IV at East Sha Chau by CED (2002) for the Northwestern WCZ from demersal trawls. Numerous mollusca species, especially gastropod snail and sea slugs (~22%) and crustacean, especially crab (~33%) were the top two dominant species in term of total number of species recorded. However the diversity is still considered to be low (H' <2) in the Northwestern WCZ which may reflect both the naturally-occurring stressors such as periodic fluctuations in the physico-chemical environment associated with Pearl River run-off and anthropogenic impacts such as trawling pressures.

8.20 Apart from the AFCD (2002) marine benthic organisms study, the surveys carried out for the HATS EEFS (EPD, 2004) provided further information on existing marine benthic community. The Study Area of the HATS EEFS WP9 mainly covered the Western Buffer, Victoria Harbour, Junk Bay, Eastern Buffer WCZs and part of Southern WCZ near to the east of Lamma Island, particularly relevant to the present Assessment Area in providing benthic infauna information for this Project. The subtidal benthic field surveys were conducted at Stonecutters Island, Junk Bay, Tathong Channel, North Point, East Lamma Channel and Sandy Bay in September and October 2002 and presented in **Figure 8.3**.

8.21 There was a total of 91 species and 745 individuals of benthic organisms recorded, belonging to seven major taxa (phyla). A summary of findings from the HATS EEFS is presented below:

Abundance

- Polychaetes were the most dominant taxon in Stonecutters Island, East Lamma Channel, North Point, Junk Bay and Tathong Channel, while mollusca was the dominant taxa in North Point (refer to **Table 8.4**.)

Table 8.4 Relative Abundance (%) of Major Taxa at 6 Study Sites

Sites	Polychaeta	Crustacean	Anthozoa	Echinodermata	Mollusca	Others
Stonecutters Island	58.8	17.6	2.9	5.9	8.8	5.9
East Lamma Channel	61.4	19.3	0.0	2.3	3.4	13.6
Sandy Bay	29.5	25.7	5.7	35.2	1.4	2.4
North Point	38.7	23.4	0.0	0.0	38.0	0.0
Junk Bay	75.0	12.5	0.0	0.0	12.5	0.0
Tathong Channel	53.1	6.9	0.0	6.2	0.8	33.1

Data are extracted from HATS EEFS (EPD, 2004)

Biomass

- In terms of biomass (wet weight) **(Table 8.5 refers)**, molluscas were the most dominate species at North Point (95.5%), Junk Bay (66%) and in East Lamma Channel (48.4%), while anthozoa dominated at Stonecutters Island (77.7%) and echinoderms dominated at Sandy Bay (66.2%). Polychaetes dominated only at Tathong Channel (45.7%). These results indicated that in terms of biomass each sampling site was represented by a distinctive benthic community.

Table 8.5 Relative Biomass (%) of Major Taxa in the Study Sites

Sites	Polychaeta	Crustacean	Anthozoa	Echinodermata	Mollusca	Others
Stonecutters Island	3.5	6.3	77.7	2.7	8.2	1.7
East Lamma Channel	3.4	17.9	0.0	0.9	48.4	29.5
Sandy Bay	2.6	24.6	0.0	66.2	6.4	0.2
North Point	2.0	2.5	0.0	0.0	95.5	0.0
Junk Bay	31.6	2.4	0.0	0.0	66.0	0.0
Tathong Channel	45.7	27.8	0.0	16.3	7.3	2.8

Data are extracted from HATS EEFS (EPD, 2004)

Most Dominant Species

- The relative abundance of the five most dominant species from each site is summarized in **Table 8.6**. Although the sites were different in terms of dominant species, it is very clear that the dominant species from each site belongs to the same trophic levels, either filter feeding epifaunal organisms or infaunal deposit feeders.

Table 8.6 Relative Abundance of the 5 Most Dominant Species

Species	Relative Abundance (%)	Species	Relative Abundance (%)
Stonecutter Island		**North Point**	
Sigambra sp.	17.65	*Ruditapes* sp.	43.70
Neoxenophthalmus sp.	8.82	*Corophium* sp.	11.76
Notomastus sp.	8.82	*Naineris* sp.	9.24
Alpheus spp.	5.88	*Glycera* spp.	8.40
Tharyx sp.	5.88	*Prionospio* sp. 2	4.20
East Lamma Channel		**Junk Bay**	
Apionsoma trichocephalus	12.50	*Prionospio* sp.1.	31.25
Glycera spp.	10.23	*Paraprionospio* sp.	18.75
Prionospio sp. 2	6.82	*Aglaophamus* sp. 1	12.50
Notonmastus sp.	5.68	*Corophium* sp.	12.50
Corophium sp.	4.55	*Nassarius* sp.	12.50
Sandy Bay		**Tathong Channel**	
Ophiactis sp.	23.81	*Apionsoma trichocephalus*	33.08
Alpheus spp.	11.90	*Prionospio* sp. 2	8.46
Aglaophamus sp.1	5.71	*Notimastus* sp.	7.31
Lobophytum sp.	4.29	*Glycera* spp.	6.92
Amphioplus spp.	3.81	*Ophionephty* sp.	5.77

Data are extracted from HATS EEFS (EPD, 2004)

- The relative biomass of the five most dominant species from each site is summarized in **Table 8.7**. Again, although the sites were different in terms of dominant species, it is very clear that the dominant species from each site belongs to the same trophic level, either filter feeding

epifaunal organisms or infaunal deposit feeders.

Table 8.7 Relative Biomass of the 5 Most Dominant Species at Each Sampling Site

Species	Relative Abundance (%)	Species	Relative Abundance (%)
Stonecutter Island		**North Point**	
Pteroeides sp.	81.26	*Ruditapes* sp.	95.47
Macoma sp.	7.39	*Eucrate* spp.	1.88
Ophionereis sp.	2.71	*Loimia* spp.	0.77
Nexenophthalmus sp.	2.09	*Naineris* sp.	0.64
Oxyurichthys spp.	1.73	*Glycera* spp.	0.25
East Lamma Channel		**Junk Bay**	
Paphia sp.	46.28	*Nassarius* sp.	65.99
Oxyurichthys spp.	29.27	*Aglaophamus* sp.1	11.50
Xenophthalmus sp.	6.15	*Paraprionospio* sp.	9.27
Eucrate spp.	4.08	*Prionospio* sp.1	8.92
Clorida spp.	3.25	*Corophium* sp.	2.44
Sandy Bay		**Tathong Channel**	
Echinogorgia sp.	90.80	*Marphysa* sp.	13.26
Lobophytum sp.	4.35	*Marphysa* sp.	11.25
Comanthus sp.	2.75	*Glycera* spp.	9.99
Ophionereis sp.	0.45	*Clorida* spp.	8.65
Scalopdia sp.	0.32	*Acoetes* spp.	8.18

Data are extracted from HATS EEFS (EPD 2004)

Comparison among Six Sites

- In order to get a whole picture of community diversity, **Table 8.8** shows the findings of means for number of individuals, weight of biomass, number of family and genera of each grab and the mean of species diversity (H') and richness (d). All of the sites are considered to have low ecological value and community diversity, based on the criteria from Wade (1972).

Table 8.8 Community Structure of 6 Study Sites

	Stonecutter Island	East Lamma Channel	Sandy Bay	North Point	Junk Bay	Tathong Channel
Mean number of individual /grab	2.83	5.87	14.00	22.83	5.33	17.33
Mean weight of biomass g/grab	2.11	1.10	59.84	31.87	0.05	0.70
Mean number of families / grab	2.50	4.40	5.93	8.17	2.67	7.20
Mean number of genera /grab	2.50	4.40	5.93	8.17	3.00	7.20
H'	0.339	0.541	0.638	0.724	0.442	0.608
D	0.345	0.605	0.659	0.814	0.444	0.619

Data are extracted from HATS EEFS (EPD 2004)

Stonecutters Island

- The infaunal benthic community at Stonecutters Island is characterized by low abundance, low biomass, and low biodiversity. The community is dominated by common small polychaetes and anthozoans in terms of the number, but over dominated by one anthozoan, *Pteroeides* sp., which is found in other soft benthic environment.

East Lamma Channel

- The infaunal benthic community is characterized by low abundance, very low biomass, and low biodiversity. The community is dominated by small polychaetes and mollusca. Most of these species are small individuals with very little conservation value.

Sandy Bay

- The infaunal benthic community in Sandy Bay is characterized by relatively high abundance, very high biomass, and high biodiversity. The infaunal community is equally represented by common polychaetes, crustaceans and echinoderms in terms of number, but over dominated by echinoderms in terms of biomass. Again, large variation in benthic community structure was detected among stations at this site.

North Point

- The infaunal benthic community is characterized by the highest abundance, highest biomass, and the highest biodiversity among the sites. The community is dominated by common polychaetes and mollusca. The most dominant species is molluscs *Ruditapes* sp., which is a commercial species, although the conservation value may not be high.

Junk Bay

- The infaunal benthic community is characterized by very low abundance, low biomass and low biodiversity. The community is dominated by small opportunistic polychaetes and mollusca. All recorded infaunal species have very little conservation value. The marine benthic environment is a relatively disturbed environment due to human activities.

Tathong Channel

- The infaunal benthic community is characterized by relatively high abundance, low biomass and high biodiversity. The infaunal benthic community is dominated by small opportunities species of polychaetes with very low conservation value.

8.22 A benthic grab survey was conducted along the northwest coast of Junk Bay (Chiu Keng Wan) for "Further Development of Tseung Kwan O Feasibility Study EIA (2005)" from Civil Engineering and Development Department CEDD (2005) and focused on the soft substrata seabed area in September 2004 (wet season). The sampling locations are presented in **Figure 8.4**. Analysis of the ecological attributes of benthic assemblages from each of the stations was conducted to include calculation of diversity (H'), evenness (J) and disturbance status (W). A summary of the survey findings is presented in **Table 8.9** as discussed below.

Table 8.9 Summary of Benthic Survey Results

Attribute	Station 1*	Station 2*	Station 3*	Overall
Physical				
Depth	8.1m	9.2m	10.2m	-
Sediment type	Silty mud / shell debris/ sand / gravel	Silty mud / shell debris	Silty mud / shell debris	-
Abundance				
No of individuals	230	188	187	605
Actinaria	-	0.53%	-	0.17%
Nemertea	2.61%	0.53%	0.53%	1.32%
Polychaeta	69.93%	93.58%	88.75%	83.14%
Sipunculida	4.35%	2.66%	-	2.48%
Mollusca	-	-	5.35%	1.65%
Crustacea	22.59%	1.59%	4.27%	10.41%
Phoronida	-	1.06%	0.53%	0.50%
Echinodermata	0.43%	-	-	0.17%
Chordata	-	-	0.53%	0.17%
Biomass (wet wt.)	1.14g	1.00g	1.69g	3.83g
Actinaria	-	1.00%	-	0.26%
Nemertea	4.42%	1.00%	0.59%	1.83%
Polychaeta	58.77%	81.00%	38.46%	55.76%
Sipunculida	3.54%	3.00%	-	1.83%
Mollusca	-	-	21.89%	9.69%

Attribute	Station 1*	Station 2*	Station 3*	Overall
Crustacea	23.89%	12.00%	32.54%	24.61%
Phoronida	-	2.00%	0.59%	0.79%
Echinodermata	8.85%	-	-	2.61%
Chordata	-	-	5.92%	2.61%
Density				
Density of individuals	460 individuals/ m^2	376 individuals/ m^2	374 individuals/ m^2	404 individuals/ m^2 (average)
Density of biomass	2.28 g/m^2	2.00 g/m^2	3.38 g/m^2	2.55 g/m^2 (average)
Community				
Species richness	34 species	30 species	29 species	51 species
Diversity (H')	2.69	2.41	2.37	2.49 (average)
Evenness (J)	0.76	0.71	0.71	0.73 (average)
Disturbance				
W statistic	-0.175	-0.211	-0.059	-0.148 (average)

Data are extracted from "Further Development of Tseung Kwan O Feasibility Study, (CEDD 2005)"

- In total, more than 600 infaunal individuals were enumerated from the grab survey as a whole. Overall, the benthos was numerically dominated by the polychaetes (83.1%). The remaining portion comprised crustaceans (10.4%), sipunculids (2.5%), molluscs (1.7%), nermerteans (1.3%), phoronids (0.5%), echinoderms (0.2%), actinians (0.2%) and chordates (0.2%).

- The polychaetes were the dominant benthic group, represented by a total of 36 species from 22 families. Overall, the Spionidae and Goniadidae were the most represented polychaete families in terms of numerical abundance. These accounted for 46.5% and 20.9% of all polychaetes identified respectively. Of the remaining polychaete families, other relatively well-represented families were the Nephtyidae (7.9%), Cirratulidae (5.0%), Capitellidae (4.6%) and Pilargiidae (2.2%).

- The most numerically abundant species from any group in the benthic survey was also a polychaete being *Pseudopolydora kempi*. Approximately 25% of all benthic animals found were identified as belonging to this species. Another polychaete, which dominated the benthos in terms of numerical abundance, was *Glycinde kameruniana*. Overall, this species comprised 17.4% of all benthic animals found in samples.

- Apart from being enumerated, benthic animals were also weighed to determine their biomass. In terms of biomass, the polychaetes were also the dominant component of benthos. Polychaetes accounted for more than half (55.8%) of the total biomass of the survey's benthos as a whole. In the same way, crustaceans accounted for about a quarter (24.6%) of the biomass. This crustacean biomass was mainly contributed by the crab, *Typhlocarcinus nudus*, which was also the survey's dominant species in terms of biomass. It accounted for 21% of the total biomass despite its overall low numerical abundance of only 10 individuals. Of the polychaetes, *Glycinde kameruniana* was the dominant species in terms of its biomass. It contributed 5.7% of the total overall biomass. Other polychaete species with relatively high abundance in terms of biomass were *Euclymene natalensis* (5.3%) and *Glycera tridactyla* (5.3%). The most numerically abundant species, the polychaete *Pseudopolydora kempi* ranked as the fourth most abundant polychaete in terms of its biomass. Its contribution was 3.7% of the total. Overall, the biomass of the benthos off Chiu Keng Wan was considered to be low (2.55g/m^2) compared to benthic communities examined from elsewhere in Hong Kong.

- Benthic infauna in Junk Bay was mainly dominated by polychaete in terms of abundance and biomass. However, the community diversity was low with H'<3 and J<0.8.

8.23 A summary on benthic community baseline condition within the Assessment Area is presented below:

- Both Victoria Harbour and Western Buffer WCZs support lowest species richness and evenness for benthic invertebrates.

- For Northwestern, Junk Bay and large proportion of Southern and Eastern Buffer WCZ do not support high biodiversity on benthic community.

- However, highest species diversity was recorded in Tathong Channel in Eastern Buffer from AFCD (2002) and HATS EEFS. A species, Amphioxus (*Branchiostoma belcheri*), of conservation interest was recorded in this area. The second higher species richness on benthic community was Soko Island in Southern WCZ.

- The dominant species in Assessment Area were generally polychaetes and mollusca in terms of abundance.

Coral Community

8.24 Coral surveys were performed for the "HATS EEFS" in 2003 at the waters around Junk Bay, North Point, Stonecutters Island, Sandy Bay and East Lamma Channel. The areas surveyed for corals are presented in **Figure 8.5**. A summary of the coral communities and their ecological values are presented below:

Stonecutters Island

- The surrounding natural habitat of the Stonecutters Island outfall had already been heavily disturbed with dense urban and industrial development along the extensively reclaimed coastline. No hard corals were found. A few soft corals were recorded along the southern shore of Tsing Yi, and the nearest significant soft and hard coral community was located near Kau Yi Chau and Green Island. Green Island area did not support assemblages of hard corals but soft corals and gorgonians were abundant and of low diversity (CED 1998). CED (1998) also mentioned that four species of soft coral and gorgonians including the Pink Soft Coral (*Dendronephthya* sp.), Orange Sea Fan (*Echinogorgia complexa*), White Sea Whip (*Euplexaura curvata*) and Purple Sea Whip (*Ellisella gracilis*) were recorded at Green Island and Little Green Island. The seabed was covered by thick mud with little hard substrate and the overall ecological value of the Stonecutters Island waters was considered low.

Ap Lei Chau (in Western Buffer WCZ)

- At Ap Lei Chau, the soft coral coverage is <5%, *Echinomuricea* spp., and *Dendronephthya* spp.

were the two most common soft coral species. Fourteen species of hard corals were recorded with <5% coverage. Faviids were the most abundant. The survey location at Ap Lei Chau had moderate high hard coral diversity but low in both soft and hard coral coverage. The distance between the SCISTW sewage outfall location to the coral is approximately 9.1 km.

East Lamma Channel (in Southern WCZ)

- The northwestern water of Lamma Island had been modified considerably. South Lamma, however, remained relatively undisturbed except busy shipping lanes in the East Lamma Channel. The highest coral coverage was in Luk Chau Wan in comparison with other sites.

- In Luk Chau Wan, there was very little soft coral (<5% cover) in deeper transect and no hard corals were recorded. However, shallow transect recorded 23 species of hard corals with a percentage cover of 25-50%. *Turbinaria peltata* was the most abundant species and the Faviids were also well represented. In Sok Kwu Wan, <5% of soft coral cover and two genera were recorded in deep transect of which *Echinomuricea* was the most abundant. In shallow transect of hard and soft corals cover were <25%. Twenty-two hard corals species were recorded of which *Platygyra acuta* was the most abundant species with the Faviids generally well represented. The coverage and diversity of corals at Luk Chau Wan and Sok Kwu Wan were high.

- In Luk Chau, the deep zone had no hard coral and low numbers of soft corals. The middle zone again had no hard corals, but *Echinomuricea* spp. dominated the soft coral community with a percent cover <25%. Hard and soft corals were recorded from the shallow transects with both having a percent cover of <5%. *Dendronephthya* spp. were the most abundant soft coral taxa and of the seven species of hard corals recorded, *Plesiastrea vesipora* was the most abundant.

Sandy Bay Area (in Western Buffer WCZ)

- The Sandy Bay area is a highly disturbed environment with recreated shoreline habitats. From spot-check dives to a maximum depth of 12m, both hard coral (14 taxa) and soft coral (5 taxa) were observed from this survey located at Sandy Bay Area. The most ubiquitous taxa were the soft corals *Echinomuricea* spp. and the bryozoans *Schizoporella errata*.

- In east Sandy Bay, there was little soft coral cover (<5%) and no hard coral recorded. Only small isolated *Echinomuricea* colonies were observed. Nine hard corals species were observed in shallow transect with <5% cover. *Psammocora superficialis* and *Porites lobata* were the most abundant species and the Faviids were also well represented.

- In west Sandy Bay, at both deep and middle transects, soft corals were present and had a percentage cover 10-50%. Seven genera were recorded with *Echinomuricea* spp. being dominant. At a shallow depth zone, soft corals were present with a percentage cover <10% with *Echinomuricea* spp. again being the most abundant taxa; 11 hard coral species with <5% cover of which Faviids were the most abundant hard corals.

- The percentage cover for soft corals in Sandy Bay was low but medium in West Sandy Bay. However the percentage cover for hard corals was low for Sandy Bay Area. The species diversity was low compared with East Lamma. The distance between the SCISTW sewage outfall location to the coral is approximately 5.8 km.

North Point (in Victoria Harbour WCZ)

- The coastline of North Point had been modified heavily due to extensive urban development. The water near North Point is a major navigation channel with high levels of marine traffic disturbance. No hard and soft coral communities were found from this study.

Junk Bay (in Junk Bay WCZ)

- Coral surveys covered east Joss House Bay, west Joss House Bay, east Junk Bay and west Junk Bay.

- From spot-check dive, 21 hard coral and 8 soft coral taxa were recorded. The most ubiquitous taxa were the hard coral *Cyphastrea* spp., the soft coral *Echinomuricea* spp.. The best area were Junk Bay for the soft coral communities and the shallow water of Joss House Bay and north-west Tung Lung Chau for the reasonably diverse but low cover hard coral community.

- In east Joss House Bay, 23 species of hard corals were recorded with a percentage cover of 10-25% in shallow transect. Of these hard corals, *Platygyra acuta* was the most abundant species and the Faviids in general were well represented.

- In west Joss House Bay, the soft corals recorded were <5% coverage of which isolated *Dendronephthya* colonies were observed. For shallow transect, 8 species of hard corals were recorded with a percentage cover <5% of which *Cyphastrea seralia* was the most abundant species.

- In east Junk Bay, with a deeper transect of which the soft corals were recorded <5% coverage; for middle transect soft corals coverage is 25-50% of which 6 genera present with *Echinomuricea* spp. being dominant. At shallow depth zone, soft corals were present with 10-25% cover with *Echinomuricea* spp. again being the most abundant taxa. One colony of *Acanthastrea echinata* was also observed on shallow transect.

- In west Junk Bay, for middle and deep transects of soft corals were recorded 25-50% coverage. Seven species of soft corals were recorded of which *Echinomuricea* spp. being dominant. At the shallow depth zone soft corals were present <10% coverage with *Echinomuricea* spp. again being the most abundant taxa. Within shallow area, 8 hard corals species were recorded with <5% coverage. *Goniopora stuchburyi* was the most abundant hard coral in this area.

East Hong Kong (near Cape Collinson in Eastern Buffer WCZ)

- Near Cape Collinson, in deep and middle depth transect, *Echinomuricea* spp. was the dominant taxa and the soft corals cover were between 10-50%. Within the shallow depth zone, the soft coral community was much more developed and diverse and the colonies were larger than those in deeper water. Seafans, gorgonians and other soft coral were recorded with a percentage cover of 25-50%. Seven species of hard coral were recorded in shallow transects with *Goniopora stuchburyi* being abundant, however, hard coral colonies were scattered with low percentage cover (<5%).

South Tung Lung Chau (In Eastern Buffer WCZ)

- In south Tung Lung Chau, both deep and middle transect showing soft coral coverage was low (<5%) and 4 genera present with *Echinomuricea* spp. being abundant. In shallow depth, soft corals were present but in very low numbers; 4 species of hard corals were recorded, but the colonies were scattered and percentage cover was low (<5%).

North Tung Lung Chau (in Easter Buffer WCZ)

- In north Tung Lung Chau, <5% of soft corals cover was recorded in both middle and shallow transect with *Echinomuricea* spp. only present in very low number. Seven hard coral species were recorded in shallow transect of which 10-25% cover and genus Favites were dominant.

8.25 The "Further Development of Tseung Kwan O Feasibility Study, EIA (2005)" provided more information for the Junk Bay WCZ in Chiu Keng Wan. The findings are summarized below:

- The survey method employ the Rapid Ecological Assessment techniques with a total 200m^2 of

belt transect at three different water depths (shallow, middle and deep) in September 2004.

- The survey results shown that hard coral was sparsely covered along the entire Chiu Keng Wan coast in all depth zones. Hard coral covers did not reach higher than 1% cover in any of the transects. Hard corals were typically small, of encrusting growth and attached to bedrock. In all, the surveys identified 8 species of hard coral from the Chiu Keng Wan coast namely *Goniopora strtchburyi, Plestiastrea versipora, Psammocora superficialis, Oulastrea crispate, Favites pentagona, Favia cf. favus, Turbinaria peltata* and the ahermatypic *Tubastrea* sp..

- The cover of soft coral was also generally low, ranging from 0-15%. The highest soft coral cover of 10-15% was found at the South Chiu Keng Wan coast and supported 2 soft corals and 4 gorgonian seawhip / seafan corals. Soft corals were *Dendronephthya* sp. and *Cladiella* sp.. The gorgonians were *Echiomuricea* sp., *Menella* sp. and *Eulexaura* sp.. No black corals were found during the surveys.

8.26 For the "Peng Chau Sewage Treatment Works Upgrade EIA (2004)" coral surveys were conducted in April and June 2001 at the Northwest of Peng Chau and around whole Tai Leng Island. The survey findings are summarized as below. The result findings from the verification survey in February 2003 had no significant changes compared with earlier surveys in April and June 2001.

- East of Tai Leng Island: the total live hard coral coverage was <5%. A total of 13 hard coral species were recorded, with the dominant species *Favites pentagona, Platygyra* spp, *Cyphastre* sp. and *Leptastrea purpurea*. Low level of partial mortality was exhibited by faviid corals, particularly *Cyphastrea* sp.. However, the majority of corals colonies appeared healthy. Numberous colonies of *Cyphastrea* sp. and *Platygyra* spp. were of large size (>25 cm diameter).

- North of Tai Lei Island: Isolated hard coral colonies were recorded on the hard boulder substratum including *Favites pentagona, Platygyra* spp., *Cyphastrea* sp., *Plesiatrea versipora* and *Goniopora columna.* Colonies of the soft coral *Dendronephytha* sp. and one gorgonian seawhip, *Euplexaura* sp., were recorded.

- Northwest of Tai Lei Island: No coral was recorded.

- Southeast of Tai Lei Island: The community Perna and bryozoans dominated the shallow boulder substratum; 5 hard corals were recorded of which faviids being dominant in Oceanway (2001b).

8.27 A coral survey conducted in 27 April 2003 for the "Peng Chau Helipad EIA (2005)" recorded no live coral. A dead skeletal coral *Goniopora* sp. was recorded along Peng Chau coastline.

8.28 A dive survey was conducted for the "Construction of Lung Kwu Chau, Jetty EIA (2002)" between the period February 2001 and February 2002 at southeast bay of Lung Kwu Chau. It was noted that the waters in the bay were highly turbid making the area especially unsuitable for hermatypic corals. The salinity of marine waters at Lung Kwu Chau was also heavily influenced by discharge from the Pearl River. Common blue coloured gorgonian short seawhip soft coral (*Euphexaura* sp.) was discovered growing attached to the shipwreck structure past the north of the bay. Also attached to the shipwreck were 2 colonies of the ahermatypic coral *Tubastrea* sp.. These were both dead. The same blue coloured *Euphexaura* sp. gorgonians were also observed growing on rusting steel bars in the southern section of the bay of the existing jetty. These colonies were small and numbered only 6 in total. No scleractinian corals were encountered within the bay.

8.29 Coral community surveys for the "Castle Peak Road Improvement between Area 2 and Ka Loon Tsuen, Tuen Wan Design and Construction Consultancy EIA (2001)" from HD (2001) were conducted in June 2001 along the coastal area in Castle Peak Road near Tsing Lung Tau and Dragon Beach. The results of the surveys are described below:

<u>Sham Tseng (East)</u>

- A species of ahermatypic cup-coral was recorded (positive identification not presently available

but thought to be either *Balanophyllia* or *Phyllangia* sp.). The percentage cover along transect was low (<1%), and a pale blue gorgonian (*Euplexaura* sp.) was recorded. Another zooxanthellate scleractinian species *Oulastrea crispate* was recorded at 2 m depth. The cup coral and octocorals (gorgonians and *Dendronephthya* spp.) were most abundant at the shallow depths of 2 and 5 m. The very common and widespread gorgonian *Echinomuricea* sp. was also recorded at 2 m depth. In summary, 2 hard coral species were recorded, *Oulastrea crispate* and *Balanophyllia* or *Phyllangia* sp. which are common and widespread in Hong Kong.

Sham Tseng (West)

- The same hard and octocorals as recorded at the Sham Tseng East Site were also recorded at Sham Tseng West. The abundance was much lower at all depths surveyed. Isolated sea-pens (*Virgularia* or *Pteroeides sp.*) were recorded.

Tsing Lung Tau

- An unknown isolated cup-coral was recorded. Pale blue gorgonian *Euplexaura sp.* was recorded as a common species. Occasional small *Dendronephthya* sp. colonies, encrusting sponges, the old sea-pen and a colony of the scleractinian species *Oulastrea crispate* were recorded. In summary, 2 hard coral species were recorded, *Oulastrea crispate* and *Balanophyllia* or *Phyllangia* sp. which are common and widespread in Hong Kong. There were 3 octocoral species (*Euplexaura* sp., *Dendronephthya* sp. and sea pens) present along the coastline.

8.30 AFCD (2004) conducted a study of "Ecological Status and Revised Species Records of Hong Kong's Scleractinian Corals. Underwater surveys were conducted around Hong Kong's coastline during 2001 to 2002. The study areas comprised south-eastern part of Lantau, south Lamma, south-eastern of Hong Kong Island, Sung Kong Island, Beaufart Island and Po Toi Island. The sampling sites are presented in **Figure 8.6**.

8.31 The AFCD (2004) report has summarized five community types in the study area and are discussed below:

Community A: Platygyra – Favia community

- Key corals with high fidelity to this community included: *Platygyra carnosis, P. acuta, Favia lizardensis, F. veroni, Goniopora labata, Favites halicora, F. maritime, F. danae, Echinophyllia aspera* and *Lithophyllon undulatum.*

- Community A had the highest average cover of hard corals (31-50%) among the five community types, moderate cover of dead corals and turf and macro-algae (6-10%), low cover of macro-algae (<5%) and lowest average cover of coralline algae (2-5%). Soft corals made no significant contribution to the benthic cover in this community type. Community A also had the highest levels of average coral species richness (34 species) among the five community types, highest total abundance and second highest average score for the Biodiversity (Local rarity) Index. The Biodiversity Index is an indication of the relative importance of rare versus common hard and soft corals in each site. The higher Biodiversity Index value implies that the higher abundance of taxa is rare species.

- No sites supporting the community structure A fall within the present EIA Assessment Area.

Community B: *Acropora solitaryensis – Montipora peltiformis* community

- Key corals with high fidelity to this community included: *Favia helianthoides, Goniastrea australensis, Acropora glauca, Goniastrea favulus* and *Psammocora profundacella.*

- Community B had the second highest average cover of hard corals (11-30%) among the five community types and highest cover of soft corals (1-5%) among the five community types.

Community B had low cover of dead corals and turf and macro-algae (<5%), but with moderate cover of coralline algae (6-10%). Community B also had the second highest levels of average coral species richness (31 species), second highest total abundance and highest average score on the Biodiversity Index among the five community types.

- Within the Assessment Area, the survey sites in Sham Wan, Sung Kong and Waglan support the community structure B.

Community C: *Psammocora – Schizoprella* (bryozoans) community

- The predominant sessile benthos were bryozoans, sponge and soft corals. There was little fidelity to this community among the hard corals.

- Indicator species included: siderastreid *Psammocora superficialis; ahermatypic dendrophylliids Balanophyllia, Tubastraea* and *Dendrophyllia* spp.; the soft corals (gorgonians) *Euplexaura* and *Echinomuricea* and; corallimorpharian *Discosoma*.

- Community C had the lowest average cover of hard corals (1-5%) and dead corals and very low cover of soft corals, macro-algae and turf algae. Community C had high cover of coralline algae growing on the sub-tidal boulders characteristic of these sites (>10%). Community C also had low levels of average coral species richness (17 species), total abundance and average score on the Biodiversity Index.

- Within the Assessment Area, the survey sites in Chung Hum Kok, Po Toi, Peng Chau, Hei Ling Chau, Cheung Chau and Cheung Sha Wan in South Lantau support the community structure C.

Community D: *Porties deformis – Cyphastrea* community

- Indicator species included: faviid *Cyphastrea microphthalma*; siderastreid *Pseudosiderastrea tayami* (only recorded from Sham Wan) and faviid *Barabattoia amicorum.*

- Community D had moderately high average cover of hard corals (10-30%), highest cover of dead corals and turf algae (10%), no significant cover of macro-algae and moderate cover of coralline algae (10%). Community D also had moderate levels of species richness (18 species on average) and total abundance, and intermediate average scores on Biodiversity Index.

- Within the Assessment Area, the survey sites including Tai Tam and Sham Wan support community structure D.

Community E: Soft coral – mollusc community

- This community supported very few hard corals, and more soft corals.

- Key indicator species included: the octocorals *Dendronephthea, Guaiagorgia, Stereonephthea, nephtheid* soft coral; Perna, tunicates, oysters (*Saccostrea* sp.).

- This community had the lowest average cover of hard corals, dead corals turf algae, macro-algae (<5% average cover, and moderately high cover of coralline algae). This community also had the lowest average species richness, total abundance and average score on the Biodiversity Index.

- Within the Assessment Area, the survey sites including Po Toi, East Beaufort Island, Hei Ling Chau, Cheung Chau, Cheung Sha Wan in south Lantau, Siu A Chau (Soko Island) and Peng Chau support community structure E.

8.32 From AFCD (2004), Community A, B and D are therefore supporting moderate to high species diversity and abundance. In the Southern WCZ, south of Sham Wan was identified as a coral richness hotspot supporting a rich coral fauna, including the rare *Stylocoeniella* and this area is the

only known sites of occurrence in Hong Kong waters of the siderastreid *Pseudosiderastrea tayami*.

8.33 From AFCD (2004), compared to the Tung Ping Chau Marine Park, Yan Chau Tong Marine Park and Hoi Ha Wan Marine Park, the Cape D' Aguilar Marine Reserve supports 29 hard coral species (**See Appendix 8.1**) which is lower than the three Marine Parks. However, in compared with general areas in the Southern WCZ, the diversity of species is high.

8.34 The subtidial dive surveys for "Penny Bay Reclamation Stage 2 by Gammon (2006) (Environmental Monitoring and Auditing, 2004) were conducted in Sze Pak Wan and Kau Yi Chau on February 2006. The coral species recorded are presented in **Appendix 8.2**. The dominant species recorded in Sze Pak Wan are *Cyphastrea* sp*, Platygyra* sp. and *Favites* sp. out of total 26 coral colonies recorded. The dominant species recorded in Kau Yi Wan were *Psammocora* sp., *Cyphastrea* sp and *Pavona decussate* out of total 15 colonies recorded, the species recorded were common and widespread in Hong Kong.

8.35 A summary on coral community baseline condition within the Assessment Area is presented below.

- In the Victoria Harbour WCZ, Green Island area did not support assemblages of hard corals but soft corals and gorgonians were abundant and of low diversity (CED 1998). Areas within Victoria Harbour WCZ other than Green Island, no coral were recorded, and thus the ecological value for coral community in this habitat is low to moderate.

- In the Western Buffer WCZ, a few soft coral species were found at Tsing Yi waters nearest to the Stonecutters Island sewage outfall. Further to the south, at Ap Lei Chau and West Lamma (within Sandy Bay Area) a moderate high hard coral species were recorded reaching 14 taxa. However, the percentage cover was still low (<5%). The highest percentage of soft coral cover was recorded from West Lamma (10-50%). No rare species were recorded. In terms of species richness and biodiversity, the ecological value for the coral community in this WCZ is considered as low to moderate.

- In the Northwestern WCZ, both soft and hard corals were recorded. Corals were recorded in Sha Chau and Lung Kwu Chau Marine Park, Sham Tseng and Tsing Lung Tau. Soft corals are dominant in this WCZ, with occasionally one colony of hard coral, or less than 1% coverage in this WCZ. All the species recorded were common and widespread in Hong Kong. The ecological value for corals community for this WCZ is considered as low.

- In the Southern WCZ, there were many areas with corals cover. Stretching from Soko Island in south Lantau to Beaufort Island, the coral species richness and diversity and varied from place to place. Sham Wan were identified as a coral richness hotspot with a rare species *Stylocoeniella*. Cape D' Aguilar was designated as Marine Reserve, despite its geological and geomorphological interest (AFCD 2006) as well as high biodiversity for coral species. Sung Kong and Waglan Island supports (10-30%) hard coral covers. Sok Kwu Wan (25-50%) and Luk Chau Wan (<25%) also support moderate-high coral coverage and more than 20 hard coral species recorded. In terms of species richness, biodiversity, coral communities in Sung Kong, Waglan, Sok Kwu Wan, Luk Chau Wan, Sham Wan, Tai Tam and Cape D' Aguilar are considered as high ecological value. Other coral communities with low species richness and supporting low coral covers (1-5%) are considered as low ecological value: in Southern WCZ, Chung Hum Kok, Po Toi, Peng Chau, Hei Ling Chau, Cheung Chau and Cheung Sha Wan in South Lantau. Po Toi, East Beaufort Island, Hei Ling Chau, Cheung Chau, Cheung Sha Wan in South Lantau, Siu A Chau (Soko Island) and Peng Chau, Tai Lei mainly supports soft coral.

- In the Junk Bay WCZ, Chiu Keng Wan support soft corals from 0-10 % and the hard corals coverage were <1%, with low species diversity. Species recorded were identified as common and widespread species in Hong Kong. While from the HATS EEFS, a maximum of 23 hard coral species were recorded in East Joss House Bay with 10-25% cover; at other locations like West Joss House Bay and East and West Junk Bay, the percentage cover of hard coral was <5% with < 8 hard coral species recorded. The ecological value for corals community in this WCZ in terms of species abundance, rarity, diversity was considered as low-moderate.

- In the Eastern Buffer WCZ, surveys were made in areas near Cape Collinson and Tung Lung Chau. The coral coverage in Cape collision for soft coral and hard coral were 10-50% and <5% respectively. Both soft coral and hard coral recorded were common and of low biodiversity. Due to the moderate high soft coral coverage, the ecological value for the coral community recorded was considered as low-moderate. For Tung Lung Chua, south of Tung Lung Chau supported low percentage cover (<5%) for both soft and hard coral, while for north of Tung Lung Chau, the hard coral coverage ranged from 10-25%, still with low soft coral cover (<5%). The survey results indicated that Cape Collinson supported moderate soft coral coverage, while north Tung Lung Chau supported moderate hard coral coverage. However, no protected and rare species were recorded.

Intertidal Community

8.36 Intertidal surveys for HATS EEFS (2004) were conducted at Fat Tong Chau, Junk Bay, Tung Lung Chau, Lamma Island and Sandy Bay in September 2002. The study area for HATS EEFS covered the Assessment Area of this EIA Study including Western Buffer (Sandy Bay and Lamma Island), Junk Bay (Junk Bay and Fat Tong Chau) and Eastern Buffer (Tung Lung Chau). The survey areas are presented in **Figure 8.3**. Key relevant findings are presented below.

Lamma Island (in Southern WCZ)

- In total, 13 species of invertebrates were found in the intertidal rocky zone; with 3 species in high intertidal zone, 11 species in mid intertidal zone and 12 species in low intertidal zone. Among all invertebrates identified, grazing snail *Nodilittorina trochoides* and *N. vidua* were the most dominant and made up of 28.8% and 39.7% of total individuals found in the intertidal zones. Other abundant invertebrates include grazing snail *Monodonta labio* and limpet *Siphonaria siria*. A summary of abundant invertebrates recorded in vertical zonation of intertidal rocky shore is presented in **Table 8.10**.

Table 8.10 The vertical zonation of abundant invertebrates recorded in Lamma Island intertidal rocky shore

Vertical Zonation	Dominant Species in terms of abundance
High Intertidal Zone	*N. trochoides* *N. vidua*
Mid Intertidal Zone	*Monodonta labio* *Siphonaria siria*
Low Intertidal Zone	*M. labio* *S. siria* *Acanthopleura japonica* *Thais clavigera*

Sandy Bay (in Western Buffer WCZ)

- In total, 15 species of invertebrates were found in the intertidal rocky zone; with 2 species in high intertidal zone, 9 species in mid intertidal zone and 13 species in low intertidal zone. Among all invertebrates identified, grazing snail *N. vidua* was the most dominant and made up of 22.2% of total individuals found in the intertidal zones. Other abundant invertebrates include grazing snail *N. trochoides* (15%), *M. labio* (10.85%) and limpet *S. siria* (11.7%) and chiton *A. japonica* (12.4%) of the total invertebrate individuals. A summary of abundant invertebrates recorded in vertical zonation of intertidal rocky shore will be presented in **Table 8.11**.

Table 8.11 The vertical zonation of abundant invertebrates recorded in Sandy Bay intertidal rocky shore

Vertical Zonation	Dominant Species in terms of abundance
High Intertidal Zone	*N. trochoides* *N. vidua*
Mid Intertidal Zone	*M. labio* *S. siria* *N. vidua*
Low Intertidal Zone	*Cellana grata* *S. siria* *A. japonica* *Patelloida pygmaea*

Junk Bay (in Junk Bay WCZ)

- In total, 17 species of invertebrates were found in the intertidal rocky zone; with 5 species in high intertidal zone, 16 species in mid intertidal zone and 13 species in low intertidal zone. Among all invertebrates identified, grazing snail *N. trochoides* and *N. vidua* was the most dominant and made up of 34.7% and 26.1% respectively of total individuals found in the intertidal zones. Other abundant invertebrates include grazing limpet *S. siria (*18.2%) and *Cellana toreuma* (11.2%) of the total invertebrate individuals. A summary of abundant invertebrates recorded in vertical zonation of intertidal rocky shore is presented in **Table 8.12**.

Table 8.12 The vertical zonation of abundant invertebrates recorded in Junk Bay intertidal rocky shore

Vertical Zonation	Dominant Species in terms of abundance
High Intertidal Zone	*N. trochoides* *N. vidua*
Mid Intertidal Zone	*N. trochoides* *N. vidua* *C. toreuma*
Low Intertidal Zone	*C. toreuma* *S. siria* *P. pygmaea* *A. japonica* Acorn barnacle, *Tetraclita squamosa* Bivalve, *Septifer virgatus* *Thais clavigera*

Fat Tong Chau (in Junk Bay WCZ)

- In total, 15 species of invertebrates were found in the intertidal rocky zone; with 5 species in high intertidal zone, 9 species in mid intertidal zone and 15 species in low intertidal zone. Among all invertebrates identified, grazing snail *N. trochoides* and *N. vidua* was the most dominant and made up of 39.3% and 41.6.1% respectively of total individuals found in the intertidal zones. A summary of abundant invertebrates recorded in vertical zonation of intertidal rocky shore is presented in **Table 8.13**.

Table 8.13 The vertical zonation of abundant invertebrates recorded in Fat Tong Chau intertidal rocky shore

Vertical Zonation	Dominant Species in terms of abundance
High Intertidal Zone	*N. trochoides* *N. vidua*
Mid Intertidal Zone	*N. trochoides* *N. vidua* *M. labio*
Low Intertidal Zone	*M. labio* *S. siria* *P. pygmaea* *T. clavigera*

Tung Lung Chau (in Eastern Buffer)

- In total, 15 species of invertebrates were found in the intertidal rocky zone; with 4 species in high intertidal zone, 14 species in mid intertidal zone and 12 species in low intertidal zone. Among all invertebrates identified, grazing snail *N. trochoides* and *N. vidua* was the most dominant and made up of 33.9% and 20.2% respectively of total individuals found in the intertidal zones. Other abundant invertebrates include grazing limpet *C. grata* (13.4%) and *C. toreuma* (7.5%). A summary of abundant invertebrates recorded in vertical zonation of intertidal rocky shore is presented in **Table 8.14**.

Table 8.14 The vertical zonation of abundant invertebrates recorded in Junk Bay intertidal rocky shore

Vertical Zonation	Dominant Species in terms of abundance
High Intertidal Zone	*N. trochoides* *N. vidua*
Mid Intertidal Zone	*C. grata* *C. toreuma*
Low Intertidal Zone	*C. grata* *S. siria* *P. pygmaea* *T. squamosa* S. *virgatus* *T. clavigera*

Artificial Seawall

- Recent results presented in the HATS Dive Survey Report for spot dives conducted close to seawalls inside Victoria Harbour (e.g. off Kai Tak, Hung Hom and North Point) in January 2003 recorded bryozoans (*Schizoporella errata*), barnacles, mussels (*Perna viridis*) and sponges. Morton and Morton (1983) suggested that common 'biofouling' organisms previously recorded on artificial seawalls and wharfs in Hong Kong include barnacles (*Tetraclita squamosa, Capitelum mitella* and *Balanus amphitrite*), polychaete tube-worms (*Hydroides elegans, Spirobis foraminosus*), mussels and oysters (*Perna viridis, Septifer virgatus, Saccostrea cucullata*), bryozoans (*Bugula neritina*), ascidians (*Ascidia sydneiensis, Ciona intestinalis, Styela plicata*) and various macro-algae (*Ulva fasciata, Entromorpha prolifera, Codium cylindricum, Colpomenia sinuosa*).

8.37 Almost all the recorded species in HATS EEFS were herbivorous grazers and filter feeders in intertidal rocky shore. The artificial seawall supported the bio-fouling species. Most of the species recorded in HATS EEFS were common and widespread in Hong Kong rocky shores and no rare species were recorded.

8.38 Recent ecological surveys for the "Further Development of Tseung Kwan O Feasibility Study, EIA (2005)" were conducted along Chiu Keng Wan provide information on intertidal community on Junk Bay WCZ. The habitats along Chiu Keng Wan comprise rocky shore, sandy shore and artificial seawall. The location of surveys is provided in **Figure 8.3**. The key findings are presented below:

Rocky Shore

- Ecological surveys were conducted twice at the rocky shore in Chiu Keng Wan in May and October 2004.

- Rocky shore fauna along the Chiu Keng Wan coast comprised species typical of other semi-exposed rocky shores of eastern Hong Kong waters and followed typical vertical zonation patterns mediated by tidal exposure. A summary of abundant invertebrates recorded in vertical zonation of intertidal rocky shore in the study period is presented in **Table 8.15**.

Table 8.15 The vertical zonation of abundant invertebrates recorded in Junk Bay intertidal rocky shore

Vertical Zonation	Dominant Species in terms of abundance
High Intertidal Zone	*Nodolittorina* spp. *Ligia exotica*
Mid Intertidal Zone	*Tetraclita* spp. *M. labio* *C. toreuma*
Low Intertidal Zone	Rock Oyster, *Saccostrea cucullata* Mussels, *Sepifera virigatus* Common Rock Crab, *Grapsus albolineatus.*

Rock Pools

- Along the Chiu Keng Wan coast, fish recorded in rock pools included the goby *Bathygobius fusca* and a single incidence of a stranded Doublebar cardinalfish *Apogon pseudotaeniatus.* During the May survey, it was also noted that small open tidal gullies along the low rocky shore provided shelter for dense schools of unidentified fish fry. Small schools of fish fry as well as juvenile Grey Mullet *Mugil cephalus* were also occasionally observed passing along the waters edge, whilst angler's catches were noted to include Rockfish, *Sebasticus marmoratus*, Russell's Snapper *Lutjanus russellii*, White-spotted Rabbit Fish *Siganus canaliculatus*, Chinese Damselfish *Neopomacentrus bankieri*, Japanese Seaperch *Lateolabrix japonicus* and Red Drum *Sciaenops ocellatus*.

- One marine species of potential conservation interest was discovered at the rocky shore habitat at Chiu Keng Wan. In May 2004, a large rock pool up to 70cm deep located on the high shore with a dense growth of Enteromorpha seaweed and sand/rubble/small boulder bottom substrata was found to have 5 individuals of the Grassy Puffer fish (also known as the Starry or Snowy Puffer), *Takifugu niphobles*. Several other dead individuals were found stranded on the high shore nearby. Ad hoc surveys conducted in October 2004 focusing on this species found two individuals, *T. niphobles* on large rock pool in Chiu Keng Wan.

- *T. niphobles* is listed as 'data deficient' in The IUCN Red List of Threatened Species (Roberts 1996, UNEP/GEF 2003). Listing of taxa in this category indicates that more information is required and acknowledges the possibility that future research will show that threatened classification is appropriate. As an intertidal spawner, *T. niphobles* gathers at the waters edge at dusk at the full or new moon when tidal heights are at their highest and strands in rock pools to spawn. Spawning is stimulated by groups of 2-4 males that bite and hang on the side of single females as they deposit eggs in sand and rubble at high tide. Individuals may remain stranded in rock pools on the high shore, until they are freed by the next high tide (Yamahira

1997a,b). The fish species *T. niphobles*, of conservation concern was recorded in rock pool in Chiu Keng Wan. It is listed in IUCN Red List of Threaten Species. Despite its IUCN listing, *T.niphobles* has a widespread regional distribution, with records from throughout the Pacific North-west region (including Japan, Korea, Taiwan, China, Hong Kong and Vietnam, Roberts, 1996). According to Sadovy & Cornish (2000), *T. niphobles* "is moderately abundant in Hong Kong and is known recently from several individuals along shallow boulder shores, such as within the Cape D' Aguilar Marine Reserve". Although it appears not to be among species recorded during monitoring of artificial reefs (cf. Wilson 2003), this may be because it generally occupies waters that are shallower than the depths at which artificial reefs are deployed. Other researchers (e.g. Yu & Yu 2002) have also reported this species to be common in Hong Kong coastal waters.

Sandy Shore

- Sandy shore surveys were conducted at low tide in May 2004 and October 2004 along Chiu Keng Wan.

- At Chiu Keng Wan, the factors contributing to the apparent presence of very few burrowing macrofauna are likely to include water pollution and the course grain size of sand on the beaches. Only Large Ghost Crab (*Ocypode ceratophthalma*) were recorded from burrows in sandy shore. Pollution caused by anthropogenic activities is a possible source of low species diversity on soft shore habitats. Eutrophication of sandy shore habitats at Chiu Keng Wan was suggested by the presence of large numbers of pollution tolerant polychaete tube-worms (*Hydroides elegans*) on the underside of boulders found along the shores. Sandy shores with coarse grain size are well-draining, which limits interstitial water retention leading to rapid desiccation of the shore and hence intolerable conditions for sandy shore infauna at the intertidal zone.

Artificial Seawall

- Given that seawalls in Junk Bay are relatively new it can be inferred that these seawalls support limited intertidal biota and are of low ecological value

- No field survey was conducted for artificial seawall in Chiu Keng Wan. Also the seawall is quite newly established. The species assumed to be present are predicted from finding by Morton and Morton (1983). Only common biofouling species would be recorded in artificial seawall.

8.39 The "Siu Ho Wan Water Treatment Works Extension EIA (2004)" provides recent information on intertidal community in the Northwestern waters WCZ as summarized below:

- Ecological surveys covering the wet season were conducted from July 2003 to October 2003 in Pui O Bay. In addition, ad hoc observations of fauna (primarily avifauna) were made during site visits conducted in the 2003/2004 dry season.

Sandy Shore

- Sandy shore habitat supported ghost crabs (*Ocypodes ceratophthalmus, Ocypodes gaimardi*) with frequent burrows at the high shore. Sand-bubbler crabs (*Scopimera globosa*) were also occasionally recorded. Hermit crabs (*Clibanarium* sp.) were infrequently recorded usually inhabiting *Turitella* shells. Surf clams (*Donax* sp.) were occasionally recorded on the low shore. At the backshore, the common sesarmine crab *Perisesarma bidens* were commonly recorded particularly in a small pool area behind the western end of Pui O beach.

Rocky Shore

- Rocky shore habitat was identified in the southwest corner of the Assessment Area fringing Pui O Bay. The rocky shore comprised moderate to large rocky boulders with medium wave exposure. Rocky shore habitat supported typical and widespread species of moderately exposed rocky comprising rock oysters (*Saccostrea cullculata*), barnacles (*Tetraclita* sp.,

Capitella mitella), sea slaters *(Ligia exotica*), small shore crabs (*Hemigrapsus sanguineus*), limpets (*Notoacmaema schrenkii)* and snails (*Monodonta labio, Nerita albicilla* and *Morula musiva*).

8.40 The sandy shore in Pui O Wan is a gazetted beach and supported mostly the common crab species, while the semi-exposed rocky shore supported common and wide spread species in Hong Kong. No rare species were recorded.

8.41 Information on intertidal shores in the Western Buffer WCZ is available from the "Improvement to Castle Peak Road between Ka Loon Tsuen and Siu Lam, EIA (2001)" are highlighted below:

- The coastal waters near Tai Lam Chung were low in salinity with moderately wave exposure (Morton and Morton, 1983). The marine ecological habitats in the study area are categorized into natural boulder coast, artificial seawall and beach. The artificial seawall was mainly located between Siu Lam and area near Ka Loon Tsuen, while the natural boulder coastline and sandy beach were located in Ka Loon Tsuen. Field surveys were conducted on the natural boulder coastline and the artificial seawall at Ka Loon Tsuen in May 2000.

<u>Natural Boulder Coastline</u>

- The natural boulder coastline is a typical sheltered rocky shore with little exposure to strong-waves. The field survey indicated that the assemblages were of sheltered shore communities with high quantities of winkles, *Nodilittorina radiata*, dominating the lower shore. Other intertidal species including common whelk, *Thais* spp., limpet, *Cellana toreuma*, smooth limpet*, Notoacmoae* spp., false limpet, *Siphonaria* spp. and barnacles *Tetraclita japonica* were recorded. No rare species was recorded in the survey.

<u>Artificial Seawall</u>

- The artificial seawall had been constructed over 20 years and small marine organisms had colonized along this old reclaimed sea-edge (Highways Department, 1996). Species composition was identified at the artificial seawall in Ka Loon Tsuen. The field survey indicated that the assemblages were of moderate exposed rocky shore communities with high quantities of *Littoriaria articulata* dominating the higher shore and *Monodonta* spp. dominating the lower shore. Other intertidal species included *Nodilittorina radiata, Cellana toreuma, Notoacmaea* spp*., Nerita albicilla* and *Thais* spp..

<u>Beach</u>

- Species composition was identified at the beach in Ka Loon Tsuen. Five cores (diameter about 10cm, length about 40cm) were sampled at high and low shores. The samples were sieved and stained with rose bengal. No macro-invertebrate was recorded in the present field survey.

8.42 Information on artificial seawall in Southern Buffer WCZ is available from the "Helipad at Yung Shue Wan, Lamma Island, EIA (2006)" are highlighted below:

<u>Artificial Seawall</u>

- The ecological survey was conducted in March 2003. The sloping seawall was approximately 200m long and an epifauna community was present only at the lower part, within the tidal range. The limpet *Cellana toreuma* and the top shell *Monodonta australis* dominated the community. Other species widespread on the lower wall, but less abundant, were the amphipod *Ligia exotica* and the acorn barnacle *Teraclita squamosa.* The pockets between the boulders of the sloping seawall were barren and no vegetation had become established. The limpets *C. toreuma* and *M. labio* dominated in artificial seawall were the common and widespread intertidal species found in Hong Kong. No rare and protected species were recorded from this study.

8.43 Information on intertidal infaunal diversity in Southern Buffer WCZ is available from the "Peng Chau Sewage Treatment Works Upgrade, EIA (2004)" are highlighted below and were conducted in the

environment near Tai Lei Island in both wet season (June 2003) and dry season (February 2003).

Rocky shores

- The ecological surveys were conducted near Tai Lei Island in June 2003 and February 2003. In total, 13 and 15 infaunal species were recorded along Tai Lei Island in the dry and wet season respectively. The dominant species recorded in both dry and wet seasons were *N. vidua*, *Patelloida saccharina* and *C. toreuma*. One study site was an artificial seawall, and only *M. labio, C. toreuma, N. trochoides* and *N. radiate* were found in this study. **Table 8.16** summarizes the dominant species (>30% of total infaunal abundance) recorded in vertical zonation along rocky shore in Tai Lei Island. The limpets *N. vidua, Patelloida saccharina* and *C. toreuma* dominated in intertidal rocky shore were common and widespread intertidal species found in Hong Kong. No rare and protected species were recorded from this study.

Table 8.16 The vertical distribution of dominant species in intertidal rocky shore

Vertical Zonation	Tai Lei Island (dominant Species)	
	Dry Season	**Wet Season**
High Intertidal Zone	*N. vidua* *N. radiate*	*N. vidua* *N. radiate*
Mid Intertidal Zone	*C. toreuma* *P. saccharina*	*P. saccharina* *P. pigmata*
Low Intertidal Zone	*P. saccharina* *Siphonaria atra* *C. toreuma*	*C. toreuma*

8.44 For the "Outlying Islands Sewage Stage 1, Phase II and Package J – Sok Kwu Wan Sewage Collection, Treatment and Disposal Facilities, EIA (2003)" a verification survey for intertidal habitats was performed in April 2002 to verify the 1999 data on Sok Kwu Wan (in Southern WCZ) on semi-exposure rocky shores. Key findings are presented below:

- In total 10 taxa and 385 species in abundance were recorded from the verification survey. In top three dominant species in terms of abundance were *N. pyramidalis, Tetraclita* sp. and *Saccostrea cucullata*. These species were common and widespread in Hong Kong. No rare and protected species were recorded from this study. The survey findings were consistent with that of the previous survey in 1999.

8.45 The intertidal survey for the "Tung Chung – Ngong Ping Cable Car Project EIA (2003)", including sandy beaches (with small boulders) in Tung Chung Bay and mudflat communities at San Tau were conducted in June and July 2002. This information on intertidal communities in the Northwestern WCZ is available from this study, as summarized below.

San Tau Mudflat

- The mudflats beside the San Tau mangal found colonies of the rare seagrass *Halophila ovata* and *Zostera japonica*. The seaweeds *Enteromorpha* sp. and *Colpomenia sinuosa* were also seasonally abundant on the mudflat near the seagrass beds. The epifauna and infauna communities were dominated by gastropods of the genera *Batillaria, Littoraria, Cerithidea* and *Nerita*. The mudflat was also an important habitat for the horseshoe crabs *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda*. The mudskipper *Periophthalmus cantonensis* is widespread. Mudflat was dominated by the gastropods *Cerithidea djadjariensis, Batillaria multiformis, Batillaria zonalis, Nerita striata* and *Clithon oualaniensis* with these species entirely covering the mudflat in some areas. These species were also present in the infauna to a certain extent. Other occasional epifauna species were the mudskipper *Periophthalmus cantonensis* that was present wherever there were tidal pools and the crab *Uca chlorothalamus*. The crab *Uca lactea* was locally dominant at open and elevated (well drained) areas of mudflat near the backshore.

Tung Chung Bay

- The Bay's estuarine waters linked the coastal marine environment and the freshwater habitats of San Tau Stream and Tung Chung Stream. Due to the variable physio-chemical environment brought about by changing salinity in the Bay, the coastal waters supported a diversity of fish species. The most abundant species include Flathead Mullet *Mugil cephalus* and Tiger Fish *Therapon jaruba*. Most activity along the west of Tung Chung Bay where shells taken were predominantly rock oysters *Sacostrea cucullata*, the mangrove clam *Gelloina erosa* and various cockles (Cartidae).

8.46 The intertidal surveys for the "Tung Chung – Ngong Ping Sewage Treatment Works and Sewage, EIA (2002) including the artificial boulder shore in Tai O was conducted from July 2001 to mid- April 2002, covering both dry and wet seasons. This information on intertidal communities in Southern WCZ is available from this study, as summarized below.

- In total, 8 species of animals and 1 species of macroalga were recorded on the artificial boulder shore in wet season, and 9 species of fauna were recorded in the dry season. Animals recorded on the shores at the surveyed sites were largely herbivorous molluscs, including the nerite *Nerita albicilla* on the high (2.5 m above CD), mid (2.0 m above Chart Datum) and low (1.5 m above CD) shore, and periwinkles *Littorina scabra* on the high shore. The species diversity and evenness are presented in **Table 8.17** which indicated that the artificial boulder shore had low diversity in both wet and dry season, but the H' value was relatively higher in dry season. The predatory gastropod *Thais clavigera* (the common dogwhelk) was also recorded in the low shore region. Sessile filter-feeding barnacles such as the rock oyster *Saccostrea cucullata* were also common on the shores (**Table 8.17**). The mussel *Septifer virgatus* and the acorn barnacle *Tetraclita squamosa* were also recorded on the shores but in low abundances during wet and dry season. The macroalgae *Ulva lactuca* was recorded in wet season but was not found in the dry season survey.

Table 8.17 Mean number of individuals, Species Diversity (H') and Evenness (J') (standard deviation) of intertidal organisms recorded from the artificial boulder shore during the survey at Tai O

	High-intertidal Zone	Mid-intertidal Zone	Low-intertidal Zone
WET SEASON			
Snail (No./m^2)			
Littorina scabra	261.6 ± 175.2	0	0
Thais clavigera	0	4.8 ± 4.4	29.6 ± 10.8
Monodonta labio	0.8 ± 1.8	0	0
Nerita albicilla	31.2 ± 12.1	83.2 ± 30.4	31.2 ± 23.9
Crustaceans (No./m^2)			
Hermit Crab	0	0.8 ± 1.8	0
Barnacle (% cover)			
Tetraclita squamosa	0	3± 2.7	0
Bivalve (% cover)			
Septifer virgatus	3.4 ± 6.5	5 ± 3.5	23 ± 4.5
Saccostrea cucullata	11 ± 6.5	39 ± 20	19 ± 5.5

	High-intertidal Zone	Mid-intertidal Zone	Low-intertidal Zone
Algae (% cover)			
Ulva lactuca	0	0	1± 2.2
Species Diversity (H')*	0.18 ± 0.12	0.05 ± 0.04	0.25 ± 0.04
Evenness (J')*	0.52 ± 0.28	0.23 ± 0.05	0.82 ± 0.11
DRY SEASON			
Snail (No./m^2)			
Littorina scabra	188.4 ± 88.9	0	0
Thais clavigera	0	5.2 ± 3.6	18.8 ± 6.8
Monodonta labio	0	1.4 ± 2.2	2.6 ± 2.6
Nerita albicilla	9.6 ± 6.3	23.8 ± 8.3	18.6 ± 9.2
Crustaceans (No./m^2)			
Hermit Crab	0	0	7.6 ± 5.9
Hemigrapsus sanguinolentus	0	0	1 ± 1.4
Barnacle (% cover)			
Tetraclita squamosa	0	13 ± 21.1	0
Bivalve (% cover)			
Septifer virgatus	1 ± 2.2	6 ± 5.5	25 ± 10
Saccostrea cucullata	5 ± 3.5	26 ± 13.9	20 ± 10
Algae (% cover)			
Ulva lactuca	0	0	0
Species Diversity (H')*	0.34 ± 0.12	1.49 ± 0.04	1.67 ± 0.04
Evenness (J')*	0.24 ± 0.28	0.83 ± 0.05	0.86 ± 0.11

Note: * - The species diversity and evenness excluded the sessile organisms which using percentage cover to represent their abundance.

8.47 The intertidal surveys for "Construction of Lung Kwu Chau Jetty, 2002" including rocky shore and sandy shore were conducted along southeast coast of Lung Kwu Chau Island in February 2001 to February 2002. This information on intertidal communities in Northwestern WCZ is available from this study, as summarized below.

Rocky Shore

- Littorinids were observed from this field survey to be most common higher up in the littoral zone, as were sea slaters, *Ligia exotica*. Patches of *Kyrturthrix* cyanobacteria were also present on the high shore. Lower down the seashore were observed the grazing snails, *Monodonta* spp. and *Nerita* spp.. Also found on the mid shore was the crustose algae *Hildenbrantia* and the limpet *T. squamosa* which was attached to the exposed rocky surfaces, while the stalked barnacle *Capitellum mitella* was confined to the shelter crevices. On the lower shore several *Saccostrea cucllata* were observed. In winter, the mid to low rocky shore was dominated by

macro-algae species, *Enteromorpha, Ulva* and *Sargassum*.

Sandy Shore

- Low macro-invertebrates were recorded during the survey. The course sand grain size limits water retention leading to desiccation of macro-invertebrates, so resulted in very low biodiversity. Only large ghost crab, *Ocepode certophthalmus,* were recorded in small number inside burrows in sandy shore.

8.48 Ecological surveys were carried out on monthly basis on springs low tides between November 1996 and October 1998 at Cape D' Aguilar Marine Reserve semi-exposed rocky shore (Hutchinson, 1999). The shore consisted of even sloping rock surfaces, sparsely covered with sessile invertebrates along this shore. Public access was limited, collection of organism was prohibited and with limited anthropogenic disturbance. In summer, the rocky shore was dominated by algae *Ralfsia expansa, Hapalospongidion gelatinosum, Hilderbrandia rubra.* In winter, it was dominated by mollusca grazers *Acanthopleura japonica, Cellana toreuma, Patelloida saccharina, Monodonta labio* and *Nerita albicilla.* The species recorded were typical semi-exposed shore species. No rare species were recorded. All were common and widespread in Hong Kong.

8.49 The intertidal survey was carried out in Sha Chau Island and Lung Kwu Chau Island rocky shores between October 2003 and November 2004 from "(Put O Ang, Jr. *et al*, 2005) Biological Monitoring in Sha Chau and Lung Kwu Chau Marine Park. Final Report submitted to the Agriculture, Fisheries and Conservation Department, HKSAR". The dominant species included *Littoraria articulate, Saccostrea cucullata, Balanus Amphitrite, Tetraclita squamosa, Nodilitorina trochoides, Septifer virgatus* and juvenile snail (<1mm). In upper shore, it was dominated *Littoraria articulate, Tetraclita squamosa, Nodilitorina trochoides, Septifer virgatus* and juvenile snail (<1mm). In upper shore, it was dominated *Littoraria articulate, Tetraclita squamosa, Nodilitorina trochoides,* and juvenile snail. In middle shore, it was dominated by *Littoraria articulate, Saccostrea cucullata, Balanus Amphitrite* and *Tetraclita squamosa.* In lower shore, it was dominated by *Littoraria articulate*, *Saccostrea cucullata, Balanus Amphitrite, Tetraclita squamosa* and *Septifer virgatus*. In general, the middle supported highest species diversity. The species recorded were typical semi-exposed shore species. No rare species were recorded. All were common and widespread in Hong Kong.

8.50 A summary of intertidal community baseline condition within the Assessment Area is presented below.

- The coastline in the Assessment Area comprises habitat types including sandy shore, boulder shore, mudflat, rocky shore and artificial seawall and boulder shore.

- Most of intertidal habitats support low biodiversity is dominated by common and widespread infauna in Hong Kong. Rare sea grasses, *Halophila ovata* and *Zostera japonica* were recorded in San Tau mudflat. Seagrass, *Halophila beccarii,* was recorded in Tai Ho Wan in (The University of Hong Kong 1999). Juvenile Horseshoe crabs were recorded from the San Tau Mudflat. Another *Takifugu niphobles* was recorded on large rock pool in Chiu Keng Wan of which this species is listed IUCN Red List of Threatened Species. However, *Takifugu niphobles* is moderately abundant in Hong Kong and is known recently from several individuals along shallow boulder shores, such as within the Cape D' Aguilar Marine Reserve. Although it appears not to be among species recorded during monitoring of artificial reefs (Wilson 2003), this may be because it generally occupies waters that are shallower than the depths at which artificial reefs are deployed. Other researchers (e.g. Yu & Yu 2002) have also reported this species to be common in Hong Kong coastal waters.

- Sandy shores is dominated by species such as the large ghost crab, while in rocky shore, it is usually dominated by grazing snails *N. trochoides* and *N. vidua* and grazing limpets *C. toreuma*. Artificial seawall, potential infauna composition would be biofouling species (Morton and Morton, 1983).

Marine Mammals, Green Turtle and Horseshoe Crab

8.51 Parts of the study area are frequented or may be traversed by cetaceans, sea turtles and horseshoe crab, which are species of conservation significance.

Marine Mammals

8.52 A total of fifteen species of cetaceans has been recorded from Hong Kong waters (Parsons et al., 1995), of which only two species are resident year round: the Indo-Pacific Humpback Dolphin, also known locally as the Chinese White Dolphin (*Sousa chinensis*) and the Finless Porpoise (*Neophocaena phocaenoides*).

8.53 Both species are recognized internationally as of ecological importance and are listed in CITES Appendix I and as "Data Deficient" in The IUCN Red List of Threatened Species. Furthermore, the Chinese White Dolphin is listed in China as a "Grade 1 National Key Protected Species", whereas the Finless Porpoise is listed as a "Grade 2 National Key Protected Species" (AFCD, 2003a).

Chinese White Dolphin (*Sousa chinensis*)

8.54 In Hong Kong, Chinese White Dolphins (*Sousa chinensis*) predominantly frequents the less saline brackish waters around the Pearl River Estuary although loss of habitat to numerous developments, fishing, shipping activity and pollution from various sources have reportedly placed increasing pressure on the local Chinese White Dolphin population (e.g., Liu and Hills, 1997; Jefferson, 2000a).

8.55 The most comprehensive and updated information on the population biology of the Chinese White Dolphin (*Sousa chinensis*) in Hong Kong waters is found in the "Monitoring of Indo-Pacific Humpback Dolphin *(Sousa chinensis)* in Hong Kong Waters – Data Analysis Final Report, 2005*"* for AFCD (Jefferson, 2005), as highlighted below.

Sightings and Distribution

8.56 Detailed sighting surveys were conducted from September 1995 to December 2004 to determine the abundance and the habitat use for Chinese White Dolphin, which reported their distribution mainly in those western waters influenced by the Pearl River Estuary. The most important habitats were assessed based on the highest concentrations of sightings in Northwestern WCZ including northern, western and southwestern Lantau Island as shown in **Figure 8.7**. A very few individuals were observed in the southern Hong Kong Island and Western Buffer WCZ. No individual was observed in Victoria Harbour WCZ.

8.57 Density varied dramatically among areas and seasons. By far, the highest density area was West Lantau, with exceptionally high densities in all four seasons of 96-219 individuals / 100 km^2. Autumn was the season with the highest density in West Lantau, 219 individuals/ 100 km^2. High densities of over 75 individuals/100 km^2 were found in Lingding Bay, Macau, and Northwest Lantau. Other areas had moderate to low densities of 5-75 individuals / 100 km^2, except for East Lantau and Lamma, which both had negligible densities of <3 individuals / 100 km^2. Density could change radically over very short distances. For instance, average seasonal densities of 185 individuals / 100 km^2 in West Lantau dropped to 1.3 individuals / 100 km^2 in East Lantau, over a distance of only about 20 km.

Abundance and seasonal variation

8.58 Abundance also varied extensively. The total of the estimates for Hong Kong waters was similar in three seasons (185 in winter, 190 in summer, and 207 in autumn). In spring, it dropped to only 91 individuals. In the Hong Kong survey areas, abundance was lowest in spring in every case.

8.59 When all the seasonal totals for all the survey areas (in Hong Kong and China) were compared, the totals were very similar in three seasons (1171 in winter, 1076 in spring, and 1139 in autumn). Only in summer, was the total dramatically different, with the sum adding to only 678 individuals.

8.60 In summary, the total abundance estimates for all the survey areas (Hong Kong and China, refer to

Figure 8.7) during three of the four seasons (about 1080 -1170 in autumn through spring) is highly suggestive that the majority of the population was included in the estimates for these seasons. Therefore, the total population size should be about 1200-1300 individuals.

Calving periods

8.61 Jefferson (2005) suggested the Chinese White Dolphin give birth in every month of the year, but with a peak in spring and summer months (from March to August). During this half of the year, 76.3% of calves are born. A peak in calving during the warmer months of the year may be typical for the species (Cockcroft 1989).

8.62 According to "(Put O Ang, Jr. *et al*, 2005) Biological Monitoring in Sha Chau and Lung Kwu Chau Marine Park. Final Report submitted to the Agriculture, Fisheries and Conservation Department, HKSAR", calves were mostly observed in central Sha Chau and around Lung Kwu Chau Marine Park. There were totally 11 calves observed in the study area from October 2003 to September 2004.

Feeding habits

8.63 Feeding habits of Chinese White Dolphin are analyzed based on stranding specimen. Croakers *Johnius* spp., lionhead *Collichthis lucida*, and anchovies *Thryssa* spp., were the most common prey. Little evidence shows that cephalopods or crustaceans are their major prey items (Parsons 1997).

Finless Porpoise (*Neophocaena phocaenoides*)

8.64 In Hong Kong waters, Finless Porpoises occur year round. These animals can be found primarily in the southern and eastern waters of the territory, and are also sighted in adjacent Chinese waters just south of Hong Kong (Jefferson and Braulik 1999; Jefferson et al. 2002a). The porpoises appear to avoid the western waters of Hong Kong, which are heavily influenced by freshwater input from the Pearl River, and are the major habitat of the humpback dolphin population (Jefferson and Hung 2004).

8.65 The most comprehensive and updated information on the population biology of the Finless Porpoises (*Neophocaena phocaenoides*) in Hong Kong waters is in "(Hung, 2005) Monitoring of Finless Porpoise (*Neophocaena phocaenoides*) in Hong Kong Waters. Final Report submitted to the Agriculture, Fisheries and Conservation Department, HKSAR.". Key baseline information based principally on survey carried out from 1 November 2003 to 31 October 2005 is described below.

Surveying effort

8.66 During the study period in 2003-05, a total of 48 line-transect surveys were conducted for the present study in Hong Kong waters. These include 16 surveys in South Lantau (SL), 14 surveys in Lamma (LA), five surveys in Po Toi (PT), nine surveys in Ninepins (NP), and four surveys in Sai Kung (SK). Twenty off-effort helicopter surveys were conducted to cover remote survey area including Mirs Bay and Deep Bay to search for Finless Porpoise.

Abundance

8.67 According to the monitoring result in Hung (2005), ninety-eight groups of Finless Porpoises totaling 314 individuals were sighted during line-transect surveys (84 sightings) and helicopter sightings (14 sightings). Most of the porpoise sightings were made in Po Toi (36 sightings) and South Lantau (29 sightings) (**Figure 8.8**).

Distribution

8.68 The distribution pattern of Finless Porpoises in 2003-05 was broadly similar to past distribution records since 1996 (**Figure 8.8**). It appeared that fewer sightings were made in Lamma survey area and more sighting were made in the eastern survey areas during the study period when compared to past sighting records.

8.69 Within South Lantau, most of the porpoise sightings were made around Tai A Chau, Shek Kwu Chau, southwestern waters of Cheung Chau and inside Pui O Wan. Around Lamma Island, the porpoise sightings were mainly made at the southwest corner (i.e. Ha Mei Tsui) and the eastern side of the island. In the eastern waters, a majority of sightings were made around Po Toi Islands, especially between the islands of Sung Kong, Po Toi and Waglan Island. Many porpoises were also sighted in the offshore areas in eastern waters, extending all the way to the border of Hong Kong territorial waters. Porpoises were also seen near Sea Ranch, and a few porpoise sightings were made toward Cha Kwo Chau. No sightings were made near Pui O beach, and porpoise generally avoided the shallow coastline with sandy beaches within Pui O Wan. Porpoises tended to engage in feeding along the rocky shores at the southwest corner of Chi Ma Wan Peninsula.

Seasonal variation

8.70 With the additional porpoise sightings made during the present study, seasonal variation in porpoise distribution within Hong Kong waters was even more evident. In winter and spring months (December to May), the majority of sightings were made in South Lantau and Lamma survey areas, while only a handful of sightings were made in eastern survey areas during these months. On the other hand, the distribution of porpoises noticeably shifted from southern waters to the eastern waters during summer months (June to August), this pattern remained more or less the same until autumn (September to November) when some porpoises gradually occurred in southeastern part of Lantau Island and western part of Lamma Island. The season distribution is presented in **Figure 8.9**.

Calving period

8.71 77% of finless porpoises are thought to be borne during the late autumn and early winter months of October to January.

Feeding habits

8.72 More than 50% of the sightings with feeding behaviour were made near Ha Mei Tsui. Analysis of stomach contents of standard animals revealed that Finless Porpoises in Hong Kong preyed on 25 species of fish, six species of cephalopods and one species of shrimp (Barros et al.2002).

8.73 Apogonidae, Sciaenidae, Engraulidae, Leiognathidae, and cephalopods species of the families Loligindae, Octopodidae and Seppiddae are the most important prey items. These prey species are primarily inshore, bottom-dwelling and mid-water species, suggesting that Finless Porpoises probably feed on different levels of the water column in nearshore habitats (Barros et al.2002).

Cetacean Mortality in Hong Kong

8.74 Strandings are usually associated with the months of calving period, but the reasons for stranding are still unknown. Jefferson (2005) reported that the numbers of stranding of Chinese White Dolphin was about 6 to 14 per year in Hong Kong and most of the dolphins found stranding were neonates (less than 137 cm in length). In addition, the monthly pattern of strandings of neonates shows a large peak from May to August, which is partly a reflection of the seasonality of calving.

8.75 The cause of death of the cetacean would be due to physical incidents and effect of environmental contamination. Jefferson (2005) mentioned that in Hong Kong, of the 89 humpback dolphin strandings that were investigated, cause of death could only be determined with certainty for 10 specimens, although a possible cause of death was found for three others. Three specimens were diagnosed as having died from net entanglement, four from vessel collisions, one from debris (in this case, net) ingestion, one from a heart or brain pathology, and one from a bone infection.. The report also mentioned the effect of contaminants to the health of cetacean. For example, recent study found that organochlorines interfere with reproductive capacity, cause immunosuppression, and have carcinogenic and teratogenic effects. In Hong Kong, organochlorine concentrations of humpback dolphin specimens are quite high, and DDT and PCB levels are higher than that in the finless porpoise population. However, due to very small sample size for tissue analysis, it is unlikely to assume that contaminants would cause either chronic or acute effects for cetacean from a proved scientific statistical analysis.

Green Turtle (*Chelonia mydas*)

8.76 Five species of sea turtle have been recorded in local waters. They are the Green Turtle, Hawksbill, Leatherback, Loggerhead and Olive Ridley. Some of the records are of live sightings, while others are from the stranding of dead specimens. Most local records are of the Green Turtle, the only species of sea turtle that breeds in Hong Kong.

8.77 Green Turtles are listed in Appendix I of the CITES and the Bonn Convention, indicating the international recognition and agreement to protect this highly endangered species. In Mainland China, Green Turtles are listed as a Class II Protected Animal in the List of State Key Protected Wildlife in China, giving the animal a national protection status against hunting and commercial exploitation. A detailed description of Green Turtle is presented below based on "Green Turtles in Hong Kong (Chan 2004)".

8.78 It has been observed that the number of nesting females has declined significantly in the last few decades in many parts of the world. This has led to concern about the survival of the species, and hence the international efforts to protect Green Turtle. Sham Wan in Hong Kong, and Gangkou National Nature Reserve for Sea Turtle, are among the few remaining nesting sites for sea turtles along the coast of South China.

8.79 The sea turtles used to nest in remote beaches in Hong Kong, for example, Lamma Island (Tung O and Ha Mei Wan), Lantau Island (Tong Fok Miu Wan and Tai Long Wan) and Hong Kong Island (Shek O and Tai Tam Bay). However, due to rapid urban and rural development, and human activities around these areas, sea turtles no longer nest there today. Sham Wan, on Lamma Island, is now the only Hong Kong site in which a small population of Green Turtles is known to nest regularly. In addition to some sporadic and incomplete historical records, regular nesting of Green Turtles at Sham Wan beach has been recorded in recent years.

8.80 The Sham Wan nesting beach and its nearby shallow waters were made a Site of Special Scientific Interest (SSSI) in June 1999 in recognition of ecological value and scientific importance. The SSSI should be protected against disturbance and encroachment by development. Only a few listed uses, essential to sustain the site or conducive to the conservation or education purposes, are permitted. To avoid or minimize human disturbance to the Green Turtle nesting site, the sandy beach at Sham Wan was gazetted as a Restricted Area, under the Wild Animals Protection Ordinance in July 1999.

8.81 The major threats against the Green Turtle include: loss of suitable nesting sites as a result of coastal development, disturbance from human activities (e.g. artificial illumination and noise), marine pollution, debris washed ashore hindering the movements of egg-laying females and emerging hatchlings, incidental capture in fishing gear, injury from boat propellers, and poaching of eggs.

Horseshoe Crab

8.82 Horseshoe crabs are an ancient and taxonomically isolated group (Class Merostomata, sub-class Xiphosura) related to spider, ticks and mites. They are important in biomedical applications where the blood of horseshoe crabs is the source of compounds used to screen for pathogens in medical facilities and on medical equipment. Three species have been reported to occur in HKSAR waters: *Tachypleus tridentatus, T. gigas* and *Carcinoscorpius rotundicauda.* These represent all species known from the South China Sea (Sekiguchi 1988), and three of four species known world-wide. Information on abundance of these species is limited. The information and distribution of horseshoe crabs summarized below is based on Chiu and Morton (1999).

Distribution

8.83 At least 140 living horseshoe crab adults and 100 juveniles, and 17 dead adult specimens were recorded during the survey period from 1995 to 1998. They are distributed at Deep Bay (e.g. Ngau Hom Shek and Sheung Pak Nai) and Lantau Island (e.g. Yi O and Hau Hok Wan). Occasionally, they were fished up at Sai Kung and Lamma Island (AFCD 2006). Adults largely occur in shallow to deep waters while juveniles were generally encountered on intertidal sandy-mud flats. Two

horseshoe crabs, namely *T. tridentatus* and *C. rotundicauda* were recorded during the surveys. The locations where horseshoe crabs were either observed or recorded during the study period are shown in **Figure 8.10**.

T. tridentatus

8.84 Most identified during the survey period were from waters off Tai O, Yi O and Tung Chung Wan, Lantau Island (~-5 m C.D.). Some of them were recorded from the East and West Lamma Channel, Lung Kwu Sheung Tan, Shek Kwu Chau, Silverstrand beach and Sharp Island, with a few recorded sporadically from Lau Fau Shan (Deep Bay) and Kau Pei Chau (southern waters).

8.85 Large dead specimens were collected around Tuen Mun, Shek Kwu Chau and Waglan Island, Pui O, Tung O Wan and Pak Nai.

8.86 Juveniles of *T. tridentatus* were mostly recorded from sand or sandy-mud flats at Shui Hau Wan, San Tau and Pak Nai, with a few occasionally recorded at Lung Kwu Sheung Tan, Nim Wan and Sha Lo Wan.

C. rotundicauda

8.87 This species occurs in Tai O, Yi O, Shum Wat Wan, Sha Lo Wan and Tung Chung Wan, Peng Chau and Sha Shau. Juveniles have been recorded in Ha Pak Nai.

8.88 Coastal surveys were conducted on June and July 2002 for the "Tung Chung – Ngong Ping Cable Car Project, 2003. 57 juvenile individuals of the *T. tridentatus* and 2 juvenile individuals of *C. rotundicauda* were found in the San Tau mudflat and mouth of Tung Chung Stream.

8.89 Chiu and Morton (1999) found that in the Southern WCZ, dead adults *T. tridentatus* were found in Pui O Beach, Shek Kwu Chau, Tung O Wan, Kau Pei Chau and Waglan Island; juvenile *T. tridentatus* were found from Shui Hau Wan; live adult *T. tridentatus* were recorded in Peng Chau and Lamma Channel. From Chiu and Morton (1999) and "Tung Chung – Ngong Ping Cable Car Project, 2003", the Project Assessment Area, the northwestern side of Lantau Island is thought to be an important habitat for horseshoe crab.

8.90 These two species of horseshoe crabs appear to be in population decline and are thought to be under severe pressure in the South China Sea, including HKSAR waters, due to habitat loss and overexploitation (Huang, 1997).

Marine Park, Marine Reserve and SSSIs

Sha Chau and Lung Kwu Chau Marine Park

8.91 The Sha Chau and Lung Kwu Chau Marine Park is situated in the open waters on the western side of Hong Kong. This marine park was designated for Chinese White Dolphin mainly on 22 November 1996. It covers a total sea area of about 1,200 hectares.

8.92 The marine environment of Sha Chau and Lung Kwu Chau Marine Park is greatly influenced by the Pearl River freshwater run-off, with high organic loading and sediment loading. Marine organisms found in this region are highly adapted to low salinity and high turbidity marine environment.

8.93 Sha Chau and Lung Kwu Chau Marine Park has rich fisheries resources. Fishes of the Engrulidae, Scieanidae and Clupeidae families are important food for Indo-Pacific Humpback Dolphin (locally known as Chinese White Dolphin) which were found in this marine park. Therefore, it provides an important feeding ground for Chinese White Dolphin.

Marine Reserve

8.94 The Cape D' Aguilar Marine Reserve was designated on 5 July 1996. It lies in the southeastern tip of Hong Kong Island. The total sea area of this marine reserve is about 20 hectares.

8.95 The biodiversity is rich in this Marine Reserve, including numerous kind of hard corals, soft corals, gorgonian and marine invertebrates. In order to protect these important habitats, water sports and coastal activities are not allowed.

SSSIs

8.96 The Shek O Headland SSSI is located about 8km south of Junk Bay. This exposed rocky shore habitat was designated a SSSI in February 1998 because it is among the areas with the richest assemblages of macroalgae (seaweed) in Hong Kong.

8.97 In 1991 the Cape D' Aguilar area was designated a SSSI in recognition of the growing interest in understanding and conserving Hong Kong's marine environment.

8.98 Sham Wan was designated as a SSSI as it provides nesting site for Green Turtle.

8.99 Lung Kwu Chau, Tree Island and Sha Chau were designated as SSSI for its importance to night-time roosting Cormorants.

Artificial Reefs

8.100 There are two artificial reefs within the Assessment Area at Sha Chau and near International Airport. The goal of the artificial reefs was to enhance marine resources, rehabilitate degraded habitats, protect spawning and nursery ground for marine life and enhances habitat quality of seabed.

Ecological Value

8.101 Based on the results from the water quality modeling (Section 5 refers) on the dispersion of pollutants (total residue chlorine and chlorination by-products) and potential changes of water quality parameters (dissolved oxygen (DO) and *E. coli*) from this Project, the impacted areas would be restricted to waters within Victoria Harbour and Western Buffer WCZs. Therefore the following assessment focus on ecological resources within these waters with potential impacts, and resources outside these waters receiving no impacts are not discussed further.

8.102 With reference to the detailed baseline description above, the ecological values of these two WCZs are assessed using criteria in EIAO TM Annex 8, as presented in **Table 8.18**, **Table 8.19 and Table 8.20**.

Table 8.18 Ecological value of marine benthos within potential impacted areas (Victoria Harbour and Western Buffer WCZs)

Criteria	Benthos	
Broad area of potential impact	**Western Buffer**	**Victoria Harbour**
Naturalness	Benthic habitats have been subject to certain degree of disturbance from urban developments and are under the influence of water pollutants from Pearl River and Hong Kong urban discharges	Benthic habitats have been subject to high degree of disturbance from urban developments and are under the influence of water pollutants from Hong Kong urban discharges, as well as Pearl River discharges
Size	Moderate large	Moderate
Diversity	Species richness is low (d< 10) and diversity is low (H'<3)	Species richness is low (d< 10) and diversity is low (H'<3)
Rarity	All species recorded are common	All species recorded are common

Criteria	Benthos	
	and widespread in Hong Kong	and widespread in Hong Kong
Re-creatability	Moderate, as habitats have been subject to certain level of disturbance	High, as habitats have been subject to high level of disturbance
Ecological linkage	No. They are not linked to other high value habitats but would provide habitat for other marine fauna	No. They are not linked to other high value habitats but would provide habitat for other marine fauna
Potential value	Low	Low
Nursery/breeding area	Possible but none documented	Possible but none documented
Age	N.A.	N.A.
Abundance	Low	Low
Ecological Value	**Low**	**Low**

Table 8.19 Ecological value of coral community in potentially impacted areas (Victoria Harbour and Western Buffer WCZs)

Criteria	Corals	
Broad area of potential impact	**Western Buffer**	**Victoria Harbour**
Naturalness	Benthic habitats have been subject to certain degree of disturbance from urban developments and are under the influence of water pollutants from Pearl River and Hong Kong urban discharges	Benthic habitats have been subject to high degree of disturbance from urban developments and are under the influence of water pollutants from Hong Kong urban discharges, as well as Pearl River discharges
Size	Only a very small/ negligible size of soft corals was recorded in south of Tsing Yi and no hard corals were recorded. In Ap Lei Chau, both low abundance of soft and hard corals were recorded. In Sandy Bay, a moderate size of soft coral communities and small communities of hard corals were recorded	Only Green Island within this WCZ had soft coral recorded and these soft coral communities were abundant. Four species of soft coral and gorgonians including the Pink Soft Coral (*Dendronephthya* sp.), Orange Sea Fan (*Echinogorgia complexa*), White Sea Whip (*Euplexaura curvata*) and Purple Sea Whip (*Ellisella gracilis*) were recorded
Diversity	Low-moderate. Low soft coral diversity was recorded in south of Tsing Yi. Low soft coral diversity and moderate high hard coral diversity were recorded in Ap Lei Chau. Low soft coral diversity and moderate high hard coral diversity were recorded in Sandy Bay	No hard coral was recorded in Green Island but soft corals and gorgonians were of low diversity
Rarity	No rare species were recorded.	No rare species were recorded.
Re-creatability	Low. It takes long years for re-colonization	Low. It takes long years for re-colonization
Ecological linkage	No. They are not linked to other high value habitats but would provide habitat for other marine fauna	No. They are not linked to other high value habitats but would provide habitat for other marine fauna
Potential value	Low	Low
Nursery/breeding area	Possible but none documented	Possible but none documented
Age	N.A	N.A
Abundance	Low-moderate. Low abundance was	The soft corals recorded in Green

Criteria	Corals	
Broad area of potential impact	**Western Buffer**	**Victoria Harbour**
	recorded in Tsing Yi and Ap Lei Chau, but moderate abundance in Sandy Bay	Island were abundant
Ecological Value	**Low-moderate**	**Low-moderate**

Table 8.20 Ecological value of intertidal community in potentially impacted areas (Victoria Harbour and Western Buffer WCZs)

Criteria	Intertidal	
Broad area of potential impact	**Western Buffer**	**Victoria Harbour**
Naturalness	The coastline along Western Buffer contains a range of habitats from disturbed habitats such as artificial seawall (e.g. in Tsing Yi Island), and gazetted beaches (e.g. in Lido, Ting Kau), to natural rocky shore (e.g. in Sandy Bay)	The coastline along the Victoria Harbour is not natural. The coastline is straightened with concrete lining and artificial seawall
Size	Moderate size of intertidal habitats in Western Buffer WCZ	The size of concrete lining along coastline and artificial seawall stretched along Victoria Harbour
Diversity	Species richness is low	The artificial seawall supported by bio-fouling species
Rarity	Low as habitats support common and widespread species in Hong Kong	The bio-fouling species are common and widespread in Hong Kong
Re-creatability	Habitat can be recreated for sandy shore and artificial seawall. For natural rocky shore, it takes long time to allow species recolonization	Habitat can be recreated as most of the areas are mounted with artificial seawall
Ecological linkage	No. They are not linked to other high value habitats but would provide habitat for other marine fauna	No. They are not linked to other high value habitats but would provide habitat for other marine fauna
Potential value	Low	Negligible
Nursery/breeding area	Possible but none documented	Possible but none documented
Age	N.A.	N.A.
Abundance	Low	Low
Ecological Value	**Low**	**Low**

8.103 The only marine species of conservation interest recorded within the potential impacted areas is the Chinese White Dolphin. The evaluation on ecological value of Chinese White Dolphins will be in accordance with EIAO Annex 8 Table 3 and is presented in **Table 8.21**.

Table 8.21 Ecological value of Chinese White Dolphin within potentially impacted areas. (Victoria Harbour and Western Buffer WCZs)

Criteria	Chinese White Dolphin
Protection status	Protected under the Wild Animals Protection Ordinance (Cap. 170); Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586) and Marine Park Ordinance (Cap. 476); Chinese White Dolphin is listed in CITES Appendix 1 and protected in the Peoples Republic of

	China
Distribution	Local population mainly distributed in estuarine habitat in Pearl River Delta and Northwestern WCZ within the Assessment Area
Rarity	Over 1000 individuals recorded in Pearl River and Hong Kong waters. It is locally not uncommon

8.104 No records of Chinese White Dolphin were made from Victoria Harbour WCZ and less than 3 individuals per 100 km^2 were recorded in Western Buffer WCZ within 3 years surveying efforts. The potential impacted area supported very low occurrence of Chinese White Dolphin.

Identification of Environmental Impacts

Construction Phase

8.105 The Project will involve minor construction works within the existing Stonecutters Island Sewage Treatment Works (SCISTW) and no marine works will be included in this Project, and therefore no ecological impacts are expected. This issue is not addressed further in this Section.

Operation Phase

8.106 As discussed in Section 5, the key water quality issue of this Project would be the effect of disinfected sewage effluent discharged from the SCISTW. Key parameters of concern would include total residual chlorine (TRC) and chlorination by-products (CBPs), *E. coli,* and dissolved oxygen (DO). The formation of TRC and CBPs in the Project effluent would be due to chlorination and dechlorination of the sewage effluent. The changes of *E. coli* in the Project would be a result of the proposed disinfection. The potential oxygen depletion impact would be related to the dechlorinating agent.

8.107 There may be direct impacts from TRC and CBP which are toxic and persistent in nature and could cause formation of mutagenic/carcinogenic and toxic by products within organisms which would pose ecological risks to marine life (Monarca et al., 2000). Other potential direct impacts may cause mortality and sub-lethal toxicity to marine life. The sub-lethal toxicity may include alternation of physiology of organism such as foot activity and byssus production and filtration rate of mussels (Rajagopal et al., 2003). The potential impacts of acute and chronic toxicity to fish from the disinfected effluent are addressed in detail under the Ecological Risk Assessment in Section 7.

8.108 *E. coli* contains many strains. Not all strains are toxic in nature to marine organisms. There are pathogenic strains which would potentially adhere to the gill surface and cause mortality of fish species (Yin et al., 2006). Some of the marine organisms such as fish would become aggressive when they are stimulated by pathogens (Efthimiou et al., 1994). However, not all the marine organisms would suffer from adverse impacts by pathogenic strains. From the *in-vitro* essay, most marine organisms including crustacean species would induce anti-bacterial enzyme or chemicals within their haemolymph, cephalothorax, exoskeleton and gills as a body defence against pathogenic strains of *E.coli*. (Hang et al., 2002).

8.109 If dissolved oxygen reaches critically low levels marine organisms may suffocate and die. If levels of DO are reduced to a low but sub-lethal level many organisms can survive by increasing their ventilation rate and volume. However the increase in oxygen consumption rate is metabolically demanding and would reduce the energy available for other vital processes (Valverde et al., 2006).

8.110 There may be potential issue related to TRC and CBPs evaporated and dissolved in rain, fog or atmospheric moisture to cause potential indirect impacts to the terrestrial and marine environment.

Evaluation of Environmental Impacts

8.111 The water quality impact modeling results in Section 5 indicated that the potential impact zone would be restricted to the Victoria Harbour and Western Buffer WCZs. Therefore, the impact assessment focuses on ecological resources including benthos, intertidal and coral communities and Chinese White Dolphin, in these two WCZs.

8.112 The potential changes in concentration of TRC, CBPs, DO and *E coli*. have been predicted by the water quality modeling in Section 5. The results show that small increase in TRC, CBPs and small decrease in DO are localized around the existing SCISTW outfall, with *E coli.* reduction in the Western Buffer and Victoria Harbour WCZs only. Therefore, the assessment below and presented in **Tables 8.22-8.25** focus only on marine ecological resources present in the potentially impacted zones, i.e. Victoria Harbour and Western Buffer WCZs. No impacts on ecological resources outside the impacted zone are expected.

8.113 As discussed in details in Section 5, the dispersal of TRC and CBPs in the disinfected effluent would be localized at the existing SCISTW sewage outfalls. The level of TRC would be lower than 0.001 mg/L, within the assessment criteria of 0.008 mg/L. It is estimated that the distances between the SCISTW sewage outfall location to the coral at Ap Lei Chau, Sandy Bay and Green Island are approximately 9.1 km, 5.1 km and 4.3 km respectively and these coral sites area located outside the ZID and mixing zone. The water quality model predicted that the SCISTW effluent would not cause any exceedance of WQO at these coral sites in terms of TRC, CBPs and DO levels. These coral sites are located outside the influence zone of TRC under emergency situations. The detailed acute and chronic effects of TRC and CBPs are assessed in Section 7, Ecological Risk Assessment of Aquatic Life and no significant adverse impact is anticipated.

8.114 With the implementation of the Project, the levels of *E. coli* would be significantly reduced. In addition, there would be a localized and slight decrease of DO level and increase of the TRC and CBP levels. There would be improvement to water quality in the Western Buffer WCZ and western Victoria Harbour WCZ. In the intermediate operation stage of HATS (in year 2013), the south of Tsing Yi Island and western Victoria Harbour WCZ would have *E coli.* levels reduced from over 50000 numbers per 100mL (without disinfection facilities) to 1000-5000 number per 100mL (with disinfection facilities). In the ultimate year operation stage of HATS, the south of Tsing Yi Island and Western Victoria Harbour *E. coli* levels would be reduced from over 500-5000 number per 100mL (without disinfection facilities) to less than 180 number per 100mL (with disinfection facilities). The reduction in *E. coli* levels by the Project would have a positive impact on marine ecology.

8.115 The predicted oxygen depletion levels at the SCISTW outfall was highest in the wet season at 0.14 mg/L and 0.21 mg/L, in the intermediate and ultimate operation years of HATS respectively. It would be expected that the actual levels would be smaller as it was predicted as a worst case scenario. Such slight decrease in DO level localized at the SCISTW outfall would not pose significant impacts to ecological resources in Western Buffer and Victoria Harbour WCZs.

8.116 As discussed in Section 11, the TRC and CBPs concentration levels in the effluent discharged from SCISTW would be very low and TRC is mostly degraded in water by self-decomposition. Therefore, the potential ecological impacts from TRC and CBPs to be evaporated into atmosphere or dissolved by rain, fog or atmospheric moisture would be insignificant.

8.117 Based on the above, in accordance with the EIAO TM Annex 8 criteria, the potential ecological impacts on marine benthic community, coral community, intertidal community and Chinese White Dolphin are presented in **Tables 8.22 to 8.25**.

Table 8.22 Potential ecological impacts on Benthos habitats within potential impacted areas (Victoria Harbour and Western Buffer WCZs)

Criteria	Western Buffer WCZ	Victoria Harbour WCZ
Habitat quality	Low	Low
Species	Dominant species are polychaetes and crustaceans, which are common and widespread in Hong Kong	Dominant species are polychaetes and crustaceans, which are common and widespread in Hong Kong
Size/ Abundance	Moderate size of benthic habitat would be impacted	Moderate size of benthic habitat would be impacted
Duration	Long term	Long term

Criteria	Western Buffer WCZ	Victoria Harbour WCZ
Reversibility	No	No
Magnitude	Low. Small localized change of TRC, CBPs and DO at SCISTW outfall and resulting ecological impacts would be insignificant. Water quality improvement with reduction of *E.coli* levels	Low. Small localized change of TRC, CBPs and DO at SCISTW outfall and resulting ecological impacts would be insignificant. Water quality improvement with reduction of *E.coli* levels
Potential Impact	**Low**	**Low**

Table 8.23 Potential ecological impacts of coral community within potential impacted areas (Victoria Harbour and Western Buffer WCZs)

Criteria	Western Buffer WCZ	Victoria Harbour WCZ
Habitat quality	Low- Moderate	Low-moderate
Species	A very few soft coral species were recorded in waters at south of Tsing Yi and no hard coral species was recorded in Tsing Yi. The soft coral species recorded in Sandy Bay and Ap Lei Chau were low. Moderate high number of hard coral taxa (>14 taxa) were recorded in Ap Lei Chau and Sandy Bay. No rare and protected species recorded	Only Green Island within this WCZ had the records soft coral species of low diversity
Size/ Abundance	Low abundance of soft coral and no hard coral community were recorded in south of Tsing Yi. Low abundance of both soft and hard corals was recorded in Ap Lei Chau. Moderate high abundance of soft corals and low abundance of hard corals were recorded in Sandy Bay	The soft corals recorded in Green Island species were abundant
Duration	Long term	Long term
Reversibility	No	No
Magnitude	Low. Small localized change of TRC, CBPs and DO at SCISTW outfall and resulting ecological impacts would be insignificant. Water quality improvement with reduction of *E.coli* levels	Low. Small localized change of TRC, CBPs and DO at SCISTW outfall and resulting ecological impacts would be insignificant. Water quality improvement with reduction of *E.coli* levels
Potential Impact	**Low**	**Low**

Table 8.24 Potential ecological impacts of intertidal communities within potential impacted areas (Victoria Harbour and Western Buffer WCZs)

Criteria	Western Buffer WCZ	Victoria Harbour WCZ
Habitat quality	Low	Low
Species	The dominant species of herbivorous grazers and limpets are common and widespread in Hong Kong	The dominant species would be the bio-fouling organisms and are common and widespread in Hong Kong
Size/ Abundance	Low abundance of species recorded	Low
Duration	Long term	Long term
Reversibility	No	No

Criteria	Western Buffer WCZ	Victoria Harbour WCZ
Magnitude	Low. Small localized change of TRC, CBPs and DO at SCISTW outfall and resulting ecological impacts would be insignificant. Water quality improvement with reduction of *E.coli* levels	Low. Small localized change of TRC, CBPs and DO at SCISTW outfall and resulting ecological impacts would be insignificant. Water quality improvement with reduction of *E.coli* levels
Potential Impact	**Low**	**Low**

Table 8.25 Ecological impact of Chinese White Dolphin within potential impacted areas (Western Buffer and Victoria Harbour WCZs)

Criteria	Chinese White Dolphin
Habitat quality for Victoria Harbour and Western Buffer WCZs	The habitats have been subject to certain degree of disturbance from urban developments and are under the influence of water pollutants from Pearl River and Hong Kong urban discharges
Species	Chinese White Dolphin is an ecologically important species listed under IUCN Red List of Threatened Species, CITES Appendix 1 and protected Animals under Hong Kong Legislation and in the People Republic of China
Size/ Abundance	Less than 3 individuals per 100 km^2 within 3 years surveying efforts were recorded in Western Buffer WCZ compared with the highest density area (West Lantau) with average seasonal densities of 185 individuals per 100 km^2. No record of Chinese White Dolphin was made in Victoria Harbour WCZ
Duration	Long term
Reversibility	No
Magnitude	Low. Small localized changes of TRC, CBPs and DO at SCISTW outfall and resulting ecological impacts would be insignificant. Water quality improvement with reduction of *Ecolab* levels
Potential Impact	**Low**

8.118 No adverse marine ecological impacts are anticipated, considering the reasons below:

- Improvement in water quality with reduction in *E coli.* levels in Western Buffer WCZ and western Victoria Harbour WCZ;
- Localized and small changes in TRC, CBPs and DO at around the existing SCISTW outfall;
- No unacceptable ecological risk on marine mammal and aquatic life in relation to acute and chronic effects. Predicted risk of chlorination by-products imposed to aquatic life was estimated to be 0.5 to 0.7 and 0.3 to 0.5 at edge of initial dilution zone and edge of mixing zone respectively. For marine mammals, predicted risk of chlorination by-products imposed to dolphins and propoises was estimated to be 0.001 to 0.002 and 0.001 respectively;
- Western Buffer WCZ and western Victoria Harbour WCZ generally support low to moderate value ecological resources.

Mitigation of Environmental Impact

8.119 The existing SCISTW outfall location was chosen at an area with low ecological value to avoid adverse impacts on key ecological resources. As discussed above there would be no adverse ecological impacts from the proposed disinfection and therefore no mitigation measures would be required. A dosing system will be used at the ADF, to minimize the chlorine dose needed for disinfection therefore reducing the potential for generation of CBPs and TRC. An operational phase environmental monitoring programme will also be recommended in the EM&A Manual to confirm the predictions of the environmental impacts made in this EIA report (Details in Section 5).

Evaluation of Residual Impacts

8.120 Based on the above assessment, no residual impact from the Project on ecological resources is anticipated.

Environmental Monitoring and Auditing

8.121 Environmental monitoring and auditing requirements in relevant to protection of ecological resources are covered in the Water Quality Assessment and Ecological Risk Assessment in Section 5 and Section 7 respectively.

Conclusions

8.122 A literature review has been conducted to establish the ecological baseline condition of the Assessment Area and assessment of potential impacts conducted in accordance with the EIAO TM requirements.

8.123 The water quality impact modeling results in Section 5 indicated that the potential impact zone would be restricted to the Victoria Harbour and Western Buffer WCZs. No impacts on ecological resources outside of this zone are expected.

8.124 The existing SCISTW outfall location was chosen at an area with low ecological resources. No adverse ecological impacts are anticipated from the Project because:

- Improvement in water quality with reduction in *E coli.* levels in Western Buffer WCZ and western Victoria Harbour WCZ;
- Localized and small changes in TRC, CBPs and DO at around the existing SCISTW outfall;
- No unacceptable ecological risk on marine mammal and marine life in relation to acute and chronic effects; and
- Western Buffer WCZ and western Victoria Harbour WCZ generally support low to moderate ecological resources.

8.125 As there would be no adverse marine ecological impacts from the proposed disinfection no mitigation measures would be required. A dosing system will be used at the ADF, to minimize the chlorine dose needed for disinfection therefore reducing the potential for generation of CBPs and TRC Environmental monitoring and auditing requirements relevant to ecological resources protection are covered in the Water Quality Assessment and Ecological Risk Assessment. An operational phase environmental monitoring programme for the ADF is recommended, details of which can be found in the EM&A Manual accompanying this study.

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