13. Marine Ecological Impact

13.1 Introduction

13.1.1.1 The Marine Ecological Impact Assessment has been conducted in accordance with the Environmental Impact Assessment (EIA) Study Brief No. ESB-250/2012 requirements under Section 3.4.10 and Appendix F, and the Technical Memorandum on Environmental Impact Assessment Ordinance Process (EIAO-TM) Annexes 8 and 16. This chapter examines the flora, fauna and other components of marine ecological habitats within the study area. Terrestrial ecological habitats and associated components have been addressed in **Chapter 12** Terrestrial Ecological Impact of this EIA Study. The potential impacts to all avifauna are discussed also in **Chapter 12** and not covered in this chapter.

13.2 Relevant Legislation, Standards and Guidelines

13.2.1.1 A number of international conventions, local legislation and guidelines provide the framework for the protection of species and habitats of marine ecological importance. Those related to the project are as follows:

- Wild Animals Protection Ordinance (Cap. 170);
- Protection of Endangered Species of Animals and Plants (Ordinance (Cap. 586);
- Marine Parks Ordinance (Cap. 476);
- Town Planning Ordinance (Cap. 131);
- Environmental Impact Assessment Ordinance (Cap. 499) and the Technical Memorandum on Environmental Impact Assessment Process (EIAO-TM);
- EIAO Guidance Notes No. 6/2010 Some Observations on Ecological Assessment from the Environmental Impact Assessment Ordinance Perspective;
- EIAO Guidance Notes No. 7/2010 Ecological Baseline Survey for Ecological Assessment;
- EIAO Guidance Note No. 11/2010 Methodologies for Marine Ecological Baseline Surveys;
- The Convention on Biological Diversity (1992) and the Strategic Plan for Biodiversity 2011-2020 and Aichi Biodiversity Targets;
- Convention on International Trade in Endangered Species of Wild Flora and Fauna (CITES);
- The IUCN Red List of Threatened Species;
- The Ramsar Convention; and
- Wild Animal Protection Law of the Peoples' Republic of China (PRC).

13.2.1.2 Under the *Wild Animals Protection Ordinance (Cap. 170)*, designated wild animals are protected from being hunted, whilst their nests and eggs are protected from destruction and removal. All

birds and most mammals including all cetaceans are protected under this Ordinance, as well as certain reptiles, amphibians and invertebrates. The Second Schedule of the Ordinance that lists all the animals protected was last revised in June 1992.

13.2.1.3 The *Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586)* was gazetted on 10 March 2006 to replace the previous Animals and Plants (Protection of Endangered Species) Ordinance *(Cap. 187)*. The new Ordinance was effective on 1 December 2006 and regulates the import, introduction from the sea, export, re-export and possession or control of certain endangered species of animals and plants and parts and derivatives of those species; and to provide for incidental and connected matters.

13.2.1.4 The *Marine Parks Ordinance (Cap. 476)* vests the Country and Marine Parks Authority the power to designate, control and manage marine parks and marine reserves for the protection of marine life in these areas.

13.2.1.5 The *Town Planning Ordinance (Cap. 131)* provides for the designation of areas such as “Coastal Protection Areas”, “Sites of Special Scientific Interest (SSSIs)”, “Green Belt” and "Conservation Area” to promote conservation or protection of significant habitat.

13.2.1.6 *Environmental Impact Assessment Ordinance (Cap. 499)*, which specifies designated projects under Schedule 2 of the Ordinance, unless exempted, must follow the statutory environmental impact assessment (EIA) process and require environmental permits for their construction and operation.

13.2.1.7 *Annex 8* of the *EIAO-TM* recommends the criteria that can be used for evaluating ecological impacts, while *Annex 16* 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.

13.2.1.8 *EIAO Guidance Notes No. 6/2010, 7/2010 and 11/2010*, which provide respectively the observations on Ecological Assessment from the EIAO perspective, the general guidelines for conducting an ecological baseline survey for ecological assessment, and methodologies for marine ecological baseline surveys in order to fulfil the requirements stipulated in the EIAO-TM in respect of marine ecological assessment for the proposed development.

13.2.1.9 The PRC is a Contracting Party to the Convention on Biological Diversity (CBD) of 1992. The Convention was extended to Hong Kong on 9 May 2011. The Convention requires signatories to make active efforts to protect and manage their biodiversity resources. The government of the Hong Kong Special Administrative Region has stated that it will be “committed to meeting the environmental objectives” of the Convention. In 2010 the Parties to the CBD adopted the *Strategic Plan for Biodiversity 2011-2020 and Aichi Biodiversity Targets* with the purpose of inspiring broad-based action in support of biodiversity over the next decade by all countries and stakeholders. The Strategic Plan comprised 5 strategic goals and 20 headline targets, known as the Aichi Biodiversity Targets (ABTs). The ABTs serve as a flexible framework for the establishment of national and regional targets for biodiversity conservation.

13.2.1.10 *The Convention on International Trade in Endangered Species of Wild Fauna and Flora of Wild Fauna and Flora (CITES)* is an international agreement between governments. Its aim is to ensure that international trade in specimens of wild animals and plants does not threaten their survival.

13.2.1.11 The International Union for Conservation of Nature (IUCN) is the world's main authority on the conservation status of species. The *IUCN Red List of Threatened Species™*, founded in 1963, is widely recognised as the most comprehensive, objective global approach for evaluating the conservation status of plant and animal species. From its small beginning, the IUCN Red List has grown in size and complexity and now plays an increasingly prominent role in guiding conservation activities of governments, NGOs and scientific institutions. The introduction in 1994 of a scientifically rigorous approach to determine risks of extinction that is applicable to all species, has become a world standard.

13.2.1.12 The *Ramsar Convention* is an intergovernmental treaty signed on 2 February 1971 in the Iranian city of Ramsar and entered into force in 1975. The Convention provides the framework for national action and international cooperation for the conservation and wise use of wetlands and its resources. The official name of the treaty is "The Convention on Wetlands of International Importance especially as Waterfowl Habitat" which reflects its original emphasis on the conservation of wetlands primarily to provide habitat for waterbirds. The Ramsar Convention enters into force in China on 31 July 1992, currently China has 41 Ramsar Sites covering 3.7 million hectares in area. Mai Po Inner Deep Bay Ramsar Site is the 7th Ramsar Site of China.

13.2.1.13 The PRC in 1988 ratified the *Wild Animal Protection Law* of the PRC, which lays down basic principles for protecting wild animals. The Law prohibits killing of protected animals, controls hunting, and protects the habitats of wild animals, both protected and non-protected. The Law also provides for the creation of lists of animals protected at the state level, under Class I and Class II. There are 97 animal species in Class I and 155 in Class II. Class I provides a higher level of protection for animals considered to be more threatened.

13.3 Objectives of the Marine Ecological Impact Assessment

13.3.1.1 The marine ecological impact assessment examines the faunal, floral and ecological attributes of the study area with the aim to provide sufficient and accurate ecological data to allow a complete and objective identification, prediction and evaluation of the potential marine ecological impact.

13.3.1.2 The broad objectives of the Marine Ecological Impact Assessment, as detailed in the EIA Study Brief, are as follows:

- Review the findings of relevant studies / surveys and collate the available information (**Section 13.4.4**);
- Evaluate the information collected, identify any information gap relating to the assessment of potential ecological impacts to the natural environment, and determine the ecological field surveys and investigations that are needed for a comprehensive assessment. The field surveys shall cover but not be limited to flora, fauna and any other habitats / species of conservation importance, and shall include subtidal and intertidal survey, benthic community

survey, and underwater dive survey for coral communities (**Section 13.4.4** and **Section 13.4.5**);

- The ecological field surveys and investigations shall include the Hong Kong International Airport Approach Area (HKIAAA), in particular Area 3 which will be directly affected by the proposed land formation, to assess the status of the intertidal, subtidal soft and hardsubstrate benthic communities. Reference sites in western Hong Kong waters with similar ecological attributes should be selected and included in the survey design in order to accurately evaluate the ecological values of the various habitat types within HKIAAA if necessary (**Section 13.4.5**);

- Establish the general ecological profile of the study area based on the information collected and describe the characteristics of each habitat found (**Section 13.4.6**);

- Investigate and describe the existing wildlife uses of various habitats with special attention to those wildlife groups and habitats with conservation interest (**Section 13.5**);

- Using suitable methodologies, and considering also any works activities from other projects reasonably likely to occur at the time, identify and quantify as far as possible any direct, indirect, on-site, off-site, primary, secondary and cumulative ecological impacts on the wildlife groups and habitats (**Section 13.6** and **Section 13.7**);

- Evaluate the marine ecological impacts using quantitative approach as far as practicable covering the construction and operation phases of the project (**Section 13.8** and **Section 13.9**);

- Recommend possible and practicable mitigation measures and evaluate the feasibility and effectiveness of the recommended mitigation measures (**Section 13.11**);

- Determine and quantify as far as possible the residual ecological impacts after implementation of the proposed mitigation measures and evaluate the significance of impact and acceptability of the residual ecological impacts (**Section 13.14**); and

- Review the need for and recommend any marine ecological monitoring programme required (**Section 13.16**).

13.3.1.3 The Chinese White Dolphin (*Sousa chinensis*) has been recognised as species of particular concern in the EIA Study Brief (No. ESB-250/2012) and the following specific objectives have been identified for the assessment of this species:

- Review and incorporate the findings of relevant studies including scientific and EIA studies and collate latest available information on the occurrence, distribution, abundance, fine-scale habitat use, social structure and geographic clustering, individual movement and range use, and residency pattern of Chinese White Dolphins (CWDs) in Hong Kong, in particular the detected declining trends in dolphin abundance in the past decade (**Section 13.4.4**);

- Evaluate the information collected and identify any information gap relating to the assessment of potential impacts on Chinese White Dolphins (**Section 13.4.4**);

- Carry out necessary field surveys/investigations to verify the information collected and fill the information gaps identified (**Section 13.4.5**). The surveys/investigations shall include, but not be limited to, the following:

- Marine mammal survey (shipboard or land-based survey) to investigate the dolphin usage, especially in HKIAAA;

- Investigation on the movement patterns of Chinese White Dolphins during different times of the years and different times of each day at or near the project area, and identification of the travelling areas of Chinese White Dolphins between their core areas of activities (i.e. Lung Kwu Chau, the Brothers and west Lantau), employing suitable methods such as shore-based theodolite tracking, focal follow, passive acoustic monitoring system, and analysis of individual range use, in northern and western Lantau waters, and especially within HKIAAA;

- Investigation on the existing marine traffic pattern and volume, and project with suitable methodology the future marine traffic in North Lantau or other areas, especially the traffic associated with the SkyPier facility, to facilitate the assessment of impact to Chinese White Dolphins due to changes in marine traffic.

- Underwater acoustic study to collect data on anthropogenic noises generated by vessel traffic (e.g. examination of the noise characteristics of vessels departing from and arriving at the SkyPier), and acoustic behaviour of dolphins (e.g. in the presence and absence of vessel noise) for detailed assessment of acoustic disturbance to Chinese White Dolphins.

▪ Compile and present survey / investigation findings (**Section 13.4.5** and **13.4.6**).

▪ Assess the direct and indirect impacts to marine mammals during the construction and operation phases of the project, in particular the following (**Section 13.9**):

- Potential changes in dolphin distribution and abundance, usage pattern, interaction between the different social clusters of dolphins, and connectivity between their core areas of activities in Hong Kong;

- Impacts to Chinese White Dolphins due to land formation, in particular the direct and permanent loss of dolphin habitat, habitat fragmentation, and reduction in ecological carrying capacity for dolphins;

- Extent of overlap of the proposed land formation footprint with the travelling areas of Chinese White Dolphins and the impact of such narrowing of travelling areas on their movement between core areas of activities, e.g. between NW and NE Lantau waters;

- Impacts to Chinese White Dolphins (and also Indo-Pacific Finless Porpoises depending on the locations of fill source and disposal sites) associated with dredging, fill extraction, filling, transportation and disposal of dredged sediments within Hong Kong;

- Impacts to Chinese White Dolphins, in particular changes in movement pattern between their core areas of activities and increased risk of vessel collision;

- Disturbance to Chinese White Dolphins associated with underwater noise, including pilling, noise generated from additional work barges and vessels during the construction phase, and long term increase in underwater noise disturbance caused by the predicted changes in marine traffic during the operation phase;

- Impacts to Chinese White Dolphins due to the proposed Deep Cement Mixing (DCM) method of land formation;

- Impacts to Chinese White Dolphins due to other associated works of the project (e.g. re-alignment of the existing aviation fuel sub-sea pipeline part of which is within the Sha Chau and Lung Kwu Chau Marine Park (SCLKCMP));
- Impacts to the prey resources of Chinese White Dolphins due to the loss of benthic habitat at the proposed land formation footprint;
- Impacts of changes in water quality / hydrodynamics properties to Chinese White Dolphins and their prey resources;
- Risks of bioaccumulation of toxic contaminants released from the disturbed or dredged sediment in particular the Contaminated Mud Pits (CMPs), oil and chemical spillage from vessel / vehicle accidents, and aircraft accidents to Chinese White Dolphins;
- Impacts to the existing SCLKCMP especially the likely increase in marine traffic volume / density and changes in overall hydrology and sedimentation as a result of the narrowing of passage between the southern boundary of the marine park and HKIAAA boundary which will be extended northward during the operation phase of this Project;
- Impacts to the planned Marine Park at the Brothers (BMP) and potential Southwest Lantau Marine Park (SWLMP) which are regarded as a core areas for Chinese White Dolphins in Hong Kong, and to dolphin movement from northwest and west Lantau to these potential Marine Parks; and
- Impacts of additional high-speed ferry traffic, land formation and changes in water quality / hydrodynamics properties resulted from the project on the functionality of the existing SCLKCMP and potential Marine Park at the Brothers as the major dolphin protected areas.

▪ Assess the overall cumulative impacts (**Section 13.15**);

▪ Identify and recommend practical mitigation measures (**Section 13.11**);

▪ Evaluate and demonstrate the feasibility and effectiveness of the recommended mitigation measures (**Section 13.11**);

▪ Evaluate the significance of residual impacts (**Section 13.14**); and

▪ Review the need for a dolphin monitoring programme (**Section 13.16**).

13.3.1.4 All the above items are covered in the relevant sections below.

13.4 Ecological Baseline

13.4.1 Background

13.4.1.1 The marine ecological baseline has been determined via a combination of literature review and ecological surveys to cover any data gaps and provided more recent and project specific data on the existing ecological conditions in the study area to form the basis of the ecological impact assessment.

13.4.1.2 Given the restricted access to HKIAAA, there is limited available ecological data on the baseline conditions in this part of the study area to determine the ecological value of the habitats. As such, the ecological field surveys have placed particular focus on this area, including areas which would be directly and potentially indirectly affected by the proposed land formation north of the existing airport platform.

13.4.2 Project Area

13.4.2.1 The three-runway system (3RS) project area is shown in **Drawing No. MCL/P132/EIA/4-001** which mainly comprises approximately 650 ha of land formation in the existing marine open waters and seawall development of approximately 5.9 km immediately north of the Hong Kong International Airport (HKIA) existing platform in the northern Lantau waters. The project area will cover a permanent total seabed footprint of approximately 672 ha. Other coastal or marine work areas include the installation of new approach lights and marker beacons for the new third runway, diversion of the existing aviation fuel sub-marine pipeline at the Aviation Fuel Receiving Facility (AFRF) in the Sha Chau and Lung Kwu Chau Marine Park (SCLKCMP) and diversion of electricity cables including minor excavation works at the field joint locations.

13.4.2.2 Seabed within the project area comprises of marine sediment and derbis formed from natural sedimentation with the influence of flows from the Pearl River Estuary. The existing seawall is largely constructed of sloping armour rock with the berthing point being constructed of vertical concrete.

13.4.3 Study Area

Background

13.4.3.1 As stipulated in Sections 3.4.10.2 and 3.4.6.2 of the EIA Study Brief (No. ESB-250/2012), the study area for marine ecology includes the North Western Water Control Zone (WCZ), North Western Supplementary WCZ, Deep Bay WCZ and Western Buffer WCZ as designated under the Water Pollution Control Ordinance (WPCO), and the water sensitive receivers in the vicinity of the project.

13.4.3.2 Sensitive areas that are close to the project site and have the potential to be impacted by the project include coral sites and Chinese White Dolphin (CWD) (*Sousa chinensis*, known internationally as the Indo-Pacific humpback dolphin) habitats in the above WCZs, intertidal habitats for horseshoe crabs and seagrass beds, intertidal habitats at Tai Ho Wan and San Tau Beach Site of Special Scientific Interest (SSSI), SCLKCMP, the planned BMP, the potential SWLMP and artificial reefs (ARs) deployed in the SCLKCMP. All these areas were covered in this chapter.

13.4.3.3 There are also other areas of conservation importance, while inside the broad study area, located in notable distance away from the project site, for example, Pak Nai SSSI, Mai Po Inner Deep Bay Ramsar Site, Inner Deep Bay SSSI and Tsim Bei Tsui SSSI. These sites are unlikely to be impacted by this project, as confirmed by the water quality assessment results (see **Chapter 8**). Therefore, the ecological assessment has largely focussed on the North Western Water Control Zone.

13.4.3.4 The study area is shown in **Drawing No. MCL/P132/EIA/13-001**.

Marine Water and Sediment Quality

13.4.3.5 The study area for marine ecology covers four WCZs. The proposed 3RS land formation area is situated in the North Western WCZ. The marine waters in this area support the subtidal hard and soft bottom assemblages, marine fishes and provide habitats for the Chinese White Dolphin (CWD). The baseline water and sediment quality conditions within the study area are provided herein as reference. This information, together with the results of water quality modeling in **Chapter 8**, would aid in the marine ecological impact assessment.

13.4.3.6 The North Western WCZ is influenced by the discharges from Pearl River, especially in the wet season. According to the findings of the routine marine water quality monitoring by the Environmental Protection Department (EPD, 2012), the total inorganic nitrogen (TIN) concentrations in the North Western WCZ comprise high background levels which fail the annual mean depth-averaged water quality objectives of ≤0.5 mg/L (with a range of 0.56 to 0.85 mg/L). The monitoring station NM6 meets the dissolved oxygen (DO) Water Quality Objective (WQO) with a depth-averaged value of ≥4 mg/L (DO concentration at mid-depth ranges from 5.9 to 8.8 mg/L at monitoring station closest to the project area (NM6)). The annual mean suspended solid concentration at station NM6 is 6.2 mg/L at depth averaged (with a range of 2.5 to 12.5 mg/L).

13.4.3.7 From the sediment quality monitoring data routinely collected by EPD from 1986 to 2012 (**Table 8.12** in **Chapter 8**, the average levels of metals including cadmium, chromium, copper, mercury, nickel, lead, zinc and silver do not exceed the corresponding Lower Chemical Exceedance Level (LCEL) in the north Chek Lap Kok area. The average level of arsenic marginally exceeds the LCEL.

13.4.3.8 Details of the baseline water quality and sediment quality of the study area are presented in **Section 8.3.3 and Section 10.4.1** of this EIA respectively.

Known Habitats or Species of Conservation Importance from Literature

13.4.3.9 Marine habitats that are sensitive to physical changes or ecological impacts and are identified to be of relevance to the project include:

- San Tau Beach Site of Special Scientific Interest (SSSIs);
- SCLKCMP (including the Lung Kwu Chau, Tree Island and Sha Chau SSSI inside the park which is discussed in **Chapter 12**, Terrestrial Ecology);
- Artificial Reef at SCLKCMP;
- Planned BMP;
- Potential SWLMP;
- Mangroves, mudflats and seagrass beds along the northern Lantau coastline;

- Horseshoe crab breeding and nursery sites along the northern Lantau coastline;
- Marine benthic macrofauna habitats; and
- Chinese White Dolphin (CWD) habitats.

13.4.3.10 Species of conservation importance that are associated with the marine habitat in the study area have been identified from the following groups:

- Coral communities;
- Intertidal flora and fauna including seagrass, mangroves and horseshoe crabs;
- Estuarine fishes and macroinvertebrates;
- Marine fishes and crustaceans; and
- Chinese White Dolphins (CWDs).

13.4.3.11 The proposed project is located within the habitat utilised by the CWD which is a "Class I National Key Protected Species" in the Mainland and is also listed under The Convention on International Trade in Endangered Species of Wild Fauna and Flora of Wild Fauna and Flora (CITES – Appendix I, which includes species threatened with extinction and trade in specimens of these species is permitted only in exceptional circumstances) and 'Near Threatened' by IUCN Red List (version 2013.2). In Hong Kong, it is protected under Wild Animals Protection Ordinance (Cap. 170) and the Protection of Endangered Species of Animals and Plants Ordinance (Cap. 586).

13.4.3.12 The locations of identified key habitats and species of conservation importance are shown in **Drawing No. MCL/P132/EIA/13-001**.

<u>Recognised Sites of Conservation Importance</u>

<u>Sites of Special Scientific Interest (SSSI)</u>

13.4.3.13 There are three Sites of Special Scientific Interest (SSSI) in the study area within the North Western WCZ comprising San Tau Beach SSSI, Tai Ho Stream SSSI and Lung Kwu Chau, Tree Island and Sha Chau SSSI (**Drawing No. MCL/P132/EIA/13-001**). Since Tai Ho Stream SSSI was designated for the conservation of stream fauna, and Lung Kwu Chau, Tree Island and Sha Chau SSSI was designated for the conservation of ardeids roosting site which are under the aspect of terrestrial ecology, these SSSIs have been discussed in **Chapter 12**.

13.4.3.14 San Tau Beach was designated as a SSSI in 1994 due to the recognition of the presence of a seagrass bed (Kwok *et al.*, 2005a). It is located at the west of Tung Chung Bay, at about 5 km from the project site. It is a shallow sheltering beach of about 2.7 ha with a mix of fine sand and silt. There are also some mangroves near the landward side of the beach. A seagrass bed of *Zostera japonica* and *Halophila ovalis* covering the intertidal mudflat outside the mangroves is one of the few places with seagrasses in Hong Kong.

Sha Chau and Lung Kwu Chau Marine Park

13.4.3.15 The SCLKCMP is situated in open waters on the western side of Hong Kong. This marine park was designated in 1996 and covers a total sea area of about 1,200 ha. The indicative location of the SCLKCMP is about 900 m from the project site, as shown in **Drawing No. MCL/P132/EIA/13-001**. The boundary is demarcated by yellow light buoys deployed at the corners of the marine park. The landward boundary largely follows the high water mark along the coastline of the islands (AFCD, 2013b). The water quality within the SCLKCMP is influenced by the Pearl River discharge, resulting in low salinity seawater but high organic nutrient levels. As such, marine organisms that are present within these waters are highly adapted to salinity fluctuations with periods of continuous low salinity, and highly turbid environments.

13.4.3.16 The SCLKCMP supports diverse flora and fauna, and is well-known for being rich in fisheries resources and also as an important habitat for the CWDs (AFCD, 2013b). The distribution of the CWDs is related to the freshwater input from the Pearl River. The majority of dolphin sighting appears on the eastern coast, the northwest and southwestern tips of Lung Kwu Chau, and near the northeast and southwest coast of Sha Chau. Nevertheless, the Marine Park acts as a protected habitat for more than 50 fish species and the CWDs within the western waters. It is protected under Cap. 476, and the following activities within the Marine Park which may affect the marine habitats and resources are prohibited (AFCD, 2013b):

- Unauthorised fishing, hunting, collecting or possessing any wild animals or plants, or their parts;
- Disturbing the eggs, juvenile or the nesting sites of any protected marine species;
- Possession of trawl net, spear gun, explosives, chemicals or devices using electric charge used for fishing;
- Operating vessels exceeding the speed of 10 knots;
- Damaging any shoreline features on a beach, mudflat, cliff or seabed;
- Obstructing waterways, polluting water body or littering; and
- Conducting any mariculture operation.

Planned Brothers Marine Park (BMP)

13.4.3.17 Within the study area, the Brothers are recognised as a planned Marine Park. The discussion on designating the BMP originated from a recommendation to designate a marine park for dolphin protection in order to mitigate the cumulative ecological impacts on the CWD as a result of the Hong Kong - Zhuhai - Macao Bridge (HZMB), Hong Kong Boundary Crossing Facilities (HKBCF), Hong Kong Link Road (HKLR) and Tuen Mun-Chek Lap Kok Link (TM-CLKL) Projects. The Highways Department is taking the lead and working with AFCD in the preparatory works for the designation of the BMP. According to the Advisory Council on the Environment (ACE) Paper 17/2011, the detailed study to finalise the marine park boundary and management plan would be initiated in around 2013/14, followed by implementation of the

relevant legislative procedure, and the designation of the marine park is tentatively planned for around 2016, immediately following the completion of the HZMB project.

13.4.3.18 The waters in the vicinity of the Brothers form one of the important habitats for CWDs in Hong Kong as identified in the long-term dolphin monitoring programme undertaken by AFCD (Jefferson 2000, 2007; Hung 2008, 2013) and discussed further in **Appendix 13.2**. The waters around the Brothers have been identified as the preferred location for establishing a marine park as an effective compensation measure for the HZMB-HKBCF Project (Arup, 2009a). According to ACE Paper 17/2011, the size of the planned marine park will be about 850 ha and will include within its boundary scattered coral colonies, an area of moderate fisheries value and important spawning grounds for commercial fisheries resources (HyD, 2011). As the coastline along the Sham Shiu Kok area was identified as important dolphin habitat, the ACE recommended incorporating the Sham Shui Kok coastline into the marine park boundary in the ACE meeting held on 30 December 2011. Therefore, the final boundary of the planned marine park is subject to be reviewed during the detailed study stage. The approximate delineation of the marine park is shown in **Drawing No. MCL/P132/EIA/13-001.**

Potential Southwest Lantau Marine Park (SWLMP)

13.4.3.19 The Southwest Lantau waters are important habitats for CWDs. In the area near the Soko Islands, both CWDs and Indo-Pacific Finless Porpoises are frequently observed although in different seasons (AFCD, 2013f). Previous studies conducted by Hong Kong Institute of Education (HKIEd) in 1998 and 1999 indicated that the sheltered shores along Southwest Lantau supported a diverse community of gastropods, acorn barnacles, goose barnacles, sponges, bryozoans, oysters, mussels, ascideans, soft corals and patches of encrusting faviid corals. Invertebrates including urchins, holothurians, gastropods and crabs were recorded throughout the subtidal zone (HKIEd, 1999). More than 22 species of fish, including snappers and butterfly fish were also recorded by the same study (HKIEd, 1999). Benthic grab sampling at a station located within the open waters off western side of Fan Lau has been conducted under the Consultancy Study on Marine Benthic Communities in Hong Kong (CCPC, 2002) in 2001. High species, individuals and biomass were recorded in both wet and dry seasons. Dominant species were polychaetes *Prionospio malmgreni, Sigambra hanaokai, Heteromastus* sp. and *Scoloplos gracilis* (CCPC, 2002).

13.4.3.20 In August 2001, the Country and Marine Parks Authority planned to designate the Southwest Lantau and Soko Islands waters as marine parks with a view to conserving the natural environment and protecting the CWDs, Indo-Pacific Finless Porpoises and other species (AFCD, 2001). The potential SWLMP is within the project study area and covers an area of 657 ha as shown in **Drawing No. MCL/P132/EIA/13-001**.

13.4.4 Literature Review

Subtidal Shores / Coral Communities

13.4.4.1 Within the study area, only one species of hermatypic coral (*Oulastrea crispata*) has been reported. While octocorals and ahermatypic cup coral are relatively common, within the vicinity of the airport island, only the gorgonian *Echinomuricea* sp. and the ahermatypic cup coral

Balanophyllia sp. were recorded at locations such as sloping boulder seawalls. However, the coral percentage cover recorded was generally low (less than 5%) as the hard substrate was often dominated by other sessile organisms such as barnacles, mussels and rock oysters. Other species recorded within the wider study area included the gorgonians *Euplexaura* sp. and *Guaiagorgia* sp., the soft coral *Dendronephthya* sp., the ahermatypic cup coral *Paracyathus rotundatus*, and isolated sea pens (*Virgularia* sp. or *Pteroides* sp.). Out of these only *Balanophyllia* sp. and *Paracyathus rotundatus* and the hard corals (Faviidae) recorded at Sha Chau were considered as species of conservation importance to be included in the assessment, according to the criteria described in **Section 13.5.2.2**.

13.4.4.2 Details of the literature review are described in **Appendix 13.1**.

Artificial Reefs

13.4.4.3 AFCD has been implementing an Artificial Reef (AR) project since 1996 to enhance fisheries resources and promote biodiversity in Hong Kong's marine waters (AFCD, 2013a). There are two ARs within the study area, located at the northeastern area of HKIAAA of Chek Lap Kok waters and at SCLKCMP (indicative location of AR at SCLKCMP is shown in **Drawing No. MCL/P132/EIA/13-001**). However, since the AR sites in the Chek Lap Kok waters are significantly affected by the construction of HKBCF (and re-provision of AR in other suitable location will be implemented as a mitigation measure), particularly with regards to the water quality (suspended solid levels), they are not considered as a marine ecological sensitive receiver and therefore be excluded from the impact assessment. While it is in the HZMB-HKBCF EIA report (Arup, 2009a) that ARs would be provided as mitigation measure, and part of them might be deployed in the planned Brothers Marine Park, details of the new ARs are not yet available at the time of the current EIA study and hence they will not be considered in the impact assessment also.

13.4.4.4 There are 6 AR deployment sites at the SCLKCMP, established with the objectives of prevention of fish trawling, as feeding stations for Chinese White Dolphins and to enhance habitat quality and marine resources (AFCD, 2013a). They comprise 24 units of ferro-cement river barges with a total volume of 4,640 m^3 and 42 concrete-coated container of volume 940 m^3 deployed in the SCLKCMP in 2000.

13.4.4.5 Details of the literature review are provided in **Appendix 13.1**.

Benthic Macro-infauna Communities

13.4.4.6 Relevant previous EIA studies and biodiversity surveys of benthic ecology within the study area were reviewed and described in **Appendix 13.1**.

13.4.4.7 Several grab sampling surveys were conducted in the HZMB study. All in all, none of the species recorded in the survey were mentioned in the IUCN Red List (Arup, 2009b). The marine benthic macro-fauna in North Lantau was composed of a high diversity of polychaete species and a low diversity of other taxa, which is characteristic in the North-western waters of Hong Kong.

Intertidal Habitats and Communities

13.4.4.8 A total of four types of intertidal habitats have been identified within the study area including:

- artificial shores;
- rocky shores;
- sandy shores; and
- mangroves and inter-tidal mudflats.

13.4.4.9 Two communities of intertidal species with conservation importance have been identified within the study area including:

- seagrass beds; and
- horseshoe crab breeding and nursery sites.

13.4.4.10 Relevant previous EIA studies and biodiversity surveys of intertidal ecology within the study area were reviewed and described in **Appendix 13.1**. Important intertidal habitats as well as intertidal species with conservation importance have been identified in the following sections.

Estuarine Fauna

13.4.4.11 Relevant EIA studies and AFCD's biodiversity surveys within the study area were reviewed and described in detail in **Appendix 13.1**. Key findings of literature are summarised as below.

13.4.4.12 Estuarine macroinvertebrate species with conservation importance were recorded in Tai Ho, Tung Chung, San Tau, Hau Hok Wan and Sha Lo Wan on North Lantau. Species which are considered as species of conservation importance in the literature review include two horseshoe crab species, *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus*, Sesarmine Crab species *Chiromantes sereni*, Greasyback Shrimp *Metapenaeus ensis* and one echinoderm *Holothuria leucospilota*. Sea cucumber *Holothuria leucospilota* and Greasyback Shrimp *Metapenaeus ensis* will not be considered as species of conservation importance in this study. Greasyback Shrimp and *Holothuria leucospilota* are listed as "Vulnerable" and "Endangered" respectively in the China Species Red List due to over exploitation in China but not for the case in Hong Kong. Besides, both of them were found to be common in Hong Kong. Therefore, they are not considered as species of conservation importance relevant to this study.

13.4.4.13 Some potential species of conservation importance of estuarine fish such as Largesnout goby *Awaous melanocephalus*, Indo-Pacific tropical sand goby *Favonigobius reichei*, Dark-margined flagtail *Kuhlia marginata*, Archpatch puffer *Takifugu ocellatus*, Pipefish species *Syngnathus scovelli*, *Syngnathoides biaculeatus* and *Syngnathus schlegeli,* spotted seahorse *Hippocampus kuda* were also previously recorded in several locations on North Lantau including Tai Ho, Tung Chung, San Tau, Sham Wat and Pak Mong.

13.4.4.14 Other examples including *Butis melanostigma* and *Psammogobius biocellatus*, which were identified during the on-going Tung Chung New Town Development Study, were recorded in Tung Chung Bay. *Scartelaos histophorus* (Walking goby) was recorded in San Shek Wan, Sha Lo Wan and Hau Hok Wan while *Luciogobius guttatus* (Flat-head goby) was recorded in San Shek Wan in HKLR study. In the HKZMB-HKBCF study, *Kuhia marginata* (Dark-margined flagtail), *Favonigobius reichei* (Indo-pacific trophical sand goby), *Takiugu niphobles* (Snowy puffer) and *Takifugu ocellatus* were recorded in several locaions included San Tau, Hau Hok Wan and Sha Lo Wan. Another four estuarine fish species of conservation importance include *Anguilla japonica* (Japanese Eel), *Eugnathogobius polylepis* (a mangrove goby) *Hemigobius hoevenii* (Banded mulletgoby) and *Glossogobius olivaceus* (Spotted Band Goby) were also recorded in Tung Chung Bay (KFBG, 2013).

13.4.4.15 Some species that were regarded as species of conservation importance in other study may not be relevant in this EIA study. After screening, estuarine fish and fauna that require further assessment include *Carcinoscorpius rotundicauda*, *Tachypleus tridentatus*, *Hippocampus kuda, Awaous melanocephalus* (Largesnout goby)*, Eugnathogobius polylepis* (a mangrove goby), *Hemigobius hoevenii* (Banded mulletgoby), *Kuhlia marginata* (Dark-margined flagtail), *Takifugu ocellatus* (Archpath puffer), *Syngnathoides biaculeatus*, *Syngnathus schlegeli* and *Chiromantes sereni* (Sesarmine Crab), details please refer to **Appendix 13.1**.

Marine Fishes and Other Fauna

13.4.4.16 Based on the CMP Environmantal Monitoring and Audit (EM&A) data (CEDD, 2013), from 2006 to 2013, a total of 397 species (including 171 fishes, 22 shrimps, 49 crabs, 9 mantis shrimps, 2 horseshoe crab, 60 gastropods, 43 bivalves, 6 cephalopods, 15 cnidarians, 10 echinoderms, 2 barnacles, 2 polychaete, 1 Echiura species, 1 Tunica species and 4 Sipuncula species) were caught by trawl survey conducted in the northwestern waters of Lantau (including SCLKCMP, northern and western waters of Chek Lap Kok) during both wet and dry seasons.

13.4.4.17 Besides corals and horseshoe crab *Tachypleus tridentatus*, 13 species are of conservation importance, including *Dasyatis akajei* (Red stingray), *Dasyatis zugei* (pale-edged stingray) and *Epinephelus coioides* (orange-spotted grouper) which are listed as “Near Threatened” by the IUCN Red List of Threatened Species; *Epinephelus bruneus* (longtooth grouper) which is listed as “Vulnerable” in IUCN Red List; *Clupanodon thrissa* (Chinese gizzard shad), *Inimicus japonicas* (Devil stinger), *Larimichthys crocea* (Yellow croaker), *Nemichthys scolopaceus* (Slender snipe eel) and *Otolithes ruber* (Tiger-toothed croaker), which are listed as “Vulnerable” in the China Species Red List; *Zebrias crossolepis* and *Oliva mustelina* (Sea snail) which are listed as “Endangered” in the China Species Red List. In addition, one individual of *Syngnathus schlegeli* (Pacific seaweed pipefish) was caught off the western waters of Chek Lap Kok. Although *S. schlegli* is listed as species of “Least Concern” in the IUCN Red List, its rare distribution in Hong Kong (To et al., 2013), low mobility (Ashley-Ross 2002) and reproduction rate (normal brood size of less than 1000 (Sogabe et al., 2012), and less than 10-fold smaller compared to other families such as Engraulidae (Watanabe and Watanabe, 2002)) make it vulnerable to environmental changes. Another species of local conservation concern is *Takifugu ocellatus* (Archpatch puffer) (Fellowes et al., 2002). Some species that were regarded as species of conservation importance in other study may not be relevant in this EIA study. Details for the screening of species are presented in **Appendix 13.1**.

13.4.4.18 According to the CMP EM&A data, the most common species recorded within the Study Area included *Turritella terebra* (sea snail), *Balanus* sp. (barnacle), hermit crab and *Charybdis* spp. (crab). The most abundant fish species were *Trypauchen vagina* (goby), *Leiognathus brevirostris* (shortnose pony), *Oxyurichthys tentacularis* (goby), *Parachaeturichthys polynema* (goby) and *Cynoglossus arel* (largescale tonguesole) while the most abundant crustacean species were hermit crab, *Charybdis* spp., *Parapenaeopsis tenella* (shrimp), *Metapenaeus ensis* (shrimp) and *Eucrate crenata* (crab). Details of the findings from the CMP EM&A are provided in **Appendix 13.1**.

13.4.4.19 Monitoring programme conducted by AFCD at SCLKCMP from 2000 to 2006 recorded one species of conservation importance, *Nemipterus virgatus* (golden threadfin bream). It is listed as "Vulnerable" under IUCN Red List while its local population is unknown.

Marine Mammals

13.4.4.20 A literature review on CWDs in Hong Kong has been undertaken in accordance with the Study Brief Appendix F, Clause 3(i), and major findings were summarised below. Details of the literature review on CWDs in Hong Kong and the Pearl River Estuary (PRE) is presented in **Appendix 13.2**.

13.4.4.21 The literature review has been based upon for approximately 20 years of data collected by AFCD's long term monitoring programme and other studies in the western waters of Hong Kong since the mid-1990's and the subsequent analyses of this data which has provided a comprehensive baseline on CWDs densities, distribution, abundance, breeding and feeding behaviour. The data cover the nine survey areas (Figure 1, **Appendix 13.2**) and provides baseline information on CWD occurrence and habitat use patterns for west, northwest, and northeast Lantau waters (Jefferson 2000, 2005; Hung, 2008). Most of this information is derived from vessel surveys and photographic identification, with the more recent incorporation of shore-based theodolite tracking and underwater sound recording as important new elements (Hung 2012, 2013).

13.4.4.22 After nearly 20 years of data collection, detailed scientific studies have shown that the Hong Kong CWDs are part of a larger population in the PRE (estimated to be over 2,500 animals, the largest known of the species anywhere in its range), and that the CWDs are common in Hong Kong's western waters. The SCLKCMP is thought to have been a successful management measure, with CWD densities in the park significantly higher than in most of the surrounding habitat more than a decade later (Hung, 2008).

13.4.4.23 However, coastal development in both Hong Kong and the surrounding areas of the Pearl River Estuary in China is on-going and CWDs continue to be affected by increased marine traffic and vessel collisions, noise from construction activities and entanglements with fishing nets. Habitat loss continues through the on-going developments and tissue samples from live CWDs have shown that contaminant levels are high in these CWDs and could be associated with signs of reduced calf survival (Jefferson et al. 2006). Evidence of a decline in numbers in Hong Kong's waters over the past ten years suggests that caution is justified in considering this population's conservation prospects. With over 2,500 individuals in the PRE as a whole and a lack of evidence for an overall long-term decline in the total population, the population does not appear

to be in any immediate danger of extinction. However, modelling studies (Huang et al., 2012) have suggested that within a few generations there is a real extinction risk. While the accuracy of such modelling exercises can be debated, CWDs habitats clearly remain under pressure from human activities.

13.4.4.24 In terms of establishing an ecological baseline for the CWDs in the 3RS project area, the extensive data from the AFCD long term monitoring programme and analysis of these data has provided notable details with respect to the CWD distribution, abundance, habitat use, ranging patterns, demography, life history, feeding habits, mortality and behavioural ecology for various time periods.

Identification of Data Gaps

13.4.4.25 The objectives of the marine ecological impact assessment are detailed in **Section 13.3** above. Desktop studies have generated a relatively comprehensive picture of marine ecological profile in the study area. However, marine ecological baseline data within the proposed project footprint and HKIAAA were found to be lacking, as HKIAAA is a marine exclusion zone which has been restricted to vessels entry since the airport opened in 1998. As a result marine ecological baseline survey at the intertidal and sub-tidal habitats that will be directly affected was required to be conducted for a robust impact assessment to be undertaken.

13.4.4.26 In addition, while ecological baseline information for the intertidal and sub-tidal habitats along the North Lantau coast was available, most of such information was gathered in or before 2009, which may not reflect the latest ecological conditions with the commencement of marine works for HZMB, HKBCF, TM-CLKL and HKLR and associated construction. It was considered that verification surveys along the North Lantau coast where potential indirect impacts could occur are required.

13.4.4.27 In respect of the CWDs, as noted in **Appendix 13.2**, the literature and data review has indicated that there is a data gap concerning the CWD use in the immediate area of the airport, including area within HKIAAA, and a need to obtain more specific data within the footprint of the proposed airport expansion project. As such, CWD field surveys have been proposed to cover these data gaps. All the field surveys for the CWD have been designed to obtain data on their density, abundance, movements and behaviour and further details on the objectives of the CWD surveys are provided below in **Section 13.4.5**.

13.4.5 Scope of Field Surveys

13.4.5.1 Marine ecological field surveys and investigations were designed to verify the information collected, fill the information gaps as identified above, and to fulfil the objectives of generation of ecological profile for the ecological impact assessment. The following types of marine ecological field surveys have been undertaken for the project:

- Habitat mapping and flora surveys;
- Sub-tidal hard and soft bottoms coral surveys;

- Sub-tidal soft bottom marine benthos surveys;
- Intertidal surveys including horseshoe crabs and seagrass beds;
- Aquatic fauna surveys including crustaceans, estuarine fish and marine fishes; and
- Chinese White Dolphins surveys.

13.4.5.2 The marine ecological field surveys covered both the wet and dry seasons between May 2012 and November 2013 and were undertaken over a period of 12 to 14 months for the CWDs, depending on the type of survey. The survey effort focussed on those areas most likely to be impacted by the 3RS project, including HKIAAA, in particular Area 3 which will be directly affected by the land formation works (**Drawing No. MCL/P132/EIA/13-008**), to assess the status of the marine waters, intertidal, sub-tidal soft and hard substrate benthic communities.

13.4.5.3 In order to facilitate the evaluation of ecological values for the habitats to be directly affected, field surveys were also conducted at intertidal, sub-tidal soft and hard substrate benthic habitats in western Hong Kong waters that are further away from the project footprint, but with similar habitat attributes to the project footprint as reference sites.

13.4.5.4 The scope of each type of field survey is described below, whilst details of the field survey methodologies are provided in **Appendices 13.3 and 13.4**.

Habitat Mapping and Flora Surveys

13.4.5.5 Mapping of intertidal and marine habitats within the study area were conducted by desktop study and with verification by ground truthing. Aerial photographs, approved Outline Zoning Plans (OZPs), relevant habitat maps in approved reports have been studied to interpret the habitats and generate preliminary habitat maps for further field verification. The habitats were subsequently verified by ground truthing with reconnaissance surveys undertaken from September 2012 to October 2013. Habitat maps of suitable scale (1:1000 to 1:5000) were prepared to show the types and locations of identified habitats in the study area, including the project area, surrounding areas which are likely to be impacted by the project and the selected reference sites. Special attention has been paid to habitats of conservation importance and habitats having connectivity with the northern Lantau waters to facilitate the review of habitat quality.

13.4.5.6 As no direct impact on vegetation is anticipated for the proposed marine works, flora surveys were conducted within the study area along the backshore by walk through survey, focusing on the dominant plant species, species of conservation importance and habitats of site of conservation importance such as seagrass beds and mangroves.

Subtidal Shores / Coral Communities

13.4.5.7 The coral surveys have included the proposed land formation footprint, especially within Area 3 of HKIAAA and areas subject to potential direct impact. Sub-tidal habitats subject to direct impact included the artificial seawall at northern coast of the existing airport island, the rocky shore at the potential pipeline diversion landing point on Sha Chau within SCLKCMP, the soft-

bottom seabed at north of Chek Lap Kok and the submarine cable diversion at west of Chek Lap Kok. Other potential coral sites that could be subject to indirect impact were also covered, including the artificial seawalls at the western and northeastern coasts of the existing airport island.

13.4.5.8 The artificial seawalls at Tung Chung Pier and North Lantau Highway near Tai Ho Wan were selected as the reference sites for the articial seawalls on the airport island as they are neither within the proposed land formation footprint nor its immediate adjacent area. The natural shorelines between Tai O to Yan O Wan and the rocky shore at the Brothers were selected as reference sites for the proposed pipeline landing point at Sha Chau, to evaluate the ecological values of the habitats.

13.4.5.9 A total of 16 coral survey points for hard bottom coral were covered. Out of these six were within project footprint (D2, D3, D4, D5, D6 and D7), one was located at the proposed pipeline landing point at SCLKCMP (D9), three were in adjacent areas to the project (D1, D8 and D16) and six were at reference sites (D10, D11, D12, D13, D14 and D15).

13.4.5.10 A total of 22 coral survey points for soft bottom coral were covered. Out of these nine were within project footprint (C4, C5, C6, C7, C8, C9, C10, C11 and C12), four along proposed submarine pipelines and cables diversion alignments and in adjacent areas (C3, C13, C14 and C15), two were within the SCLKCMP (C16 and C17), and four other sites to the west and east of the airport island (C1, C2, C18 and C19) were selected as reference sites. Three sites with rock outcrops recorded at the northern Lantau waters (SC2, SC10 and SC12)) were also covered (**Drawing No. MCL/P132/EIA/13-008**).

13.4.5.11 The survey locations were based on the existing information on seabed features and on the latest geophysical survey conducted in December 2012 for the planning of soft bottom coral survey points (**Drawing No. MCL/P132/EIA/13-008**). It should be noted that there was no coral survey point on the eastern coast of the airport island due to safety considerations for diving activities in areas with heavy marine traffic in association with the marine works for the HZMB-HKBCF Project and the existing high-speed vessels travelling routes to and from SkyPier. After discussion with various marine stakeholders and the Marine Department, the use of remote technique and devices such as Remotely Operated Vehicles (ROVs) was also not a practicable alternative underwater survey method as the marine traffic might interfere with the operation of the ROVs.

13.4.5.12 The coral survey was conducted once at each site (between August 2012 and September 2013) as coral is sessile and relatively stable. Details of the survey methodologies are described in **Appendix 13.3**.

Artificial Reefs

13.4.5.13 As part of the fisheries survey, an artificial reef site visit has been made in July and November 2013 at the SCLKCMP to review the status of the artificial reefs as well as the suitability of carrying out further underwater visual count surveys.

Benthic Macro-infauna Communities

13.4.5.14 Marine benthos survey covered a total of 22 sampling points (Thirteen locations within Project footprint (B1 – B5 & B7 – B10), potential alignments of the submarine pipeline and cable and adjacent waters (B6, B11, B18 and B19), three locations within SCLKCMP (B12, B14 and B15) and six locations to the west, north and east of the airport island (B13, B16, B17, B20, B21 and B22) as reference sites as they are not within the proposed land formation footprint nor at the proposed alignment locations for diversion of the submarine fuel pipeline and cable) covering locations within and in the vicinity of the project footprint, as presented in **Drawing No. MCL/P132/EIA/13-009**.

13.4.5.15 The benthos surveys were conducted between July 2012 and April 2013 in the wet season and November 2013 in the dry season. Details of the survey methodologies are described in **Appendix 13.3**.

Intertidal Habitats and Communities

13.4.5.16 Field surveys of intertidal habitats and communities were undertaken in both wet and dry seasons. The locations of intertidal field surveys are indicated in **Drawing No. MCL/P132/EIA/13-010**.

13.4.5.17 Intertidal field surveys at Chek Lap Kok (the existing airport island) were conducted twice in each season considering the proximity to works area and potential loss of habitats.

13.4.5.18 For other intertidal habitats and communities on Lantau Island which may be indirectly affected, considering their distance from the works area and the availability of recent studies that covered the baseline information along the northern coast of Lantau, intertidal surveys were conducted for once in each season to verify the baseline information collected. Both qualitative and quantitative field surveys were arranged for each intertidal habitat. Details of the field survey methodologies are described in **Appendix 13.3**.

Estuarine Fauna

13.4.5.19 Aquatic fauna survey covering the estuarine crustaceans, macroinvertebrates and estuarine fish were conducted as part of the stream / estuarine fauna survey under **Chapter 12 Terrestrial Ecological Impact**. Details of the methodology refer to **Appendix 12.2**.

Marine Fishes and Other Fauna

13.4.5.20 Marine fish survey in open waters covering the proposed land formation footprint, sites of conservation interest and adjacent waters were conducted as part of the fisheries survey under **Chapter 14 Fisheries Impact**. Details of the methodologies refer to **Section 14.3.6 and Appendix 14.3**.

Marine Mammals

13.4.5.21 Three major types of field survey were proposed to cover a period of 12-14 months for the CWD, depending on the survey type, so that all four seasons were covered and seasonal differences could be examined, as follows:

1) Focussed vessel line transect surveys of the proposed land formation (and surrounding) area to provide line transect data for estimating density and abundance, and also to collect individual dolphin identification photos for examination of ranging patterns. As part of this vessel-based work, focal follows of individual CWD groups provide information on movements and travel patterns and areas. This survey work was proposed to cover the following data gaps identified by the Literature Review as detailed in **Appendix 13.2**:

   (a) Smaller-scale information on the distribution, density, habitat use and behaviour of CWDs in the 3RS work area and west of the airport platform. This is important to understand how the CWDs are using the project area for the 3RS;

   (b) Further work to elucidate individual movements and social structure in and around the 3RS project area; and

   (c) Determine if portions of the 3RS project area are being used for travelling area by CWDs while moving between core habitat areas. It should be noted that while the Study Brief refers to “travel corridors”, as CWD do not follow distinct defined routes during their travelling activities, the term “travel area” would more accurately describe the waters transected and this term is used in this EIA Report. It is also acknowledged that a designation of "travelling area" is not exclusive to this behaviour, but that other behaviours of foraging (which is not just feeding, but also attempting to locate food), resting, socialising, calf-rearing, etc., can occur coincidentally with travelling, and also form major components of habitat use in so-called travelling areas.

2) Land-based theodolite tracking of movements to provide information on swimming and movement patterns of dolphin groups, and responses to vessels and other potential stressors. This survey work was proposed to cover data gaps (b) and (c) identified in Item 1 above; and

3) Autonomous passive acoustic monitoring (PAM) of the dolphins and their environment (especially vessel and marine-construction noise), to provide daytime and nighttime information on dolphin presence and vocal activity, as well as noise levels in CWD habitat. This survey work was proposed to cover data gaps relating to the need for further evaluation of the acoustic habitat of the CWDs and the impacts of anthropogenic noise in the 3RS work area using passive acoustic monitoring, as identified by the Literature Review as detailed in **Appendix 13.2**;

13.4.5.22 In addition, existing marine traffic patterns were obtained from the Marine Traffic Impact Assessment to correlate with information on CWD distribution, movements and abundance to assess the changes in movement patterns and behaviour and risk of vessel collision (see **Appendix 13.13**).

13.4.5.23 The surveys detailed above were designed to fill a recognised data gap and provide information on CWD distribution, habitat use, activities and behaviour within the 3RS proposed land formation footprint (airport north) and the area directly to the west of the current airport (airport west), which have not previously been surveyed due to the restrictions of HKIA Exclusion Zone. The intent of the surveys was to use vessel line transect analysis to obtain estimates of density and abundance for both of these survey areas, but it was recognised that stratifying the 12-14 months of data by season and obtaining robust seasonal estimates would be difficult due to small sample sizes after stratification. Also, it is noted that it would not be possible to obtain any trends information for these areas from just a single year of data. It is noted that each method proposed has its own strengths and weaknesses. For example, land based surveys are better at detecting behavioural issues such as travelling and milling, vessel surveys are best for describing density and abundance patterns and underwater acoustic (PAM) data can describe the presence of CWDs during all hours of the day and night. Therefore all three methods were considered to be required to obtain a robust and comprehensive data set.

13.4.5.24 It is also, recognised that the proposed survey areas are not 'pristine' and have not been so for many decades. They have been and are influenced to varying degrees by a number of anthropogenic factors, not the least the current on-going construction works for HZMB related projects, particularly HKBCF. It is not possible to isolate and factor out influences from the range of other ongoing projects in trying to establish a baseline that is free from influence from these projects. However, as it is not feasible to use any historical or other detail in defining a baseline, it is judged that the baseline as has been established – including potential influences from current on-going construction works and other activities – is a valid baseline. The present intensive EIA-related data have been compared in this EIA with the long-term data set (for example, as summarised by Hung 2012 and 2013), and thus provide insight into the present situation verses earlier periods with different or no development activities in the general North Lantau area.

13.4.5.25 Details of the field work methodologies for the CWD surveys are described in **Appendix 13.4,** while the field survey dates are given in **Appendix 13.6**:

13.4.6 Summary of Survey Results and Baseline Conditions

Habitat Maps of Coastal Waters

13.4.6.1 The coastal waters along the North Lantau coast are nourished by several intertidal streams. The main streams included the Tai Ho Stream, Tung Chung Stream, San Tau Stream, Hau Hok Wan Stream, Sha Lo Wan Stream and Sham Wat Wan Stream. Soft shore habitats including mudflat and mangrove are mainly formed at the western coast of the bay, with sandy shore at the estuarine region and rocky shore at the eastern coast of the bay. The intertidal habitats recorded in the recent surveys are artificial seashore, rocky shore, sandy shore, mangrove and intertidal mudflat. Seagrass bed was also recorded on soft shores at San Tau Beach SSSI and Sham Wat Bay.

13.4.6.2 The habitat maps showing the types and locations of habitats and species of conservation importance recorded in the recent field surveys are shown in **Drawing No. MCL/P132/EIA/13-014** to **Drawing No. MCL/P132/EIA/13-020**.

Habitat Maps of Marine Waters

13.4.6.3 The marine waters in this area support the sub-tidal hard and soft bottom assemblages, marine fauna and provide habitats for the Chinese White Dolphin. The locations with coral communities recorded in the habitat maps **Drawing No. MCL/P132/EIA/13-014 to Drawing No. MCL/P132/EIA/13-020**.

Subtidal Shores / Coral Communities

13.4.6.4 For hard bottom substrates, only *Balanophyllia* sp. and *Guaiagorgia* sp. were recorded. The highest coral coverage was found at the proposed pipeline landing point at Sha Chau, where the seabed consisted mostly of large boulder rocks. Within the proposed land formation footprint, only *Guaiagorgia* sp. was recorded but with a low coverage. At the reference sites, *Balanophyllia* sp. usually occurred together with *Guaiagorgia* sp.

13.4.6.5 For soft bottom substrates, four coral species (*Guaiagorgia* sp., *Echinomuricea* sp., *Paracyathus rotundatus* (and *Balanophyllia* sp.) were observed in total. *Paracyathus rotundatus* has been previously reported in Pillar Point, Tai Mo To and outside Tai Ho Wan by the TM-CLKL study (AECOM, 2009b). The corals were only found at three survey locations, all of them within the SCLKCMP (C16, SC2 and SC10) where the bottom substrate was rock or soft mud with broken shells. The coral cover was also low (less than 5%). No coral was found within the proposed land formation footprint. Details of survey findings are described in **Appendix 13.5**.

Artificial Reefs

13.4.6.6 Two dive visits were conducted on 11 July and 8 November 2013 at the artificial reefs of SCLKCMP. The waters around the artificial reefs are similar to other areas in the western Hong Kong waters, i.e. being turbid and with low visibility of less than 1 m on both days of the site visit. Secchi disk measurements were also made on 5 and 6 November 2013 to review the water clarity and suitability of conducting underwater visual count. The secchi disk measurements indicating the visibility at SCLKCMP was continuously having turbid waters with secchi depth below 1 m. Due to the high turbidity and low observation range, quantitative surveys by underwater visual count was not feasible and only qualitative records were obtained from the two dive visits. Gorgonians were observed in low density on the artificial reefs, with macroinvertebrates (e.g., unidentified crabs) and sessile fauna recorded as being attached to the artificial reefs. This indicated the artificial reefs do serve the function of providing hard substrates for the colonisation of marine benthic fauna.

Benthic Macro-infauna Communities

Wet Season

13.4.6.7 In wet season survey, a total of 2,848 benthic organisms, comprising 155 species from 101 families in 11 phyla (Annelida, Arthropoda, Chordata, Cnidaria, Coelentera, Echinodermata, Euchiura, Mollusca, Nemertinea, Platyhelminthes and Sipuncula) were found in the marine benthic grab survey. Polychaetes (Annelida) were collected at all locations and represented the highest species richness and abundance in the samples during the season. Abundant species

recorded included amphipod *Byblis* sp., pea crab *Neoxenophthalmus obscurus*, polychaetes *Aglaophamus dibranchis* and *Mediomastus californiensis.*

13.4.6.8 Generally, two sites within the proposed land formation footprint (B7 and B8) and one site in the northern waters of Chek Lap Kok (B11) had the highest species richness and highest species abundance. On the other hand, the biomass at one site at the proposed alignment location for diversion of submarine fuel pipeline and submarine cable (B19) was recorded to be highest.

13.4.6.9 In the proposed land formation footprint, around 13 to 62 species were recorded. 62 species were recorded in survey location B8, which was the highest among survey locations in proposed project footprint. The lowest number of species was in location B2 and B3 with only 13 species recorded. The highest abundance and biomass were recorded in location B7 and B8 (see **Appendix 13.5**). Abundant species recorded within proposed land formation footprint included *Byblis* sp., *Neoxenophthalmus obscurus, Mediomastus californiensis* and *Eunice indica*, whilst *Neoxenophthalmus obscurus*, *Ruditapes philippinarum* and *Paphia exarata* were recorded with highest biomass in the proposed land formation footprint (see **Appnedix 13.5**). The Shannon diversity (H') in the land formation footprint is between 2.23 to 3.54 and the Evenness (J') is within 0.76 to 0.95.

13.4.6.10 Almost all species recorded were not species of conservation importance, except one single individual of Amphioxus *Branchiostoma belcheri*, which was recorded at one of the replicates in B19 located at north Chek Lap Kok waters outside the proposed land formation footprint. *Branchiostoma belcheri* is listed under class II protection in China. This species is usually found in sandy seabed in Hong Kong and regarded as a living fossil link in the evolution of marine invertebrates to vertebrates. As observed on site, the sediment in B19 sampling location, together with all other sampling locations in the northern Lantau waters covered by the present survey, was mainly muddy sediment, which is different from the sandy substrate preferred by amphioxus as reported by previous study (Chan, 2007). The single individual recorded was probably being washed from other preferred habitats outside the study area as a transient and the northern Lantau waters is not considered as a suitable habitat for this species. Details of survey findings for benthic grab sampling are described in **Appendix 13.5**.

<u>Dry Season</u>

13.4.6.11 In dry season survey, a total of 1,030 benthic organisms, comprising 112 species from 78 families in 10 phyla (Annelida, Arthropoda, Chordata, Cnidaria, Echinodermata, Euchiura, Mollusca, Nemertinea, Platyhelminthes and Sipuncula) were found in the marine benthic grab survey (see **Appendix 13.5 Annex B**). Polychaetes (Annelida) were collected at all locations and represented the highest species richness and abundance in the samples. Other abundant species recorded included amphipod *Byblis* sp. and *Aglaophamus dibranchis*. No species of conservation importance was recorded during dry season.

13.4.6.12 Generally, two sites within the proposed land formation footprint (B1 and B8) and one site in the western waters of the airport (B21) had the highest species richness and highest species abundance. On the other hand, the biomass at one site at the proposed alignment location for diversion of submarine fuel pipeline and submarine cable (B19) was recorded to be the highest. The highest biomass at B19 was mainly contributed by a gastropod *Turritella terebra*.

13.4.6.13 In the proposed land formation footprint, around 6 to 39 species were recorded. Thirty-nine species were recorded in location B1, which was the highest among survey locations in proposed land formation footprint as well as all the survey locations. The lowest number of species was in location B10 with only 6 species recorded. The highest abundance and biomass were recorded in location B1 and B8 (see **Appendix 13.5**). Abundant species recorded within proposed land formation footprint included *Mediomastus californiensis* and *Eunice indica*, *Prionospio queenslandica* and *Corophium* sp., whilst *Turritella terebra* and *Neoxenophthalmus obscurus* were recorded with the highest biomass in the proposed land formation footprint (see Annex B). The Shannon diversity (H') in the land formation footprint is between 1.53 to 3.30 and the Evenness (J') is within 0.85 to 0.95.

Intertidal Habitats and Communities

Artificial Shores

13.4.6.14 Sloping seawall is the most common feature along the artificial shoreline within the study area while other minor portions consist of vertical seawall. Sloping seawalls are found surrounding the airport island and along the North Lantau coastline from Tung Chung to Tai Ho. This habitat is constructed of large armour rocks and sparsely vegetated, with little vegetation growing from gaps between boulders. The common species recorded are lichen, cyanobacteria and algae, including *Corallina* spp., *Endarachne binghamiae, Hapalospongidion gelatinosum, Hildenbrandia rubra, Ralfsia expansa, Chroococcus* sp. and *Ulva* spp. No floral species of conservation importance were recorded in this habitat. Details of the floral species list are provided in **Chapter 12** (**Appendix 12.3 Annex B**).

13.4.6.15 Results of desktop review and field surveys which formed the baseline conditions of artificial shores are presented in section 4.1 of **Appendix 13.5**. Number of species recorded at this habitat is between 30 at North Tung Chung and 53 at Chek Lap Kok.

13.4.6.16 From field survey results, the species diversity (H') index is between 1.22 and 1.98 and evenness (J') index is within 0.40 to 0.60 at the artificial shores of Chek Lap Kok and North Lantau, which are low compared to other natural rocky shores. Amongst the artificial shores, number of species recorded within HKIAAA (i.e. at the north of Chek Lap Kok) was less than that recorded at the west of Chek Lap Kok, whilst similar to those at Tung Chung and Tai Ho.

13.4.6.17 Abundant species generally found at artificial shores were *Echinolittorina radiata*, *Cellana toreuma*, *Patelloida pygmaea*, *Siphonaria japonica* and *Saccostrea cucullata*. All species recorded were common in artificial / rocky shores of Hong Kong. No species of conservation importance was recorded at this habitat.

13.4.6.18 Within the proposed land formation footprint, a total of 32 intertidal species (28 species in dry season and 24 species in wet season) were observed from field survey at the artificial sloping seawall habitat.

Rocky Shores

13.4.6.19 Rocky shore is the dominant habitat along the natural coastline within the Study Area. This habitat is sparsely vegetated with salt-tolerant floral species. A total of 68 floral species have been recorded in this habitat. Details of the species recorded are described in **Chapter 12** (**Appendix 12.3 Annex B**).

13.4.6.20 Results of desktop review and field surveys which formed the baseline conditions of rocky shores within the North Western Water Control Zone are presented in section 4.2 of **Appendix 13.5**. In general, two types of rocky shores were encounted: (1) bedrock shore with a steep profile and (2) boulder shore with a flat profile. Number of species recorded at this habitat is between 29 and 54.

13.4.6.21 From field survey results for rocky shores, in dry season the species diversity (H') index is between 1.31 to 2.37 and the species evenness (J') index is within 0.39 to 0.73; whilst in wet season the H' index is between 1.43 to 2.35 and the J' index is within 0.41 to 0.70. Overall the species diversity and evenness at the relatively undisturbed rocky shores of north-western Lantau, Sha Chau area and Tai Mo To are moderate. Rocky shores at South Chek Lap Kok and San Tau, where more human disturbance is present, have relatively lower species diversity and evenness.

13.4.6.22 Abundant species found at the rocky shores were *Echinolittorina radiata*, *Littoraria articulata*, *Monodonta labio* and *Saccostrea cucullata*. All species recorded were common in rocky shores of Hong Kong. No species of conservation importance was recorded at this habitat.

Sandy Shores

13.4.6.23 Sandy shore is found discontinuously along the North Lantau coastline at Sham Wat Wan, Sha Lo Wan and Hau Hok Wan in which the sandy substrate is mainly fine and silty in nature. This habitat is also found along the coastline of Lung Kwu Chau and Sha Chau where the substrate is composed of coarse sand. A small extent of coarse sandy shore is also presented at Yan O. This habitat is sparsely covered with vegetation, particularly close to the coastline. A total of 44 floral species have been recorded in this habitat. Details of the species recorded are described in **Chapter 12** (**Appendix 12.3 Annex B**).

13.4.6.24 Results of desktop review and field surveys which formed the baseline conditions of sandy shores within the North Western Water Control Zone are presented in section 4.3 of **Appendix 13.5**. Number of species recorded at this habitat is between18 and 94.

13.4.6.25 In general, two types of sandy shores were encounted: (1) open sandy shore with coarse sand and gravel; and (2) sheltered sandy shore with fine sand and some boulders. Open sandy shore habitat at Sha Chau and Lung Kwu Chau area is species-poor as reflected by the low species diversity obtained from both literature review (Maunsell, 2002) and field survey results that the H' index is between 1.07 to 1.11 and the J' index is within 0.46 to 0.48. In comparison, the open sandy shore habitat at Yan O has relatively higher species diversity and evenness (the H' index between 1.41 to 2.06 and the J' index within 0.50 to 0.67). Abundant species at Yan O were found to be *Tapes philippinarum* and *Littoraria articulata.* On the other hand, at sheltered sandy

shores of Hau Hok Wan and Sha Lo Wan with fine/silty sand, the species diversity and evenness are higher than those of open sandy shores (the H' index between 2.19 to 2.64 and the J' index within 0.61 to 0.71). Abundant species were found to be *Cerithidea cingulata* and *Cerithidea diadjariensis*. Nevertheless, all species recorded were common in Hong Kong. No species of conservation importance was recorded at these locations.

13.4.6.26 At Tai Ho Wan, Tung Chung Bay, San Tau and Sham Wat Wan, relatively large areas of mudflats were identified. In fact, these areas contained a mixed habitat of sandy/silty soft shore, as reflected by the species richness, species diversity index and species evenness index recorded at the sandy shores of these areas. Therefore, findings in the sandy portion of these sites, would be combined with relevant ecological baseline findings on intertidal mudflat habitat for evaluation in **Section 13.5.1**.

Mangroves and Intertidal Mudflats

13.4.6.27 Mangroves are found along the North Lantau coastline in the intertidal zone at San Tau, Tung Chung Bay and Tai Ho Wan. This habitat is densely covered with true mangrove species with other salt-tolerant floral species commonly observed. A total of 39 floral species have been recorded in this habitat. Dominant species observed include *Acanthus ilicifolius*, *Aegiceras corniculatum*, *Avicennia marina*, *Hibiscus tiliaceus* and *Kandelia obovata*. Floral species of conservation importance recorded in this habitat include *Halophila ovalis*, *Thespesia populnea* and *Zoysia sinica*. Details of the species recorded are described in **Chapter 12** (**Appendix 12.3 Annex B**).

13.4.6.28 Mudflats are found associated with mangroves along the North Lantau coastline at Sham Wat Wan, San Tau, Tung Chung Bay, Tai Ho Wan and Yan O. This habitat is mainly coastal open area with soft substrate and little vegetation, or sometimes covered with seagrasses. A total of five floral species have been recorded in this habitat with seagrass species of conservation importance including *Halophila beccarii*, *Halophila minor*, *Halophila ovalis* and *Zostera japonica*. Details of the species recorded are described in **Chapter 12** (**Appendix 12.3 Annex B**).

13.4.6.29 Results of desktop review and field surveys which formed the baseline conditions of mangroves and intertidal mudflats within the North Western Water Control Zone are presented in section 4.4 of **Appendix 13.5**. Number of species recorded at this habitat is between 52 and 128.

13.4.6.30 From field survey results for Tai Ho Wan, Tung Chung Bay and San Tau, the species diversity (H') index is between 1.43 and 2.61 and the species evenness (J') index is within 0.38 to 0.66. At Sham Wat Wan where its substrate ranges from fine sandflat with boulders to soft silty mudflat with only a fringe of mangroves present at part of the backshore, both species diversity and evenness were recorded with large ranges (the H' index is between 0.78 and 1.51 and the J' index is within 0.27 to 0.68).

13.4.6.31 Abundant species found at the mangrove and mudflat habitats were *Batillaria multiformis, Batillaria zonalis, Cerithideopsilla djadjariensis* and *Cerithidea cingulata*. Species of conservation importance including *Halophila beccarii*, *Halophila ovalis*, *Zostera japonica*, *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda* were recorded at this habitat, which are discussed in details in the subsequent sections on seagrass bed and horseshoe crab.

13.4.6.32 Mangroves and mixed sandy / silty soft shore habitats of Tai Ho Wan, Tung Chung Bay, San Tau and Sham Wat Wan have been surveyed during previous EIA studies and survey results have been well-documented. Field surveys for this project have verified the importance of mangrove and soft shore habitats of these locations. The presence of seagrass and horseshoe crab of conservation importance were also verified, and their sizes / numbers were updated to the latest condition.

Seagrass Beds

13.4.6.33 Results of desktop review and field surveys which formed the baseline conditions of seagrass beds within the North Western Water Control Zone are presented in section 4.5 of **Appendix 13.5**.

13.4.6.34 The presence of seagrass beds at San Tau was verified in this survey with two seagrass species *Zostera japonica* and *Halophila ovalis* recorded. *Zostera japonica* was found along the mangrove fringe with a length of approximately 30 m. *Halophila ovalis* was found abundant, covering the mudflats in dense patches next to *Z. japonica* and extended seaward. No *Halophila minor* was found in this survey, so the most up-to-date status of this seagrass species is regarded as the record at San Tau in 2009.

13.4.6.35 The presence of seagrass beds of *Halophila beccarii* at Tai Ho Wan was also verified in this survey. Two small patches of *Halophila beccarii* were found at the mudflat of Tai Ho Wan in the wet season of 2013. No seagrass beds were found at Tung Chung Bay or Yan O in the field survey for the 3RS study.

13.4.6.36 On the other hand, it is worth noting that a new locality of *Halophila beccarii* was found at Sham Wat Wan in this survey and also recorded during AFCD's survey conducted in 2013. Several small patches of *Halophila beccarii* were found at the mudflat of western part of Sham Wat Wan.

Horseshoe Crab Breeding and Nursery Sites

13.4.6.37 Results of desktop review and field surveys which formed the baseline conditions of horseshoe crab nursery sites within the North Western Water Control Zone are presented in section 4.6 of **Appendix 13.5**.

13.4.6.38 The two horseshoe crab species, *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda* were both recorded within the study area. *T. tridentatus* was recorded at San Tau, Tung Chung Bay, Sham Wat Wan and Tai Ho Wan, while *C. rotundicauda* was recorded at Tung Chung Bay, Sham Wat Wan and Tai Ho Wan. Individuals of tiny juvenile horseshoe crab were also found at Hau Hok Wan and Sham Wat Wan. No mating activity of horseshoe crab was observed during the course of survey.

13.4.6.39 From the significant number of horseshoe crab juveniles and sub-adults recorded in literature review and survey, it was identified that Sham Wat Wan, San Tau, Tung Chung Bay and Tai Ho Wan were some of the nursery grounds of horseshoe crabs in Hong Kong.

Estuarine Fauna

13.4.6.40 The detail findings of desktop review and field surveys were presented in **Appendix 13.1** and **Appendix 13.3** respectively. The following sections summarised the key findings recorded within the study area.

13.4.6.41 During literature review, three relevant estuarine macroinvertebrate species of conservation importance were reported. These three species include two horseshoe crab species Mangrove Horseshoe Crab *Carcinoscorpius rotundicauda* and Tri-spine Horseshoe Crab *Tachypleus tridentatus* and one crustacean species Sesarmine Crab *Chiromantes sereni*. For estuarine fish, eight species of conservation importance were reported from literature review. These eight estuarine species include Largesnout goby *Awaous melanocephalus*, Dark-margined flagtail *Kuhlia marginata*, *Eugnathogobius polylepis* (a mangrove goby), *Hemigobius hoevenii* (Banded mulletgoby), Archpatch puffer *Takifugu ocellatus*, one seahorse *Hippocampus kuda* and two pipefish species *Syngnathoides biaculeatus* and *Syngnathus schlegeli*. The approximate locations of these estuarine fauna species of conservation importance were shown in **Drawing No. MCL/P132/EIA/13-002 to MCL/P132/EIA/13-007**.

13.4.6.42 The stream / estuarine fauna survey at six locations on Lantau including Tai Ho, Tung Chung, San Tau, Sha Lo Wan, Hau Hok Wan and Sham Wat were conducted during both dry and wet season between March and August 2013.

13.4.6.43 The findings for estuarine macroinvertebrates indicated that Tung Chung had the highest species diversity in dry season, with high diversity index (H': 2.59) and moderate species evenness index (J: 0.64). Sha Lo Wan also had a moderate-high evenness index similar to Tung Chung. In wet season, Sha Lo Wan had the highest diversity and evenness records (with H': 2.92 and J: 0.73 respectively). Hau Hok Wan also had a high evenness index similar to Sha Lo Wan, which indicated the species recorded are evenly distributed.

13.4.6.44 For the estuarine fish records, Sham Wat had the highest species diversity index (H': 2.37) while Hau Hok Wan had the highest species evenness index (J': 0.76) in dry season. In wet season, Tai Ho had both the highest species diversity and evenness records, with H' and J indices 2.83 and 0.79 respectively.

13.4.6.45 Four estuarine fish species of conservation importance were recorded, including Banded mulletgoby *Hemigobius hoevenii*, Archpatch puffer *Takifugu ocellatus*, Spotted Seashorse *Hippocampus kuda* and Seaweed Pipefish *Syngnathus schlegeli*. The locations recorded were shown in **Drawing No. MCL/P132/EIA/13-014** to **MCL/P132/EIA/13-020**. Although the Red Stingray *Dasyatis akajei* was recorded from the stream fauna survey, it is primarily a marine fish (Fishbase, 2013), and hence would be considered as marine fish species of conservation importance in the following assessment.

Marine Fishes and Other Fauna

13.4.6.46 The detail findings of desktop review and field surveys were presented in **Appendix 13.1** and **Appendix 13.5** respectively. The following sections summarised the key findings recorded within the study area.

13.4.6.47 The field surveys conducted for this project have recorded a total of 182 species, including 134 fish species from 75 families, six species of mantis shrimps from one family, 11 species of shrimps from three families, 13 species of crabs from six families, and 18 species from 16 other families (including blood cockle, sea snail, sea urchin, sand slug, peanut worm, common frog shell, squid, green mussel, octopus, sea pen, cuttlefish, squid, clam, and horseshoe crab) have been recorded from field survey.

13.4.6.48 There are 10 species of conservation importance identified from the species recorded, including *Dasyatis zugei* (pale-edged stingray), *Scomberomorus commerson* (banded tuna), *Epinephelus coioides* (Orange-spotted grouper), *Epinephelus bruneus* (Longtooth grouper), *Hippocampus kuda* (Spotted seahorse), *Aetobatus flagellum* (Longheaded eagle ray), *Dendrophysa russelii* (Goatee croaker), *Larimichthys crocea* (Yellow croaker), *Otolithes ruber* (Tiger-toothed croaker) and *Carcinoscorpius rotundicauda* (horseshoe crab). From literature review, an additional 10 species of conservation importance were identified for marine fishes and other fauna, including *Dasyatis akajei* (Red stingray), *Clupanodon thrissa* (Chinese gizzard shad), *Inimicus japonicas* (Devil stinger), *Nemichthys scolopaceus* (Slender snipe eel), *Nemipterus virgatus* (Golden threadfin bream), *Syngnathus schlegeli* (Pacific seaweed pipefish), *Tachypleus tridentatus* (horseshoe crab), *Takifugu ocellatus* (Archpatch puffer), *Oliva mustelina* (Sea snail), and *Zebrias crossolepis.* Amongst the 20 species of conservation importance identified above with the study area, Longheaded eagle ray, Pale-edged stingray, Goatee croaker, Long-tooth grouper, Orange-spotted grouper and Tiger-toothed croaker were found within the project footprint. Most of them were also recorded outside the project footprint, except Longheaded eagle ray. Most of the species of conservation importance could be found in the northern waters of Chek Lap Kok outside the project footprint. The locations recorded were shown in **Drawing No. MCL/P132/EIA/13-026**.

Marine Mammals

General

13.4.6.49 As noted in **Section 13.4.5** above, three types of field surveys have been undertaken for the purposes of filling the identified CWD baseline data gaps, as follows:

- Focussed vessel line transect surveys;
- Land-based theodolite tracking; and
- Autonomous passive acoustic monitoring (PAM).

13.4.6.50 The results of the three types of surveys are presented in the sections below with further details presented in **Appendices 13.7 – 13.12.**

Focussed Vessel Line Transect Surveys

CWD Sighting Results

13.4.6.51 The results of the vessel line transects form the primary basis for investigating CWD usage of the project area, especially the footprint of the proposed land formation for the 3RS, as required by Appendix F, Clause 3(iii)(a) of the project Study Brief. A total of 56 vessel surveys were conducted over a period of 14 months between October 2012 and November 2013.

13.4.6.52 The dates of the CWD vessel transect surveys are shown in **Appendix 13.6,** with the raw data provided in **Appendix 13.12**.

13.4.6.53 A total of 2,943 km of line-transect vessel survey effort was conducted in the designated survey area. Of this, 2,300 km were completed in good sighting conditions (Beauford 0-3) in the airport North area and a further 295 km in good conditions in the airport west area, providing results for estimating density and abundance from line transect analysis. The remaining 348 km of survey effort were completed in Beauford conditions of 4 or above, and were thus not used in the line transect analyses.

13.4.6.54 As noted in Table 1 in **Appendix 13.7**, a total of 77 groups of CWDs numbering 277 individuals were sighted during these surveys. Of these, 58 (75%) have been made in the airport north survey area and the remainder 19 (or 25%) in the airport west area. Of this total, 43 on-effort sightings in good sighting conditions were made in the airport north survey area and 13 in the airport west survey area (**Drawing No. MCL/P132/EIA/13-021**), allowing these data to be used in the line transect analyses. The surveyed area north of the airport is considerably larger than that west of the airport, so these sighting differences are not to be taken as the north airport area being more used than the west one. The remaining CWD sightings made were either off-effort or were made during poor sighting conditions of Beau 4 or above and, therefore not, used in the line transect analyses. However, the data collected off-effort or in Beauford 4+ conditions have been used to analyse CWD distributions, group sizes and habitat use pattern and these data are, however, presented in **Appendix 13.12** for completeness. CWD sightings were shown to be distributed throughout the entire survey areas, as shown in **Drawing No. MCL/P132/EIA/13-021**, demonstrating that the CWDs do use the entire survey area to some extent. **Drawing No. MCL/P132/EIA/13-021** shows all CWD group sightings as red dots (both on- and off-effort), with each group containing one or more CWDs.

13.4.6.55 As noted in **Appendix 13.4,** in the airport north area, there were two transect routes surveyed on each day (**Drawing No MCL/P132/EIA/13-011**). However, only the first set (Set A) of transect lines conducted in this area on each day have been used in the density and abundance estimation. This was because the first set of survey lines had closer spacing, providing better coverage, and the second set was primarily for examining individual CWD movements in the area throughout the day.

13.4.6.56 The calculations of the relative numbers of CWD group sizes in the two main survey areas, airport north and airport west, compared to the broader study areas surveyed in the AFCD long-term study are presented in **Table 13-1** below.

13.4.6.57 The results show that the CWD group sizes in the survey area are generally similar to those of the AFCD long-term study, but with CWD groups sighted within the two airport survey areas appearing to be slightly larger (**Table 13-1**). However, sighting rates of the CWD groups in the

3RS airport survey areas appear to be less than those recorded in the areas north and west of Lantau Island during the AFCD monitoring (**Table 13-1**).

13.4.6.58 Estimates of density and abundance have been calculated for the airport north and airport west survey areas, based on the line transect data collected during the vessel surveys for this EIA (October 2012-November 2013). The resulting seasonal estimates are presented in **Table 13-1, upper portion**. For the airport north area, densities were similar for all four seasons, ranging from about 12 to 19 dolphins/100 km^2 (**Table 13-1**). However, for the airport west area, densities were moderate in winter and spring (12-15 CWD/100 km^2), but much lower in summer (<1 dolphin/100 km^2) and appear higher in autumn (24 CWDs/100 km^2) (**Table 13-1**). These large seasonal fluctuations for the airport west survey area are probably a result of the very low sample sizes associated with this small region when stratified by season and it is considered the true fluctuations in density would not be expected to be so marked. However, it is also important to note that construction work for the HZMB related projects have been on-going and may have possibly affected these results. It is recognised that the survey areas are not 'pristine' and have not been so for many decades. They are influenced to varying degrees by a number of anthropogenic factors and while it is not possible to isolate and factor out the influences from these other projects, the baseline that has been developed recognises that other factors have an influence on the results and takes account of this fact.

13.4.6.59 CWD densities and abundance for all four seasons combined have also been calculated for the airport north and airport west survey areas and compared with the comparable density/abundance estimates for the three main survey areas that have been shown to contain the most CWDs in the AFCD long-term study (**Table 13-1, lower portion**). It is recognised that the survey periods compared are not exactly equal, however this is due to availability of data from AFCD records. The average seasonal densities for the airport north and airport west were about 13-14 CWD/100 km^2, which is considered moderate. These values are very similar to densities for the northeast Lantau and southwest Lantau survey areas (**Table 13-1**). However, the other two survey areas (northwest Lantau with 44 dolphins/100 km^2 and west Lantau with 67 dolphins/100 km^2) have much higher densities (**Table 13-1**). Thus, it can be said that the airport north and airport west areas, including the project area for the 3RS, have densities of CWDs at the low end of the moderate range, which are similar to those of northeast Lantau and southwest Lantau but much lower than the average densities for the overall area of northwest Lantau and the nearby west Lantau area (from AFCD data).

Table 13-1: Comparison of Seasonal Density and Abundance Parameters between the Surveyed Regions (Airport North and Airport West) and Broader Study Area in Hong Kong (data from AFCD long-term database).

Area	Year(s)	Season	Average Group Size	Sighting Rate (No./100 km)	Density (No. /100 km^2)	Abun-dance	CV[(1)]	Source
Airport North	2012/ 2013	Winter	3.8	1.13	12.13	2	71	This study
Airport North	2012/ 2013	Spring	4.0	1.20	11.51	2	50	This study
Airport North	2012/ 2013	Summer	3.0	3.88	19.33	4	37	This study
Airport North	2012/ 2013	Autumn	4.6	1.99	14.96	3	50	This study
Airport West	2012/ 2013	Winter	2.5	3.18	11.69	1	91	This study
Airport West	2012/ 2013	Spring	6.0	1.74	15.32	1	100	This study
Airport West	2012/ 2013	Summer	5.7	4.98	0.76	0	nd	This study
Airport West	2012/ 2013	Autumn	3.7	6.06	24.25	1	64	This study
Airport North	2012/ 2013	All seasons	4.1	2.05	14.48	3	52	This Study
Airport West	2012/ 2013	All seasons	4.5	3.99	13.01	1	64	This Study
Northeast Lantau	2012	All seasons	2.8	2.99	12.33	7	25	AFCD dataset
Northwest Lantau	2012	All seasons	3.4	7.39	44.10	38	13	AFCD dataset
West Lantau	2012	All seasons	3.2	13.73	67.41	19	17	AFCD dataset
Southwest Lantau	2012	All seasons	2.2	3.49	13.99	9	36	AFCD dataset

Note (1): CV is the coefficient of variation, a measure of variance.

13.4.6.60 The group sizes from the CWD sightings from all vessel surveys (on or off-effort and all Beaufort states) and both surveyed areas, airport north and airport west, have been combined to produce **Chart 1** of **Appendix 13.7.** The group sizes show ranges from singletons to groups of up to 14 individuals, with the average group size being 3.6.

CWD Photo-Identification Results

13.4.6.61 Photo-identification of the CWDs sighted was conducted during all of the vessel surveys to provide photographic records of individual CWDs where possible. A total of 54 different individuals were identified, with 117 re-sightings made among them during the surveys. Nearly 60% of these re-sightings were made to the north of the airport, while 47 re-sightings were made to the west of the airport. In addition, 22 of the 54 (41%) individuals occurred in both areas to the north and west of the airport, showing some limited movements within the northwest Lantau region. The records of the CWDs which have been identified by the photo-identification process are detailed in **Appendix 13.12b**.

13.4.6.62 Twenty-seven of the identified CWDs were observed only once or twice, and the rest (n=27) were re-identified in the survey areas 3-9 times. For example, NL179 and NL288 were re-identified seven times, and all these re-sightings occurred in airport North region. A mother-calf pair (NL123 and NL285) was re-identified six times, and all except one re-sighting were made in airport North region. Two other mother-calf pairs (NL33 with her calf with no ID yet, and NL264 with her calf NL288) also occurred regularly in the study areas. The re-sightings of many individuals three to nine times within the 14-month survey period suggest that a significant portion of individual CWDs has been using the survey areas to the north and west of airport as a significant part of their home ranges. Information from the AFCD long-term database also back up these findings. Most CWDs in Hong Kong have home ranges of 100-150 km^2, with an average of 135 ± standard deviation of 63.53 $km^{2.}$ The actual ranges are quite variable from 39 to 339 km^2 (Hung 2008; see **Appendix 13.2**).

13.4.6.63 Of the six individuals that were observed most often (7-9 times each), one individual (NL24) is a well-known animal that had been observed 201 times up to early 2013. CWD NL24 is female and it is a year-round resident that ranges through the northwest Lantau and northeast Lantau areas. Its core range encompasses the area from the Brothers to Black Point and south to the Tai O area (Hung 2013). The most-frequently observed individual (NL242, n=9) is a year-round resident, seen in the marine park and the Brothers areas (Hung 2013). The sex of the CWD is determined to be female when an individual is seen repeatedly closely associating with a small calf in accordance with standard marine mammal biology survey techniques. In addition, several other well-known individuals with greater than 10 sightings in the long-term catalogue were observed in the study area, including EL01 (a long-term North Lantau resident seen once in the study area), NL18 (a north / west Lantau resident seen once), NL24 (a north / west Lantau resident seen seven times) and SL35 (a south / west / northwest Lantau resident seen six times).

13.4.6.64 In fact, the majority of these 54 individual dolphins were re-sighted regularly in Hong Kong waters in the past during different monitoring studies conducted by the Hong Kong Ceataceans Research Project (HKCRP) (Hung 2013). Thirty-nine individuals were re-sighted 30 times or more, and twenty individuals were re-sighted more than 50 times during the past decade, according to the latest photo-identification records maintained by HKCRP. The residency patterns of 35 individual dolphins re-sighted during the present study were also assessed by Hung (2013). Only two of them were considered visitors that occurred sporadically in the past, while 22 and 11 individuals were considered year-round residents and seasonal residents respectively, showing their intensive usage of Hong Kong waters in the past.

13.4.6.65 In examination of their range use with reference from Hung (2013), the majority of them centered their core areas around the SCLKCMP and the Brothers, and several individuals even centered their core area use to the northeast corner of airport platform (i.e. NL98, NL104, NL123 and NL246). Fifteen individuals used both the marine park and the Brothers as their core areas, implying that they have to travel frequently through the travelling area between these two core areas. On the other hand, only six of the 54 individuals centered their core area use in western Lantau waters, and two of them have both core areas in the marine park and western Lantau waters, indicating their frequent movement between the two through the study area.

13.4.6.66 Notably, even though some individuals centered their core areas in the north Lantau or west Lantau region respectively, they have shown extensive movements between the two regions during the present 14-month study. For example, the range use of NL24, NL98 and NL242 were mainly in the north Lantau region, but they were also sighted repeatedly in airport west region during the present study. On the contrary, the range use of WL15 and WL46 mainly centered their core area use in west Lantau region, but they were also sighted repeatedly in the airport north region during the present surveys. Movements of these individuals imply that resident CWDs in Hong Kong moved frequently across the current study area between the North and west Lantau regions.

Focal Follows

13.4.6.67 Twenty-nine vessel-based CWD focal follows were conducted between 11 October 2012 and 25 September 2013, 20 of them in the airport north and nine in airport west. The duration of the individual follow times ranged between 0.08 hours and 02.32 hours with a total of 25.5 hours of follow time. Distances of the CWD tracks ranged from 0.16 km to 11.74 km and mean swimming speed per track ranged from 1.41 km/hr to 5.86 km/hr. Examples of two focal follow tracks are shown in **Appendix 13.8**.

13.4.6.68 During focal follows, positional information and behavioural state data were collected at 5-minute sampling intervals. Details in the mean CWD swimming speeds in the two main surveyed areas, airport north and airport west, in addition to during the various solar and oceanographic seasons, times of day and during different behavioural activities are presented in **Table 1** of **Appendix 13.8**. It is important to note that collection of behavioural data from a vessel requires that the boat be relatively close to the CWDs and that this means it is likely that the boat will affect their behaviour, sometimes strongly. This is an area, where land-based data collection is considered far superior, and therefore reliance is placed more strongly on the land-based data to assess issues such as CWD swimming speeds, directionality, and behaviour state/activity information.

13.4.6.69 The mean CWD swimming speed in each of the surveyed areas was similar, with 2.67 km/hr in the airport North area and 2.86 km/hr in the airport West area. Relative to oceanographic seasons, mean speed of movement was noted to be highest during the dry season at 3.07 km/hr and lowest during the wet season at 2.57 km/hr. In the solar seasons, mean speeds of movement were highest during winter (3.79 km/hr) and spring (3.02 km/hr) and lowest during the autumn (2.25 km/hr) and summer (2.34 km/hr). In addition, the swimming speeds were highest during the morning hours (prior to 10:00 hours) at 2.40 km/hr and mid-day (10:00 hours to 14.00 hours) at 2.60 km/hr and lowest in the afternoon (later than 14:00 hours) at 1.52 km/hr.

13.4.6.70 Behavioural state data were recorded for 251 of the 331 5-minute sampling intervals. Percentages for each behavioural state were similar in each of the two survey areas except for foraging which was not observed in the airport west area. In the airport north survey area, milling was observed 75% of the time, travelling was observed 17% of the time, socialising was observed 5% of the time and foraging approximately 3% of the time. In the airport west survey area, milling was observed 70% of the time, travelling was observed 20% of the time and socialising was observed 10% of the time. The mean speed of movement was highest during travelling (4.52 km/hr), lowest during foraging (1.73 km/hr) and mid-range during socializing

(2.04 km/hr) and milling (2.33 km/hr), as shown in **Appendix 13.8**. CWD were also noted to spend approximately 18% of the time travelling in the areas to the northern and western sides of the airport. These findings support suggestions of a potential travel corridor between west Lantau and northwest Lantau (Hung 2012, 2013).

Land-based Surveys and Theodolite Tracking

13.4.6.71 The land-based surveys and theodolite tracking provide the primary means of assessing movement patterns of CWDs within the survey areas, along with vessel surveys and photographic identification of individuals (discussed above), in accordance with Appendix F, Clause 3(iii)(b) of the project Study Brief, and also allow the identification of key CWD travelling corridors. The land-based theodolite tracking surveys have been undertaken from 12 October 2012 to 26 November 2013, comprising a total of 127 days and 676:22 (hh:mm) of survey effort, as shown in **Table 13-2.** While 105 days were spent surveying, on 22 of these days, surveys were conducted at two separate stations simultaneously; therefore, 127 independent surveys were conducted.

13.4.6.72 A total of 117 CWD groups have been tracked during the land-based surveys (**Table 13-2**). Further details of the number of CWDs in each group on each survey day are provided in Table 1 of **Appendix 13.9**. The total number of CWD groups tracked from land is useful when assessing occurrence, distribution and habitat use at each location; however, tracking duration per CWD focal follow varied (see Marine Mammal Survey **Section 13.4.6**). Because CWD focal follows varied in duration, each CWD track was split into 10-minute segments for movement analyses in order to standardise the data. After the raw data were filtered to only include tracks with at least 10 minutes of tracking per CWD focal follow, 82 groups fit the criteria for inclusion in the movement analysis (**Table 13-2**).

13.4.6.73 CWD focal follows and, therefore the number of 10-minute segments per group, varied in duration and in order to reduce pseudoreplication, an analysis was undertaken to determine the temporal lag at which two segments from the same focal group were no longer autocorrelated. After this autocorrelation analysis was undertaken on the qualifying groups, 79 segments met the criteria for inclusion.

Table 13-2: Land-based Survey and Theodolite Effort and CWD Group Summary

Land-Based Station ID	Number of Survey Days	Survey Effort (hh:mm)	Number of CWD Groups Sighted	Dolphin Group Sightings Per Surveys Hour	Number of CWD Groups After Filtering	Number of 10-Minute Segments After Auto-Correlation
A	33	182:28:00	25	0.137	16	21
B	29	159:36:00	11	0.069	7	7
C	37	201:14:00	34	0.169	33	34
D	28	133:04:00	47	0.353	26	17
TOTAL	**127**	**676:22:00**	**117**	**0.173**	**82**	**79**

13.4.6.74 The surveys have shown that CWD group sightings per survey effort was the greatest from Station D at Sha Chau (0.353) and lowest from Station B at airport north (0.069) as detailed in **Table 13-3** and shown graphically in the left figure of **Drawing No. MCL/P132/EIA/13-022**.

13.4.6.75 The diurnal pattern of CWD occurrence per station was calculated by dividing the sum of dolphin groups tracked (based on the hour block in which they were first sighted) by the effort per hour block. These percentages give a good representation of times that groups moved into view at each station, but since they are first recordings of a group, do not by themselves give indication of length of stay within the survey area. The highest percentage of CWD groups observed per hour of effort off Station A were first observed during the 12:00 hour block (40.00%), as shown in Chart 1 in **Appendix 13.9.** All the CWD Groups off Station B were first observed between 09:00 and 13:00 hours. Most of the CWD Groups observed from Station C were first observed earlier in the morning between the 08:00 and 10:00 hour blocks and then again during the 1500 block (88.00%). Most CWD Groups off Station D at Sha Chau, where the greatest group sightings per survey effort were noted, were first observed during the 11:00, 14:00, 16:00 and 17:00 hour blocks (52.63%). Based on these shore-based data, the CWDs appear to use the waters off the western side of Chek Lap Kok during the morning hours of visible daylight and again in the afternoon (around 15:00), while utilising the waters to the north and northeast of the Chek Lap Kok airport island at mid-day and waters off Sha Chau from mid-day through the afternoon (except around 1500 when they are observed more to the west of Chek Lap Kok). These data have been standardised by survey effort per hour for each station.

13.4.6.76 The plot at the right side of **Drawing No. MCL/P132/EIA/13-022** shows the vessels spotted in the land-based surveys with the data divided into high speed ferries and all other marine vessels.

13.4.6.77 The data are unbalanced based on sample categories, that is, there are more 10-minute segments with vessels not present than with vessels present, as detailed in **Table 13-3** below. Of the 79 10-min segments that achieve the criteria for analysis, 52 had no vessels present during the focal follows, and 27 including vessels within 500 m of the focal group. This does not mean that vessels were not in the general vicinity but that they were outside of the 500 m threshold established for this analysis (**Section 13.4.6.81).** During the daytime, 26 10-min segments occurred during the morning category, 44 occurred during the mid-day category and 9 occurred during the afternoon category. Seasonally, 26 segments occurred during the autumn season, 24 occurred during winter, 11 occurred during the spring and 18 occurred during the summer. Although seasonal data are unbalanced, CWD groups tracked per survey effort hour were highest during the winter season (0.148) and lowest during the spring (0.077) (**Table 13-3**).

Table 13-3: Number of 10-min Segments by Solar Season, Time of Day and Vessel Presence

Season	Survey Effort		CWD Groups/	Morning		Mid-day		Afternoon	
	(hh:mm)	n	Survey Hour	No Vessel	Vessel	No Vessel	Vessel	No Vessel	Vessel
Autumn	215:16	26	0.121	4	2	9	10	0	1
Winter	162:42	24	0.148	7	1	7	5	3	1
Spring	143:30	11	0.077	4	0	5	1	1	0
Summer	154:54	18	0.116	6	2	4	3	1	2

Statistical Analyses

13.4.6.78 Between October 2012 and November 2013, 9,929 positional fixes of high speed ferries, 17,906 positional fixes of other vessels and 3,384 positional fixes of CWD individuals and groups were made. Details of the statistical analysis of transformations are provided in **Appendix 13.9.**

13.4.6.79 A discussion on the results of the statistical analyses for the three CWD response variables, swimming speed, reorientation rates and linearity, as an indication of behavioural states and activities, is provided in the sections below.

Swimming Speed

13.4.6.80 The raw data are presented in **Appendix 13.12d.**

13.4.6.81 The descriptive statistical analysis undertaken on the data shows that the mean swimming speed of CWDs was higher when vessels were within 500m of the focal group (i.e. "boat presence") than when vessels were outside of this threshold, slightly higher when high speed ferries were present, higher off Station B, higher at mid-day, higher during the summer season, and higher during the wet season **Appendix 13.9, Table 5 , Chart 3** and **Chart 4**. However, CWD swimming speed was lower off Station C to the west of the airport, lower in the afternoon, and lower during the spring season. Univariate statistical analyses (one-factor Analysis of Variance, ANOVA) showed no significant relationship at the 0.05 alpha level between swimming speed and the following explanatory variables:

- boat presence (p-value = 0.5418);
- high speed ferry presence (p-value = 0.6523);
- location (p-value = 0.0572);
- time of day (p-value = 0.1705);
- solar season (p-value = 0.2732); and
- oceanographic season (p-value = 0.4780).

13.4.6.82 Such differences in behaviours by area, time of day and season are often related to such aspects of differential foraging or travelling amount by time and space, but the details are variable and beyond the scope of this EIA study. Overall, it is considered that the general slower swimming speeds west of the airport are one indication of less travelling in the area close to the shoreline and potentially more foraging there.

Reorientation Rate

13.4.6.83 The raw data are presented in **Appendix 13.12d.**

13.4.6.84 Reorientation rate measures how much an individual or group of CWDs changes course or heading over time (°/min). Overall reorientation rate increases when an individual or a group

changes bearing more and decreases when bearing changes occur less. Often, lowered reorientation rate values are related to straighter line movement, or travel.

13.4.6.85 The descriptive statistical analysis shows that the reorientation rate of CWDs was higher when vessels were within 500 m of the focal group (i.e. "boat presence") than when vessels were outside of this threshold, higher when high speed ferries were present, higher off Station B, higher in the morning, higher during the autumn season, and higher during the wet season (**Table 6**, **Chart 13.5** and **Chart 13.6** in **Appendix 13.9**). Reorientation rate was lowest off Station D at Sha Chau, lower in the afternoon, and lower during the winter season. Such potentially lowered reorientation rates south and east of Sha Chau, where the most tracks of CWDs were obtained, signifies more directed movement indicative of travel in this area north of the existing airport platform and generally north of the area largely effected by high speed ferries. The univariate statistical analyses (one-factor ANOVA) showed no significant relationship at the 0.05 alpha level between reorientation rate and the following explanatory variables:

- boat presence (p-value = 0.0957);
- high speed ferry presence (p-value = 0.2252);
- location (p-value = 0.3703);
- time of day (p-value = 0.6262);
- solar season (p-value = 0.6459); and
- oceanographic season (p-value = 0.9254).

13.4.6.86 The rate of CWD reorientation was highest in the morning and mid-day and lowest in the afternoon. One interpretation of these results is that CWDs exhibited more non-directional milling behaviors (such as socialising and foraging) in the afternoon and exhibited more directional movement, such as travelling and resting, during the morning and mid-day hours. In addition to milling behaviours, non-directional movement can indicate a change in heading to avoid waterborne objects. For example, reorientation rates were highest off Station A, east of the airport island, where high speed ferry traffic is dense, and lowest off Station D at Sha Chau, where vessel traffic is relatively low. However, sample sizes were unbalanced and comparatively smaller off Station D (n=6) than off Station A (n=9), and lower for HSF presence (n=5) compared to no vessel presence (n=52). It is considered that CWDs change bearing more often in waters off Station A to avoid vessels that regularly utilise the area. Reorientation rate also increased in the presence of high speed ferries (vs. no vessels present). Decreased reorientation rate off Station D indicates more directed travelling or resting behaviour.

13.4.6.87 There is no equivalent analysed data available from the AFCD long term monitoring for comparison.

Linear Movement

13.4.6.88 The raw data are presented in **Appendix 13.12d.** Linearity is an index of net movement ranging from 0 to 1, with 0 equating to no net movement and 1 equating to straight line movement. It is calculated by taking the net distance between the first and last fix of a track and dividing by the sum of distances travelled for each leg. The more linear the movement of a CWD group, the more indication of straigh-line movement, typically related to travel.

13.4.6.89 The descriptive statistical analysis of the land-based surveys data shows that movement of CWDs was more linear when vessels were within 500 m of the focal group (i.e. “boat presence”), but less linear when high speed ferries were present. CWD movement was also more linear off Station D, during the afternoon, during winter months, and during the dry season as shown iin **Appendix 13.9** (**Table 7**, **Chart 7** and **Chart 8**). However, sample sizes were unbalanced and comparatively smaller for HSF vessel presence (n=5) than with no vessel presence (n=52). In addition, CWD movement was less linear off Station B, north of the existing platform, at mid-day, and during the spring. Univariate statistical analyses (one-factor ANOVA) showed no significant relationship at the 0.05 alpha level between linearity and the following explanatory variables:

- boat presence (p-value = 0.1215);
- high speed ferry presence (p-value = 0.5125);
- station location (p-value = 0.3027).
- time of day (p-value = 0.5131);
- solar season (p-value = 0.3953); and
- oceanographic season (p-value = 0.8444).

13.4.6.90 In most cases, when reorientation rate increased, linearity decreased, including when high speed ferries were present, in waters off Stations A, B, and C, during mid-day hours, during autumn and spring months, and during the wet season. CWDs moved in a less linear path when high speed ferries were present and off Station A where high speed ferries traverse. As noted above, this movement pattern is judged to reflect avoidance of waterborne objects. CWDs moved in a less linear path during mid-day hours which may indicate socializing or foraging behaviour based on non-directional movement. It is not surprising that when individuals or a group of individuals change bearing more often, the path of movement becomes less linear. Likewise, when reorientation rate decreased, linearity increased, including when high speed ferries were not present, in waters off Station D at Sha Chau, during afternoon hours, during winter months, and during the dry season. Alternatively, during the morning hours, and during summer months, both reorientation rate and linearity increased. This relationship is unusual given that an increase in bearing change should reflect a less linear or straight line path and could reflect unbalanced data and a low sample size for these factors. Overall, the findings from Station D (at Sha Chau) of generally more linearity and less re-orientation, indicates more directed travel in the area outside of the influence of the high speed ferry lane just north of the existing HKIAAA.

Discussion of Land-Based Survey Results

13.4.6.91 Based on data collected from the four land-based stations, it can be concluded that the CWDs use the waters to the north, northeast and west of Chek Lap Kok and off Sha Chau, often being located quite close to shore. The highest percentage of dolphins per survey effort was observed off Chek Lap Kok and more CWDs per survey effort were observed during the winter season. CWDs used the waters to the west of the airport mostly in the morning, to the north / northeast mostly at mid-day and towards Sha Chau between mid-day and in the afternoon. Overall, the CWD and vessel positions tracked from shore-based stations indicate that dolphins are observed less in areas where vessel traffic is high, particularly where high speed ferries traverse, as seen in the vessel survey data in **Drawing No. MCL/P132/EIA/13-022,** although preferences in location are likely influenced by many factors including environmental conditions (Jefferson and Karczmarski 2001, Atkins et al. 2004).

13.4.6.92 CWD movement patterns are known to vary based on natural factors, for example, the time of day or season, as well as anthropogenic activities like vessel presence, and CWDs appear to use patches within the overall surveyed habitat in different ways and at different times of the day. In terms of natural factors, the CWDs swam faster during mid-day hours, in the waters proximate to Station B, just north of the existing airport platform, during the summer, and during the wet season. However, fewer dolphins were observed from Station B and it is possible that they are using this area primarily to travel from one area to the next, with shorter appearances in the area, making it more difficult to sight and track them. This is consistent with the faster mean speed of travel off this area. In terms of reorientation rates, that is, bearing changes these were highest at mid-day, off Station B, in the autumn, and during the wet season which coincide with the times of the least linear movements, and lowest during afternoon hours, in the waters off Station D, in the winter, and during the dry season, which coincides with most linear movement. It is expected that if CWDs are travelling, they would swim in a faster and more linear path; however, the highest swim speeds were concurrent with increased reorientation rate and reduced linear movement as observed off Station B and during mid-day. This behaviour reflects travelling through areas where they also have to maneuver away from waterborne objects. Slower swimming speed and less linear movement, as observed off Station C and during morning hours, indicates increased resting or “milling” behavior (Norris et al. 1994).

13.4.6.93 Relative to vessel activity, the CWDs swam faster, changed bearing more, and moved in a less linear fashion when vessels were present. Higher speeds and lower linearity are observed during a number of different behavioural states, including foraging and active socialising, however, it is possible that increased swimming speeds, often with erratic movements, would also indicate approaches towards or fleeing from a moving vessel (Würsig pers. observ. with a suite of dolphin species). The same patterns have been observed when high speed vessels presence was examined (Hung 2012, 2013, Piwetz et al. 2012).

13.4.6.94 The data from vessel focal follows are gathered quite differently from those of shore-based theodolite tracking of focal groups and results can be compared but should not be treated as one data type. For example, focal follows by vessels could be affecting the behaviours of those animals being followed to some degree, while theodolite tracks tend to be fewer and more sporadic for animals that surface only seldomly as they travel through an area. Overall, vessel-based focal follows to the immediate north and west of the existing airport platform indicated

that the CWDs were travelling about 17% and 20% of the time **(Section 13.4.6.70**), respectively, similar to data from Hung (2012, 2013). Overall swimming speeds were similar between the vessel and shore-based platforms, with shore-based tracking work showing an increase in swimming speed to the north of the airport at mid-day and afternoon (**Section 13.4.6.81**), indicating more travel during those times than in the morning. While much behaviour was classified as "milling" in both the airport north and airport west survey areas, the overall assessment of the theodolite tracking data indicated that "milling" was more often related to changing positions, that is, travel, in the airport north area compared to the airport west area. The data are especially confounded because CWDs north of the airport appeared to have been often affected by the transits of high speed ferries resulting in erratic movements and making it difficult to obtain the up to ten-minute tracks needed for statistical evaluations. Thus, for the determination of the fact that more travel is occuring, the data of lowered re-orientation rates and higher linearity just north of the high speed ferry corridor has been used, as assessed by tracks from Sha Chau.

13.4.6.95 Although findings were not statistically significant at alpha level 0.05, some of the values were significant at the less stringent alpha level 0.1. Furthermore, variation in fine-scale movement patterns may be biologically significant, even if not reflected in the statistical analysis, for this long-lived species. A smaller vessel distance threshold would likely have identified statistically significant changes in CWD movement patterns relative to human activity; however, sample sizes at the 500m distance threshold were small and would have decreased further with a smaller threshold. CWDs likely alter behavior by moving away from areas with high vessel traffic and this type of fine-scale displacement is important when considering increased anthropogenic activity in CWD habitat.

Passive Acoustic Monitoring

13.4.6.96 The passive acoustic monitoring (PAM) was undertaken between December 2012 and December 2013 at a 20% duty cycle (one minute recording then 4 minutes not recording, etc.), 24 hours per day. Acoustic data were gathered in all seasons to listen for CWD occurrence patterns and to obtain anthropogenic noise information simultaneously. This work involved a type of Passive Acoustic Monitor (PAM) (Wiggins and Hildebrand 2007) termed an Ecological Acoustic Recorder (EAR).

13.4.6.97 Five sets of passive acoustic EARs were located within HKIAAA and footprint of the proposed airport extension reclaimed platform, as shown in **Drawing No. MCL/P132/EIA/13-013**. Further details of the EAR placements and data recording are presented in **Table 13-4** below.

13.4.6.98 Overall ambient noise measurements and detections of CWD sounds have been accomplished for all five EARs, A1-A5. The EAR ambient noise data for each of the five stations are presented by date and time of day (hour) in **Appendix 13.10**. Ambient noise is made up of an aggregate of all sounds in the marine environment, including sounds of shipping, any other industrial noises such as from a barge or from dredging activities, sounds made by surface waves or waves on a shoreline (these are often wind speed related in shallow water environments such as for this work), snapping shrimp, fish chorusing, and, to a very minor degree as they are not numerous, sounds of CWDs.

13.4.6.99 For Station A1 (**Figures 1** of **Appendix 13.10**), there was relatively little ambient noise from 6 December 2012 to about 14 February 2013, with a rising noise spectrum after that, especially so in the lower frequency bands, but also detectable throughout all bands to 32 kHz. By 23 May 2013, the 0-2 kHz band had reached up to almost 115dB re. 1ţPa, with a slow reduction in that band after that time. However, overall noise level ("Average of Fullband", **Appendix 13.10**, **Figure 1**) did not decrease until the beginning of August. While anthropogenic influence was first suspected, this rise in noise turned out to be largely due to the biological sounds of chorussing of unknown species of fish, especially so in the afternoon-evening (evening (see Spring and Summer and the early days of Autumn, **Appendix 13.10, Figure 4 and 5**). During the winter months, 21 December to 20 March, there was also a clear peak of noise energy in the lower frequency band around noon and 17:00 hours during the day (**Figure 2** in **Appendix 13.10**) and the mid-day noise increases are considered to be related to vessel traffic, with the full band noise levels during these times reaching about 109 dB re. 1ţPa. The same trend is apparent to a certain extent in both the dry and wet seasons (**Figures 6** and **7** in **Appendix 13.10**).

13.4.6.100 There was less ambient noise at most frequencies and overall at EAR station A2 than at A1 (**Figure 8** in **Appendix 13.10**), and a general tendency for less noise at night (about 21:00 to 08:00) than in daytime during winter (**Figure 9** in **Appendix 13.10**). As for EAR Station A1, a dramatic rise in noise, but this one quite limited to the lower frequency 0-2 kHz octave band, occurred in evening, around 1800-2000 hrs., in the spring and lasted through early autumn (**Figures 10-12** in **Appendix 13.10**). This evening rise can be seen in the dry season (**Figure 13** in **Appendix 13.10**) but more dramatically so in the wet season (**Figure 14** in **Appendix 13.10**).

13.4.6.101 EAR Stations A3, A4, and A5 all show similar characteristics, comparable to Stations A1 and A2, with much less noise in the winter months than in spring and very early Summer and with most of the increases in noise occurring in the lower octave bands, in the afternoon to evening, starting from 14 March 2013, and continuing into early autumn. While mid-day noise levels were slightly higher than at night-time, considered to be related to the amount of traffic in the day compared to the nighttime, even the daytime noise levels were drowned out by the very intensive increase in noise from croaker fish signatures (Figures 15-35, including dry and wet season effects, **Appendix 13.10**).

<u>CWD Sound Observations and Discussion</u>

13.4.6.102 A review of land-based survey data (see **Section 13.4.6.71 - 13.4.6.94**) reveals a large number of CWD positions collected via land-based tracking to be located near to the five EAR devices **(Drawing No. MCL/P132/EIA/13-022**) and this provides data on the approximate locations of the CWDs at the time their signals are detected. Thus, overlaps of land-based CWD sightings and the EAR recorded sounds of CWDs have been analysed. Seven periods of overlap were analysed to provide data on how far away the EARs can pick up the CWD sounds. One overlap period was on the 7 January 2013, four on the 16 January 2013, one on the 21 February 2013 and one on the 24 April 2013, which have allowed the distance of the focal CWD group from the associated EAR recorder to be calculated. The distances ranged from 0.06 km to 1.17 km and each of the detection types included CWD clicks. Thus, the presence of the CWDs can be detected by their sounds at times as far as one kilometre from the EARs, and can thereby give

a good indication of CWD presence in the area when visual surveys are not occurring, such as no theodolite tracking schedule during many days of inclement weather and at night.

13.4.6.103 The details of the dual detections and the distances as detailed below and summarised in **Table 13-4**:

- On 7 January 2013, a group of 3 dolphins (milling with apparent foraging) were tracked from land-based theodolite Station C, on the west of the airport island, between 09:05 and 11:25 in good weather (visibility 3, Beaufort 3). At 09:10, CWD clicks were detected by EAR A1. The distance between the CWD group (tracked at 09:05) and EAR A1 (detection time at 0910) was 1.17 km;

- On 16 January 2013, a group of 5 dolphins engaged in social behaviour were tracked from land-based Station C between 09:15 and 10:01 in good weather (visibility 3.5, Beaufort 2). CWD clicks were detected by EAR Station A1 at 09:15, 09:20, 09:25, and 09:40 hours and distances between the group and EAR Station A4 were 0.74 km, 0.69 km, 0.71 km, and 0.83 km, respectively;

- On 21 February, 2013, an individual dolphin (designated as potentially feeding) was tracked via the land-based Station A, east of the airport island, between 12:06 and 14:07, in good weather (visibility 2.5, Beaufort 2). Positional locations included recordings at 12:14 and 12:16 via theodolite and EAR Station A4 detected clicks at 12:15. The focal CWD was 0.55 km (at 12:14) and 0.56 km (at 12:16) from EAR Station A4; and

- On 24 April, 2013, a group of 2 dolphins were tracked via land-based Station D, near Sha Chau, between 12:59 and 13:50 in good weather (visibility 3, Beaufort 2). At 12:55, CWD clicks were detected by EAR A5. The distance between the CWD group (tracked at 12:59) and EAR A5 (detection time 12:55) was 0.06 km.

Table 13-4: Summary of Overlap between CWD Focal Follows via Land-based Tracking and CWD Detection by Associated EAR.

Date	Location		EAR Detection		Corresponding Land Time (hh:mm:ss)	Dolphin		Distance (km)
	Land	EAR	Time	Type		Grp Size	Behaviour	
7-Jan-13	C	A1	0910	click	9:05:57	3	Mill / Forage	1.17
16-Jan-13	C	A1	0915	click	9:15:57	5	Social	0.74
16-Jan-13	C	A1	0920	click	9:20:03	5	Social	0.69
16-Jan-13	C	A1	0925	click	9:24:59	5	Social	0.71
16-Jan-13	C	A1	0940	click	9:43:37	5	Social	0.83
21-Feb-13	A	A4	1215	click	12:14:26	1	Forage	0.57
24-Apr-13	D	A5	1255	click	12:59:55	2	Travel	0.06

13.4.6.104 CWD sound detections at the 5 EARs are presented in **Appendix 13.11**, by number of files with detections and number of detections by time of day (hour). Whistle sounds were separated from clicks beyond the general overall percentages of files by day (Figures 1, 8, 15, 22, and 29 for EAR data A1-A5, respectively). The results show that, overall, clicks made up the predominant sound patterns of the CWDs during the survey. This does not necessarily mean that there were so many more clicks than whistles as indicated in the record, as whistles may have been masked at times by other noises and not have travelled as far as some clicks. However, the

clicks recorded were generally broadband, that is, had major energy above the lower frequencies of anthropogenic noise, and it is therefore unlikely that many clicks were masked by anthropogenic activities duting both the day and nighttime. Thus, diurnal differences in recordings (often with more at night than daytime) reflect real conditions, with either more occurrence of CWDs commensurate with more click sounds, or more click sounds being made at particular stations and times, or a combination of both.

13.4.6.105 Overall, there were no dramatic increases in sounds by time of year, although fewer sounds were detected at A1 after May 2013 than in the first half of the recordings, and (opposite to that) A4 shows an increase in sounds from May 2013 on relative to the earlier part of the year. The results at EAR A1 did not show strong differences in occurrence by time of day (**Figures 2-7** in **Appendix 13.11**). The EAR A2 data show strong diurnality in both the dry and wet seasons, with most recordings occurring at night (**Figures 8-14** in **Appendix 13.11**). EAR A3 results showed no strong or consistent seasonal or hourly differences, except for an indication of more sounds at night in summer (Fig. 18), reflected also in the wet season data (**Figure 21**). EAR A4 data showed no strong seasonal differences but had more signals in the evening, from about 15:00 to 22:00hours in the dry season and with a dramatic increase of sounds at night vs. daytime in especially summer and early autumn, reflected in wet season data (**Figures 25-28** in **Appendix 13.11**). In respect of EAR A5, the results showed no strong seasonal correlations, but with a potential shift of use of the area between the dry season -- slightly fewer sounds in early morning, before noon, than at other times of day or night), and the wet season, with a potential, but not strong, reverse of this situation (**Figures 34 and 35** in **Appendix 13.11**).

13.4.6.106 Overall, to the west of the airport (EAR A1), there was much sound activity by the CWDs during both the daytime and nighttime in the winter (and generally dry season) months, with a reduction in sounds, and therefore presumably CWD presence, in spring. Theodolite sighting data show a similar pattern and also indicated that notable foraging activities occurred quite close to shore just west of the airport in winter. To the north and northeast of the airport (EARs A2-A4), including the listening station just southeast of the island of Sha Chau (EAR A5), both winter and spring data did not show dramatic differences in detections, but there was a general tendency for more sounds at night than during the daytime (EARs A2, A4, A5), with this tendency very weak at EAR A3. This indicates more CWD presence at night in the area north of the airport than was obtained from the visual data alone and further indicates the potential greater importance of the habitat north of the airport to CWDs than had previously been known. It is hypothesised that CWDs travel through the area north of the airport, and thus do not linger as long, during the daytime rather than the nighttime. One caveat, EAR A5 showed quite a few signals in early daytime, and this is reflected in a weak wet season increase in early daytime as well (Figures 32 and 35).

<u>Sound Masking by High Speed Ferries</u>

13.4.6.107 As noted in the CWD Literature Review provided in **Appendix 13.2**, communication by the CWD, based on data obtained for the bottlenose dolphins (*Tursiops sp.*), occurs by a series of clicks and whistles, with the latter within frequencies from about 3 to 8 kHz, or higher. The literature has estimated the potential communication distances for whistles of 7-13 kHz to reach to about 2 km distance without background noise in shallow muddy-bottomed waters, and with some higher frequency whistles (13-19 kHz) detectable to even greater distances in open water

channels (Quintana-Rizzo et al. 2006). Janik (2000) presented comparable distances for similar sources levels of about 1.5-4 km.

13.4.6.108 Data by Sims et al. (2012) show that the high speed ferries of Hong Kong release a lot of noise energy into the marine environment along their travel route, with a ferry approaching at a greater than 20 knots speed at 166 m distance from the hydrophones resulting in an overall sound pressure level of around 120 dB re. 1 ąPa , with levels still being as high as 100-105 dB at a distance of 565 m, in the CWD communication range of about 3 kHz and higher. Evidence from the surveyed EAR data shows comparable information. High speed ferries were tracked by theodolite from the land-based Station A, to the east of the airport, to and from the Border Crossing Facility under construction, northeast of the present airport and recorded by EAR Station A4. At an average distance of 500 m from the EAR, sound pressure levels in the 4-8 kHz octave band (important for CWD whistle communication) of about 97 dB at speeds 6-8 knots, 99 dB at speed 11-15 and 16-20 knots, 100 dB at speeds of 21-25 knots and 103 dB at speeds of 26-30 knots were recorded, with each dB level calculated as a mean from 5 ferries per speed category. Every 3 dB increase in sound represents a perception of doubling in "loudness" to the mammalian ear, meaning that this increase is a 4-fold increase in loudness from less than 10 knots to a 26-30 knot vessel speed. In addition, these results represent the “loudness” at the EAR receiver point, that is about 500 m from the vessel and, therefore, the sound pressure level would be much higher at closer distances. Since CWD sounds have been measured as about 168 dB re. 1ąPa at their source (Li et al. 2012), 1 m distance from the CWD’s head, and since their sounds attenuate strongly with distance, there is the potential that fast ferries mask or restrict the range of the CWD communication.

Behavioural Disturbance caused by High Speed Ferries

13.4.6.109 Vessel noise has long been known to change aspects of whale and dolphin behaviours, ranging from short term changes in surfacing / dive characteristics, attraction or repulsion of the animals relative to the vessel to abandonment of an area (Richardson et al. 1995, Würsig and Richardson 2009, Bejder et al. 2006). This has more recently been assessed in the peer reviewed literature for CWDs but not with detailed data relative to fast ferries (Ng and Leung 2003, Piwetz et al. 2012).

13.4.6.110 The vessel line transect surveys north of HKIA have shown that there is an area of lowered CWD occurrence in an east to west vessel lane running approximately 1 to 3 km from the northern edge of the runway, where high speed ferries traverse (**Drawing No. MCL/P132/EIA/13-021**).This pattern of lowered occurrence in this area is supported by data collected via the elevated land-based theodolite tracking surveys, as shown in the overall occurrence of first sightings of CWDs from all theodolite stations (**Drawing No. MCL/P132/EIA/13-022**). Systematic visual scans were conducted throughout each tracking session for an overall snapshot of CWD distribution within the viewing area. Based on positional fixes of CWDs made during scans and focal individual and group tracking sessions, CWDs were observed less in the east to west vessel lane (**Drawing No. MCL/P132/EIA/13-022**). Between October 2012 and November 2013, over 5,000 positional fixes of high speed ferries and over 2,100 positional fixes of CWD individuals and groups were made. However, after filtering data only six periods of dolphin-high speed ferry overlap (within 500 m of one another) were available for analysis. This is because high speed ferries pass through the area of theodolite

tracking distances very rapidly and therefore the requisite time for tracking is generally unavailable. Evaluation of this small data set indicated potential behavioural changes by CWDs when high speed ferries were within 500 m, including increased swimming speed and reorientation rates (change in bearing or heading) and decreased linearity. While direct data are not presented on this issue from the long-term AFCD data set, there has been a general decline of dolphin observations in and near intensively-used high speed ferry lanes and Hung (2012, 2013) addresses the likelihood that the ferries are responsible for this decrease.

Conclusions / Synthesis

13.4.6.111 Overall, crucial data have been obtained for conducting a full evaluation of the importance of the proposed works area to the CWDs, based on a synthesis of information from previous studies, especially by AFCD (for recent examples, see Hung 2012 and 2013); these and others reviewed in **Appendix 13.2,** and the results of the current field work directed at assessing impacts within the 3RS project area and specifically within the current HKIAAA. While the abundance of CWDs within the two surveyed areas (airport north and airport west) is low, with the understanding that part of this low abundance of CWDs at any time is due to both relatively low density and the small survey areas, the densities of CWDs in those areas are similar to those in important CWD habitats, such as in northeast Lantau and Southwest Lantau (Hung 2008 and **Appendix 13.2**). While these are much lower than for the densities in the most critical habitat areas of northwest Lantau and west Lantau, in light of the declining abundance of CWDs in Hong Kong waters (Hung 2013), northeast Lantau and Southwest Lantau, and therefore the area occupied by HKIAAA and proposed 3RS project footprint, would still be considered important habitat for the Hong Kong sub-populations whose core range is in this area. It is important to note that passive acoustic studies suggest that CWDs use the areas directly north of the airport (see **Section 13.4.6.113**) even more at night than during the day.

13.4.6.112 CWD use the airport north and airport west survey areas (**Drawing No. MCL/P132/EIA/13-011**) as part of their general habitat, with a variety of activities occurring in these areas. Although these areas do not seem to represent prime feeding areas for the CWDs, all the evidence collected appears to point to their major use for travelling areas between feeding habitats to the east, at the Brothers and Sham Shui Kok, and to the west at the SCLKCMP and west Lantau area (Hung 2012 and 2013). The area very close to the western border of the airport seems to be used for at least some feeding, and may be important for this. Although the value of these focussed survey areas was not readily apparent from historical studies of CWDs in Hong Kong, recent changes in the habitat, such as due to the building of the SkyPier and its attendant new vessel traffic just north of the airport (Hung 2012, 2013), on-going intensive construction of HKBCF directly northeast of the existing airport island and the construction of HKLR to the west and south of the airport, have the potential to result in variations in how the CWDs are using the available space and these areas could have been used more than in the past due to this (Hung 2013).

13.4.6.113 A summary of the findings of the surveys undertaken is provided below:

- **Occurrence** / **Distribution**. The occurrence data from the focussed surveys for this project indicate that the CWDs use the entire airport north and airport west areas as habitat. The distribution of CWDs from the surveys does not show any dramatic variation throughout the

study area, with the CWDs appearing to be relatively evenly distributed, except for HSF routes where it was noted that CWDs appear to avoid these areas. While the combined abundance of CWDs in the study area is very low (generally < 6 individuals), this is partly due to the very small areas involved. The densities in the two surveyed regions to the immediate north and west of the airport are similar to those areas like northeast Lantau and Southwest Lantau, when compared to estimates made from the AFCD long-term data (Hung 2008, 2012, 2013 and **Appendix 13.2**). In addition, CWDs often avoid the ferry lanes, making the habitat in these locations sub-optimal to them and entering these waters can increase the risk of injury or death from collisions (**Appendix 13.2**).

- **Density** / **Abundance**. CWD densities and abundance for all four seasons combined were calculated for the airport north and airport west survey areas and compared with the corresponding density/abundance estimates for the three main survey areas that have been shown to contain the most CWDs in the AFCD long-term study (Hung 2008, 2012, 2013, and **Appendix 13.2**). The average seasonal densities for the airport north and airport west were about 11-12 CWD/100 km^2, which is considered to be in the low end of moderate. There is no universal classification scheme for dolphin densities. However, in previous work densities of greater than 50 dolphins/km^2 have generally been considered high and those below 10 dolphins/km^2 have generally been considered low (see Jefferson 2007). Thus, densities of 11-12 dolphins/km^2, as were found in the airport north and airport west areas would by this scheme be considered at the very low end of the moderate range. These classifications only take into account CWD densities and do not account for habitat quality, which is assessed separately. These values are very similar to densities for the northeast Lantau and Southwest Lantau survey areas based on the AFCD long- term monitoring data. However, the other two relevant AFCD survey areas (northwest Lantau with 44 dolphins/100 km^2 and west Lantau with 67 dolphins/100 km^2) have much higher densities**.** Thus, the airport north and airport west areas, including the potential footprint / works area for the 3RS project, have moderate densities of CWDs that are much lower than the average densities for the adjacent remaining area of northwest Lantau and the nearby west Lantau area.

- **Declining Trends in Abundance.** While declining trends have been noted for CWDs in Hong Kong waters (Hung 2008, 2012, 2013), new analysis for airport north and west areas for this EIA study as noted in Section 13.3 to Section 13.4 in **Appendix 13.2**, together with future surveys being planned under the EM&A program, would allow for a more comprehensive analysis and better understanding on this aspect.

- **Habitat Use.** CWDs north and west of the airport engage in generally similar behaviours and thus use the habitat as broadly elsewhere, but with indications of more travel in the north and some very directed foraging close to the airport in the west (see below), and with no particular social types standing out. For example, while newborn young occur in the survey areas, they are not prime nursery habitats, as has been ascertained for areas further north off Lung Kwu Chau (Hung 2012, 2013). Speeds of travel and directionality (orientation and reorientation) behaviours identified from the theodolite tracks of CWD groups indicated that there is more travelling behaviour with some foraging behaviour off the airport north area and somewhat less travelling behaviour with comparatively more foraging behaviour off the airport west area.

- The diurnal pattern of CWD occurrence per station, standardised for search effort, showed some differences in habitat use by time of day, overall as described above. Based on these shore-based data some general movement patterns have been observed and the CWD appear to use the waters off the western side of Chek Lap Kok during the morning hours of visible daylight and again in the afternoon (around 15:00), while utilising the waters to the north and northeast of the Chek Lap Kok airport island at mid-day and waters off Sha Chau from mid-day through the afternoon (except around 15:00 when they are observed more to the west of Chek Lap Kok). These data are newly gathered during this EIA project and have no correlation to the long term AFCD data base or at present other published studies.

- The quality of CWD habitat should take into consideration both the density of dolphins in the area (which is an objective, quantifiable parameter) and how the CWDs use the area and if it is used for important social functions. Mating and calving areas are of the highest importance (and thus have the highest influence on 'quality') and would have the most impact on the CWDs if they were lost. These types of areas generally have certain characteristics that make them optimal for the particular activity that CWDs do there, and would thus be more difficult to find alternatives for if they were lost. Areas that are used primarily for travelling, however, although definitely important to the CWDs, are considered to be somewhat less critical. Based on this, the airport west area, which has a density of about 11 dolphins/km^2 and is used for both travelling, foraging and with CWDs milling also in the area, would be considered of slightly higher quality habitat than airport north, which has a similar density, but appears to be used primarily for travelling, with CWDs generally moving through more quickly. However, taking all factors into account both the airport north and airport west areas would be considered to be of an overall moderate quality for CWDs, with airport west being slightly higher in the moderate range. The area specifically within the existing HKIAAA is considered to be of moderate-high habitat quality taking into account the whole marine ecology.

- **Social Structure and Geographical Clustering.** The focussed CWD surveys undertaken for this EIA did not reveal any additional data that had not already been concluded by the AFCD long-term monitoring programme as detailed in **Appendix 13.2**.

- **Individual Movement, Range and Residencies.** The CWDs appear to use the surveyed area for foraging, socialising, milling, and with travel between prime feeding areas to the east and west, and individual dolphins identified in the study area are generally those with home ranges to the north of Lantau Island (Hung 2008, 2012, 2013, **Appendix 13.2**). In examination of the range used by the photo-identified individuals (Hung, 2013), the majority of CWDs centred their core areas around the SCLKCMP and the Brothers, and several individuals even centred their core area use to the northeast corner of the existing airport platform but in neither case over the footprint of the proposed 3RS land formation area (although the centrepoint was in these areas, the actual ranges do extend well beyond those centrepoints). Fifteen individuals used both the Marine Park and the Brothers as their core areas, implying that they travel frequently through the current study area between these two core areas. On the other hand, only six of 46 individuals centred their core area use in western Lantau waters, and two of these have both core areas in the Marine Park and western Lantau waters, indicating their frequent movement between the two through the study area. Even though some individuals centred their core areas in the north Lantau or

west Lantau region, respectively, they have shown extensive movements between the two regions during the present 12-month study. For example, the range use of three known individuals was mainly in the north Lantau region, but they were also sighted repeatedly in the airport west region during the present study. On the contrary, the range use of two other individuals mainly centred their core area use in west Lantau region, but they were also sighted repeatedly in the airport north region during the present surveys. Movements of these individuals imply that resident dolphins in Hong Kong moved frequently across the current study area between the North and west Lantau regions. It is also important to note that the study area is already quite degraded, and that CWDs probably used the area off the current airport island as part of their home range in the past. Though AFCD surveys started after the airport island was reclaimed, and there is no actual survey data to examine this, there is some older, opportunistic information that suggests that CWDs did occur at some level within the area that is now part of the airport island.

- **Underwater Occurrence as Determined by Acoustics.** CWD sound detections at the 5 EARs showed no strong tendencies for seasonal differences in CWD sounds, with the exception of EAR A1 (directly west of the airport), where the results demonstrated notably fewer signals being recorded in the wet rather than the dry season, that is, from April onwards. Overall, west of the airport (EAR A1), there was much sound activity by the CWDs during both the daytime and nighttime in the winter (and generally dry season) months. Theodolite sighting data show a similar pattern and also indicated that notable foraging activities occurred quite close to shore just west of the airport in winter. At the same time, this area is probably also an important travelling area, as mentioned by Hung (2013). To the north and northeast of the airport (EARs A2-A4), including the listening station just southeast of the island of Sha Chau (EAR A5), both winter and spring data did not show dramatic differences in detections, but there was a general tendency for more sounds at night than during the daytime (EARs A2, A4, A5)), or in the evening (EAR A3). This indicates more CWD presence at night in the area north of the airport than was obtained from the visual data alone and further indicates the potential importance of the 3RS footprint area north of the existing airport to CWDs than had previously been known. It is considered that CWDs often travel through the area, and thus do not linger as long, during the daytime rather than the nighttime, and the increase in vocalisations at night may indicate an increase in habitat use at night, perhaps for foraging, socialising, etc.

13.4.6.114 A summary of the main findings of the focussed surveys is provided in **Table 13-5** below.

Table 13-5 Summary of Key Findings of the Focussed Surveys

Categories	Survey Findings
Occurrence/Distribution	CWDs occur throughout survey area (both airport north and airport west)
Group Sizes	Average about 3.6, similar to AFCD database results
Density/Abundance	CWDs densities and abundance are moderate
Behaviour/Activities	CWDs use the airport north area mainly for travelling CWDs use the airport west mainly for travelling and foraging Acoustic data generally indicate more use of nearshore areas at night
Movements/Residency	Survey area used as portion of larger range by several dozen CWDs No evidence that CWDs use survey area as entire range

13.5 Evaluation of Ecological Importance

13.5.1 Habitat Evaluation

13.5.1.1 The following sections evaluate the ecological importance of each habitat type recorded within the study area that are likely to be impacted by the project site (as mentioned in **Section 13.4.3.3**, some sites of conservation importance within the study area are distance away and unlikely to be impacted by the project site as confirmed by the water quality assessment results in **Chapter 8**), based on the criteria set forth in Annex 8 Table 2 of the EIAO-TM.

13.5.1.2 The key habitats and recognised sites of conservation importance identified in the study area above, based on literature review and field survey findings, are listed below:

- San Tau Beach SSSI;
- Marine Park at Sha Cha and Lung Kwu Chau and planned or potential Marine Parks at the Brothers (BMP) and Southwest Lantau (SWLMP) respectively;
- Hard shores habitats including artificial and rocky shores;
- Soft shores habitats, including sandy shores, intertidal mudflats and mangrove areas;
- Sub-tidal habitats comprising of soft substrates (benthos) and hard substrates (with and without corals);
- Artificial reefs; and
- Marine waters.

13.5.1.3 The results are presented in **Table 13-6** to **Table 13-18** below.

Table 13-6: Ecological Evaluation of Recognised Sites of Marine Conservation Importance within the Northwestern WCZs

Criteria	San Tau Beach SSSI	SCLKCMP	Planned BMP	Potential SWLMP
Naturalness	Natural habitat comprises sandy shore, mudflat and mangrove	Natural, apart from the artificial reefsdeployed	Natural	Natural
Size	About 2.7 ha	Approx. 1,200 ha	Approx. 850 ha	Approx. 657 ha
Diversity	Moderate species diversity	Moderate	Moderate-low	Moderate
Rarity	Sandflat / mudflat and mangrove habitats are not common in Hong Kong; species of conservation importance including three seagrass species *Halophila minor*, *Zostera japonica* and *Halophila ovalis,* two horseshoe crab species *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus* and estuarine fish species *Kuhlia marginata* and *Takifugu ocellatus* are recorded.	Common habitat in western Hong Kong; Species of conservation importance including Chinese White Dolphin *Sousa chinensis*, ahermatypic cup coral *Balanophyllia* sp., ahermatypic cup coral *Paracyathus rotundatus*, hard coral of Faviidae family, two horseshoe crab species *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus*, estuarine fish species *Takifugu ocellatus*, marine species Chinese gizzard shad *Clupanodon thrissa,* Red Stingray *Dasyatis akajei*, Pale-edged stingray *Dasyatis zugei*, Goatee croaker *Dendrophysa russelii*, Long-tooth grouper *Epinephelus bruneus*, Slender snipe eel *Nemichthys scolopaceus,* Golden threadfin bream *Nemipterus virgatus*, Devil stinger *Inimicus japonicus*, Tiger-toothed croaker *Otolithes ruber*, *Zebrias crossolepis, Syngnathus schlegeli* and Sea snail *Oliva mustelina*.	Common habitat in western Hong Kong; Species of conservation importance including Chinese White Dolphin *Sousa chinensis,* ahermatypic cup coral *Balanophyllia* sp. and ahermatypic cup coral *Paracyathus rotundatus*, marine fish species Longtooth grouper *Epinephelus bruneus,* Banded tuna *Scomberomorus commerson,* Goatee croaker *Dendrophysa russelii* and seahorse *Hippocampus kuda*	Common habitat in western Hong Kong; Species of conservation importance including Chinese White Dolphin *Sousa chinensis* and Finless Porpoise *Neophocaena phocaenoides* were recorded
Re-creatability	Not re-creatable	Not re-creatable	Not re-creatable	Not re-creatable
Fragmentation	Unfragmented	Unfragmented	Unfragmented	Unfragmented
Ecological linkage	Generally linked with the open sea and the rocky shore	Structually and functionally linked with the open waters	Structurally and functionally linked with the open waters	Structurall and functionally linked with the open waters
Potential value	Already designated as SSSI.	Already designated as Marine Park.	Moderate. Upon designated as Marine Park.	Moderate. Upon designated as Marine Park.

Criteria	San Tau Beach SSSI	SCLKCMP	Planned BMP	Potential SWLMP
Nursery/ breeding ground	Nursery ground for horseshoe crabs	Nursery ground for CWD, crustaceans, mollusca and bottom dwelling fishes	Nursery ground for CWD	Nursery ground for CWD
Age	Designated as SSSI on 19 Octo ber, 1994	Designated as MP on 22 Novem ber, 1996	N/A	N/A
Abundance/ Richness of wildlife	Moderate	High for CWD and moderate for marine fishes	High for CWD	High for CWD
Ecological value	High	High	High	High

Table 13-7: Ecological Evaluation of Artificial Shores

Criteria	North Chek Lap Kok (within Project footprint)	Chek Lap Kok (outside Project footprint)	North Tung Chung (Reference Site)	North of Tai Ho Wan (Reference Site)
Naturalness	Artificial habitat	Artificial habitat	Artificial habitat	Artificial habitat
Size	Medium (approx. 5.9 km)	Long (approx. 13.5 km)	Medium (approx. 4.4 km)	Medium (approx. 6.1 km)
Diversity	Very low floral diversity; Moderate-low in fauna diversity (similar to other locations on Chek Lap Kok) (32 intertidal species)	Very low floral diversity; Moderate-low in fauna diversity (H' from 1.53 to 1.73) (15 intertidal species at South CLK to 42 intertidal species at West CLK)	Very low floral diversity; Moderate-low to low in fauna diversity (H' from 1.38 to 1.70) (30 intertidal species)	Very low floral diversity; Moderate-low to low in fauna diversity (H' from 1.22 to 1.98) (41 intertidal species)
Rarity	Common habitat in Hong Kong	Common habitat in Hong Kong	Common habitat in Hong Kong	Common habitat in Hong Kong
Re-creatability	Readily re-creatable	Readily re-creatable	Readily re-creatable	Readily re-creatable
Fragmentation	Unfragmented	Unfragmented	Unfragmented	Unfragmented
Ecological linkage	Functionally linked with open sea	Functionally linked with open sea	Functionally linked with open sea	Functionally linked with open sea
Potential value	Moderate potential if eco-enhancement features to be adopted and certain protection level to the surrounding waters be included	Moderate potential if eco-enhancement features to be adopted and certain protection level to the surrounding waters be included	Moderate potential if eco-enhancement features to be adopted and certain protection level to the surrounding waters be included	Moderate potential if eco-enhancement features to be adopted and certain protection level to the surrounding waters be included
Nursery/ breeding ground	No special nursery / breeding ground function observed	No special nursery / breeding ground function observed	No special nursery / breeding ground function observed	No special nursery / breeding ground function observed
Age	Around 16 years	Around 16 years	N/A	N/A
Abundance/ Richness of wildlife	Moderate-low abundance of intertidal species	Moderate-low abundance of intertidal species	Moderate-low abundance of intertidal species	Moderate-low abundance of intertidal species
Ecological value	Low	Low	Low	Low

Table 13-8 Ecological Evaluation of Rocky Shores – (1)

Criteria	Sheung Sha Chau	Sha Chau	Tai Mo To	South Chek Lap Kok
Naturalness	Natural habitat	Natural habitat	Natural habitat	Natural habitat
Size	Small	Medium	Medium	Small
Diversity	Moderate-low floral diversity at backshore; Moderate in fauna diversity (H' from 1.46 to 2.06) (29 intertidal species)	Moderate-low floral diversity at backshore; Moderate in fauna diversity (H' from 1.43 to 2.02) (50 intertidal species)	Low floral diversity at backshore; Moderate in fauna diversity (H' from 2.35 to 2.37) (39 intertidal species)	Moderate-low floral diversity at backshore; Moderate-low in fauna diversity (H' from 1.39 to 1.90) (54 intertidal species)
Rarity	Common habitat in Hong Kong	Common habitat in Hong Kong	Common habitat in Hong Kong	Common habitat in Hong Kong
Re-creatability	Not re-creatable	Not re-creatable	Not re-creatable	Not re-creatable
Fragmentation	Unfragmented	Unfragmented	Unfragmented	Fragmented
Ecological linkage	Generally link with the open sea	Generally link with the open sea	Generally link with the open sea	Generally link with the open sea
Potential value	Low	Low	Low	Low
Nursery/ breeding ground	No special nursery / breeding ground function observed	No special nursery / breeding ground function observed	No special nursery / breeding ground function observed	No special nursery / breeding ground function observed
Age	N/A	N/A	N/A	N/A
Abundance/ Richness of wildlife	Moderate-low abundance of intertidal species	Moderate-low abundance of intertidal species	Moderate abundance of intertidal species	Moderate-low abundance of intertidal species
Ecological value	Moderate-low	Moderate-low	Moderate-low	Moderate-low

Table 13-9: Ecological Evaluation of Rocky Shores – (2)

Criteria	San Tau	Hau Hok Wan	Sham Wat Wan	Tai O
Naturalness	Natural habitat	Natural habitat	Natural habitat	Natural habitat
Size	Small	Medium	Medium	Medium
Diversity	Moderate-low floral diversity at backshore; Moderate-low in fauna diversity (H' from 1.84 to 1.89) (51 intertidal species)	Moderate-low floral diversity at backshore; Moderate-low in fauna diversity (H' from 1.31 to 1.98) (44 intertidal species)	Moderate-low floral diversity at backshore; Moderate in fauna diversity (H' from 2.04 to 2.20) (46 intertidal species)	Moderate-low floral diversity at backshore; Moderate in fauna diversity (H' from 2.05 to 2.11) (44 intertidal species)
Rarity	Common habitat in Hong Kong	Common habitat in Hong Kong	Common habitat in Hong Kong	Common habitat in Hong Kong
Re-creatability	Not re-creatable	Not re-creatable	Not re-creatable	Not re-creatable
Fragmentation	Unfragmented	Unfragmented	Unfragmented	Unfragmented
Ecological linkage	Generally link with mudflat	Generally link with sandy shore and open sea	Generally link with mudflat	Generally link with the open sea
Potential value	Low	Low	Low	Low
Nursery/ breeding ground	No special nursery / breeding ground function observed	No special nursery / breeding ground function observed	No special nursery / breeding ground function observed	No special nursery / breeding ground function observed
Age	N/A	N/A	N/A	N/A
Abundance/ Richness of wildlife	Moderate-low to low abundance of intertidal species	Moderate-low abundance of intertidal species	Moderate to moderate-low abundance of intertidal species	Moderate-low abundance of intertidal species
Ecological value	Moderate-low	Moderate-low	Moderate-low	Moderate-low

Table 13-10: Ecological Evaluation of Sandy Shores

Criteria	Sha Chau and Lung Kwu Chau	Yan O	Hau Hok Wan	Sha Lo Wan
Naturalness	Natural habitat	Natural habitat	Natural habitat	Natural habitat
Size	Small	Small	Medium	Small
Diversity	Low floral diversity at backshore; Low in fauna diversity (H' from 1.07 to 1.11) (18 species)	Moderate-low floral diversity at backshore; Moderate-low in fauna diversity (H' from 1.41 to 2.06) (28 species)	Moderate-low floral diversity at backshore; Moderate in fauna diversity (H' from 2.20 to 2.30) (84 species)	Low floral diversity at backshore; Moderate in fauna diversity (H' from 2.19 to 2.64) (74 species)
Rarity	Common habitat at exposed shores in Hong Kong	Uncommon habitat due to its location (at an enclosed bay) but not rare	Uncommon habitat but not rare	Uncommon habitat but not rare
Re-creatability	Re-creatable by ordinary wave action	Re-creatable by ordinary wave action	Re-creatable by presence of suitable hydrodynamic (depositional) regime	Re-creatable by presence of suitable hydrodynamic (depositional) regime
Fragmentation	Unfragmented	Unfragmented	Unfragmented	Unfragmented
Ecological linkage	Generally link with the open sea	Generally link with the open sea	Generally link with the open sea	Generally link with the open sea
Potential value	Low (major substrates type is coarse sand)	Low (major substrates type is coarse sand)	Moderate-low (major substrates type is mud)	Moderate-low (major substrates type is mud)
Nursery/ breeding ground	No special nursery / breeding ground function	No special nursery / breeding ground function	Potential nursery ground for horseshoe crabs	Not a special nursery / breeding ground
Age	N/A	N/A	N/A	N/A
Abundance/ Richness of wildlife	Low abundance of intertidal species	Moderate-low abundance of intertidal species	Moderate-low abundance of intertidal species 2 individuals of horseshoe crab were recorded	Moderate-low abundance of intertidal species
Ecological value	Low	Moderate-low	Moderate	Moderate

Table 13-11: Ecological Evaluation of Mangroves and Intertidal Mudflats – (1)

Criteria	Tai Ho Wan	Tung Chung Bay
Naturalness	Natural habitat	Natural habitat
Size	Medium for mangroves; Large for mudflat	Large
Diversity	Moderate-low floral diversity with true mangrove recorded; Moderate in fauna diversity (max. H' recorded = 2.32) (115 intertidal species); Moderate-high in estuarine fish diversity (H' = 2.04 in dry season, 2.83 in wet season)	Moderate-low floral diversity with true mangrove recorded; Moderate in fauna diversity (max. H' recorded = 2.61) (110 intertidal species)
Rarity	Uncommon habitat in Hong Kong; Seagrass species of conservation importance recorded included the seagrass species *Halophila beccarii*; Horseshoe crabs *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus,* estuarine fish species *Hemigobius hoevenii* and *Takifugu ocellatus,* pipefish species *Syngnathus schlegeli,* seashorse species *Hippocampus kuda,* marine fish species *Dasyatis akajei* which are fauna species of conservation importance, were recorded.	Uncommon habitat in Hong Kong; Estuarine fish species largesnout goby *Awaous melanocephalus*, mangrove goby *Eugnathogobius polylepis,* banded mulletgoby *Hemigobius hoevenii* and archpatch puffer *Takifugu ocellatus,* horseshoe crabs *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus,* pipefish species *Syngnathoides biaculeatus and Syngnathus schlegeli,* seashorse species *Hippocampus kuda* which are fauna species of conservation importance, were recorded.
Re-creatability	Mangroves re-creatable provided that adequate resources and suitable substrate are available and in the absence of disturbance; Mudflat not re-creatable	Mangroves re-creatable provided that adequate resources and suitable substrate are available and in the absence of disturbance; Mudflat not re-creatable
Fragmentation	Unfragmented	Unfragmented
Ecological linkage	Functionally linked to streams, salt marsh and coastal waters	Functionally linked to Tung Chung River and coastal waters
Potential value	High given the established mangrove stands and the potential for colonisation of seagrass beds.	High given the established mangrove stands
Nursery/ breeding ground	Potential nursery ground for horseshoe crabs	Potential nursery ground for horseshoe crabs
Age	N/A	N/A
Abundance/ Richness of wildlife	Moderate-high abundance of intertidal species; Low coverage of seagrass; The highest count of 23 individuals of horseshoe crab was recorded.	Moderate-high abundance of intertidal species. The highest count of 3 individuals of horseshoe crab was recorded.
Ecological value	Moderate-High	Moderate-High

Table 13-12: Ecological Evaluation of Mangroves and Intertidal Mudflats – (2)

Criteria	San Tau	Yan O
Naturalness	Natural habitat	Natural habitat
Size	Medium	Small
Diversity	Moderate-low floral diversity for true mangrove species; Moderate in fauna diversity (max. H' recorded = 2.59) (128 intertidal species) ; Low in estuarine fish diversity (H' = 1.65 in dry season and H' = 1.84 in wet season)	Moderate-low floral diversity for true mangrove species; Moderate in fauna diversity (max. H' recorded = 2.83) (85 intertidal species)
Rarity	Uncommon habitat in Hong Kong; Seagrass species of conservation importance *Halophila ovalis* and *Zostera japonica* were recorded; Horseshoe crabs *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus,* estuarine fish species *Kuhlia marginata* and *Takifugu ocellatus,* which are fauna species of conservation importance, were recorded.	Uncommon habitat in Hong Kong; Seagrass species of conservation importance *Halophila ovalis* was recorded; Horseshoe crab *Tachypleus tridentatus* and pipefish species *Syngnathoides biaculeatus* was recorded
Re-creatability	Mangroves re-creatable provided that adequate resources and suitable substrate are available and in the absence of disturbance; Mudflat not re-creatable	Mangroves readily re-creatable provided that adequate resources and suitable substrate are available and in the absence of disturbance; Mudflat not re-creatable
Fragmentation	Unfragmented	Unfragmented
Ecological linkage	Functionally linked to streams and coastal waters	Functionally linked to coastal waters
Potential value	High given the established mangrove stands and colonisation of seagrass beds	High given the established mangrove stands and the potential for colonisation of seagrass beds
Nursery/ breeding ground	Potential nursery ground for horseshoe crabs	Potential nursery ground for horseshoe crabs
Age	N/A	N/A
Abundance/ Richness of wildlife	Moderate-high abundance of intertidal species. Relatively high coverage of seagrass; The highest count of 19 individuals of horseshoe crab was recorded.	Moderate-low abundance of intertidal species
Ecological value	High	Moderate

Table 13-13: Ecological Evaluation of Mangroves and Intertidal Mudflats – (3)

Criteria	Sham Wat Wan
Naturalness	Natural habitat
Size	Medium
Diversity	Low floral diversity; Moderate in fauna diversity (max. H' recorded = 1.51) (52 intertidal species); Moderate in estuarine fish diversity (H' = 2.37 in dry season, H' = 2.54 in wet season)
Rarity	Uncommon habitat in Hong Kong; Seagrass species of conservation importance *Halophila beccarii* was recorded; Horseshoe crabs *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus,* estuarine fish species *Takifugu ocellatus*, pipefish species *Syngnathus schlegeli* and marine species *Dasyatis akajei* which are fauna species of conservation importance, were recorded
Re-creatability	Not re-creatable
Fragmentation	Unfragmented
Ecological linkage	Functionally linked to adjacent rocky shore habitats and coastal waters
Potential value	Moderate-high given the colonisation of patchy seagrass beds
Nursery/ breeding ground	Potential nursery ground for horseshoe crabs
Age	N/A
Abundance/ Richness of wildlife	Moderate abundance of intertidal speciesLow coverage of seagrass; The highest count of 19 individuals of horseshoe crab was recorded.
Ecological value	Moderate-High

Table 13-14: Ecological Evaluation of Sub-tidal Soft Bottom Habitat

Criteria	Project Footprint	Northern Lantau outside Project Footprint	SCLKCMP	Planned BMP	Potential SWLMP
Naturalness	Most of the seabed was artificially formed by capping of CMP; seabed was deposited with dead shell with muddy sediment.	Natural but being disturbed by fish trawl activities prior to trawl ban and high usage of marine traffic; seabed was deposited with dead shell and muddy sediment.	Natural, apart from the artificial reefs deployed; seabed was deposited with muddy sediment.	Natural; seabed was deposited with muddy sediment.	Natural; seabed was deposited with muddy sediment (CCPC, 2002).
Size	Approx. 672 ha (650 ha + 22 ha – 10 ha + 10 ha)	Very large	Approx. 1,200 ha	Approx. 850 ha	Approx. 657 ha
Diversity	Moderate to high diversity (H' from 2.23 to 3.54) in wet season and low to high diversity (H' from 1.53 to 3.30) in dry season (13 to 62 species in wet season; 6 to 39 species in dry season).	Moderate to high diversity (H' from 2.91 to 3.45) in wet season and moderate diversity (H' from 2.29 to 2.80) in dry season (36 to 56 benthic species in wet season; 15 to 17 benthic species in dry season)	Moderate diversity (H' from 2.23 to 2.72) in wet season and low to moderate diversity (H' from 1.91 to 2.54) in dry season (16 to 23 benthic species in wet season; 8 to 18 benthic species in dry season)	Moderate diversity (H' from 2.44 to 2.72) in wet season and moderate diversity (H' from 2.63 to 2.84) in dry season (14 to 20 benthic species in wet season; 26 to 28 benthic species in dry season)	High (34 benthic species in wet season; 38 benthic species in dry season)
Rarity	Common habitat and species in western Hong Kong; no rare species recorded	Common habitat in western Hong Kong; Species of conservation importance includes one individual of amphioxus *Branchiostoma belcheri* recorded in wet season benthic surveys	Common habitat and species in western Hong Kong. Species of conservation importance include ahermatypic cup coral *Balanophyllia* sp., ahematypic cup coral *Paracyathus rotundatus* and hard coral of Faviidae family	Common habitat in western Hong Kong; Species of conservation importance include ahermatypic cup coral *Balanophyllia* sp. and ahematypic cup coral *Paracyathus rotundatus*	Common habitat in western Hong Kong; no rare species recorded
Re-creatability	The seabed is not re-creatable, but the area above contaminated mud pit is recreatable due to artificial filling.	The seabed is not re-creatable	The seabed is not re-creatable	The seabed is not re-creatable	The seabed is not re-creatable
Fragmentation	Unfragmented	Unfragmented	Unfragmented	Unfragmented	Unfragmented
Ecological linkage	Functionally linked with the open waters	Functionally linked with the open waters	Functionally linked with the open waters	Functionally linked with the open waters	Functionally linked with the open waters
Potential value	Low	Low	Low	Low	Low
Nursery/ breeding ground	Nursery ground for crustaceans, mollusca and bottom dwelling fishes	Nursery ground for crustaceans, mollusca and bottom dwelling fishes	Nursery ground for crustaceans, mollusca and bottom dwelling fishes	Nursery ground for crustaceans, mollusca and bottom dwelling fishes	Nursery ground for crustaceans, mollusca and bottom dwelling fishes
Age	Young for the CMP area	Not Known	Not Known	Not Known	Not Known

Criteria	Project Footprint	Northern Lantau outside Project Footprint	SCLKCMP	Planned BMP	Potential SWLMP
Abundance/ Richness of wildlife	High abundance of crustacean in wet season but low abundance for other benthic fauna in both wet and dry season;	High abundance of crustacean and echinoderm in wet season but low abundance for other benthic fauna in both wet and dry season; one individual of amphioxus *Branchiostoma belcheri* recorded in wet season; very low coverage of gorgonians recorded on rock outcrops	Low abundance of benthic fauna in both wet and dry seasonvery low coverage of gorgonians recorded on rock outcrops	Low abundance of benthic fauna in both wet and dry season	Moderate abundance of benthic fauna in both wet and dry season (CCPC, 2002)
Ecological value	Moderate-low	Moderate-low	Low	Low	Moderate-Low

Table 13-15: Ecological Evaluation of Sub-tidal Hard Bottom Habitat – (1)

Criteria	Project Footprint	Chek Lap Kok (outside Project Footprint)	SCLKCMP	Planned BMP	Yan O
Naturalness	The seawall is artificial	The seawall along the airport island and rock outcrops are artificial	The rocky shore is natural, the rock outcrops are artificial	Natural	Natural
Size	N/A	N/A	N/A	N/A	N/A
Diversity	Low	Low	Low	Low	Low
Rarity	Common habitat in western Hong Kong; no coral species of conservation importance.	Common habitat in western Hong Kong; coral species of conservation importance recorded includes *Balanophyllia* sp.	Common habitat in western Hong Kong; coral species of conservation importance recorded includes *Balanophyllia* sp.	Common habitat in western Hong Kong; coral species of conservation importance recorded includes *Balanophyllia* sp.	Common habitat in western Hong Kong; coral species of conservation importance recorded includes *Balanophyllia* sp.
Re-creatability	The hard bottom substrates are re-creatable	The hard bottom substrates are re-creatable	The rocky shore is not re-creatable while the hard bottom substrates is re-creatable	The rocky shore is not re-creatable	The rocky shore is not re-creatable
Fragmentation	Unfragmented	Unfragmented	Unfragmented	Unfragmented	Unfragmented
Ecological linkage	Functionally linked with the open waters	Functionally linked with the open waters	Functionally linked with the open waters	Functionally linked with the open waters	Functionally linked with the open waters
Potential value	Low	Low	Low	Low	Low
Nursery/breeding ground	N/A	N/A	N/A	N/A	N/A
Age	Around 16 years	N/A	N/A	N/A	N/A
Abundance/ Richness of wildlife	Low abundance of benthic fauna with low coverage of gorgonians	Low abundance of benthic fauna including mussels, both hard corals and gorgonians of low coverage, barnacle, sea snail, hermit crab and oyster	Low abundance of benthic fauna dominated by sponges and bryozoan, with moderate-low coverage of hard corals and gorgonians	Low abundance of benthic fauna with low coverage of hard corals and gorgonians	Low abundance of benthic fauna dominated by sponges and bryozoan, with low coverage of hard corals and gorgonians, oyster and mussels
Ecological value	Low	Low	Moderate-Low	Low	Low

Table 13-16: Ecological Evaluation of Sub-tidal Hard Bottom Habitat – (2)

Criteria	Tai Ho Wan	Tung Chung	Hau Hok Wan	Tai O	Sham Wat
Naturalness	The seawall is artificial	The seawall is artificial	Natural	Natural	Natural
Size	N/A	N/A	N/A	N/A	N/A
Diversity	Low	Low	Low	Low	Low
Rarity	Common habitat in western Hong Kong; coral species of conservation importance recorded includes *Balanophyllia* sp	Common habitat in western Hong Kong; coral species of conservation importance recorded includes *Balanophyllia* sp.	Common habitat in western Hong Kong. No species of conservation importance was recorded	Common habitat in western Hong Kong; coral species of conservation importance recorded includes *Balanophyllia* sp.	Common habitat in western Hong Kong; coral species of conservation importance recorded includes *Balanophyllia* sp.
Re-creatability	The seawall is re-creatable	The seawall is re-creatable	The rocky shore is not re-creatable	The rocky shore is not re-creatable	The rocky shore is not re-creatable
Fragmentation	Unfragmented	Unfragmented	Unfragmented	Unfragmented	Unfragmented
Ecological linkage	Functionally linked with the open waters	Functionally linked with the open waters	Functionally linked with the open waters	Functionally linked with the open waters	Functionally linked with the open waters
Potential value	Low	Low	Low	Low	Low
Nursery/ breeding ground	N/A	N/A	N/A	N/A	N/A
Age	N/A	N/A	N/A	N/A	N/A
Abundance/ Richness of wildlife	Low abundance of benthic fauna with low coverage of hard corals and gorgonians	Low abundance of benthic fauna with low coverage of hard corals and gorgonians	No coral species recorded	Low abundance of benthic fauna with low coverage of hard corals and gorgonians	Low abundance of benthic fauna with low coverage of hard corals and gorgonians
Ecological value	Low	Low	Low	Low	Low

Table 13-17: Ecological Evaluation of Artificial Reefs at SCLKCMP

Criteria	Artificial Reefs at SCLKCMP
Naturalness	Artificial habitat
Size	5,580 m^3 (4,640 m^3 + 940 m^3)
Diversity	Low species diversity
Rarity	ARs were deployed in 11 locations in Hong Kong; Gorgonian was recorded on the AR
Re-creatability	Re-creatable
Fragmentation	Unfragmented
Ecological linkage	Functionally linked to seabed and open waters within the Marine Park
Potential value	Moderate
Nursery/ breeding ground	Breeding / Nursery ground for marine species
Age	14 years since 2000
Abundance/ Richness of wildlife	Low to moderate
Ecological value	Moderate-low

Table 13-18: Ecological Evaluation of Marine Waters

Criteria	Project Footprint		Northern Chek Lap Kok waters outside Project Footprint and Marine Parks	SCLKCMP	Planned BMP
	Within HKIAAA	Outside HKIAAA			
Naturalness	Natural with a large area having limited disturbance due to restrictions to vessel entry	Natural but being disturbed by fish trawl activities prior to ban on fishing with trawl nets and high usage of marine traffic	Natural but being disturbed by fish trawl activities prior to ban on fishing with trawl nets and high usage of marine traffic	Natural with limited disturbance due to vessel speed limit and marine protected area status	Natural but being disturbed by fish trawl activities prior to ban on fishing with trawl nets and high usage of marine traffic
Size	Approx. 240 ha and its water column	Approx. 410 ha (650 ha – 240 ha) and its water column	Very large	Approx. 1,200 ha and its water column	Approx. 850 ha and its water column
Diversity	Moderate diversity for marine fishes and a single species of cetacean (CWD)	Moderate diversity for marine fishes and a single species of cetacean (CWD)	Moderate diversity for marine fishes and a single species of cetacean (CWD)	Moderate diversity for marine fishes and a single species of cetacean (CWD)	Moderate diversity for marine fishes and a single species of cetacean (CWD)

Criteria	Project Footprint		Northern Chek Lap Kok waters outside Project Footprint and Marine Parks	SCLKCMP	Planned BMP
	Within HKIAAA	Outside HKIAAA			
Rarity	Common habitat in western Hong Kong; Habitat for CWD; Species of conservation importance included Tiger-toothed croaker *Otolithes ruber*, Goatee croaker *Dendrophysa russelii*, Longtooth grouper *Epinephelus bruneus*, Pale-edged stingray *Dasyatis zugei* and Longheaded eagle ray *Aetobatus flagellum*	Common habitat in western Hong Kong; Habitat for CWD; Species of conservation importance included Goatee croaker *Dendrophysa russelii*, Longtooth grouper *Epinephelus bruneus*, Orange-spotted grouper *Epinephelus coioides*, and Pale-edged stingray *Dasyatis zugei*	Common habitat in western Hong Kong; Species of conservation importance included Archpatch puffer *Takifugu ocellatus*, Red Stingray *Dasyatis akajei*, Banded tuna *Scomberomorus commerson*, Goatee croaker *Dendrophysa russelii*, Longtooth grouper *Epinephelus bruneus*, Pale-edged stingray *Dasyatis zugei,* Devil stinger *Inimicus japonicus*, Orange-spotted grouper *Epinephelus coioides,* Slender snipe eel *Nemichthys scolopaceus,* Tiger-toothed croaker *Otolithes ruber*, Spotted Seahorse *Hippocampus kuda*, horseshoe crab *Carcinoscorpius rotundicauda* and Seaweed pipefish *Syngnathus schlegeli*.	Common habitat in western Hong Kong; Habitat for Chinese White Dolphin; Species of conservation importance included Archpatch puffer *Takifugu ocellatus*, Chinese gizzard shad *Clupanodon thrissa,* Red stingray *Dasyatis akajei*, Pale-edged stingray *Dasyatis zugei*, Goatee croaker *Dendrophysa russelii*, Longtooth grouper *Epinephelus bruneus*, Devil stinger *Inimicus japonicus*, Slender snipe eel *Nemichthys scolopaceus,* Goldern threadfin bream *Nemipterus virgatus*,Tiger-toothed croaker *Otolithes ruber*, *Zebrias crossolepis*, Sea snail *Oliva mustelina*. Seaweed pipefish *Syngnathus schlegeli* and horseshoe crabs *Carcinoscorpius rotundicauda* and *Tachypleus tridentatus*.	Common habitat in western Hong Kong; Habitat for Chinese White Dolphin; Species of conservation importance included Longtooth grouper *Epinephelus bruneus*, Banded tuna *Scomberomorus commerson*,Goatee croaker *Dendrophysa russelii* and Spotted Seahorse *Hippocampus kuda*.
Re-creatability	The marine water is not re-creatable	The marine water is not re-creatable	The marine water is not re-creatable	The marine water is not re-creatable	The marine water is not re-creatable
Fragmentation	Unfragmented	Unfragmented	Unfragmented	Unfragmented	Unfragmented
Ecological linkage	Functionally linked with the seabed and artificial seawall within HKIAAA and open sea habitats outside HKIAAA; important travel area for CWDs	Functionally linked with the seabed and open sea habitats at HKIAAA; important travel area for CWDs	Functionally linked with the seabed and marine habitats of SCLKCMP	Functionally linked with the seabed and coastal habitats	Functionally linked with the seabed and coastal habitats

Criteria	Project Footprint		Northern Chek Lap Kok waters outside Project Footprint and Marine Parks	SCLKCMP	Planned BMP
	Within HKIAAA	Outside HKIAAA			
Potential value	Moderate to high potential for longer time period; potential to add to protected areas for CWDs.	Moderate to high potential provided the disturbance by marine traffic be reduced	Moderate to high potential provided the disturbance by marine traffic be reduced and ecological linkage improved	Already a marine protected area	Proposed to be a marine protected area
Nursery/ breeding ground	Used as habitat for reproductive female CWDs	Used as habitat for reproductive female CWDs	Nursery ground for pelagic fish (subject to larvae survey findings)	Nursery ground for pelagic fish and Chinese White Dolphin	Nursery ground for pelagic fish and Chinese White Dolphin
Age	N/A	N/A	N/A	N/A	N/A
Abundance/ Richness of wildlife	Moderate abundance for marine fishes and moderate abundance for CWD	Moderate abundance for marine fishes and moderate abundance for CWD	Moderate abundance for marine fishes; moderate abundance for Chinese White Dolphin.	Moderate abundance for marine fishes; moderate to high abundance for Chinese White Dolphin	Moderate for marine fishes; moderate abundance for Chinese White Dolphin
Ecological value	Moderate-high	Moderate	Moderate	High	High

13.5.1.4 The habitats present within the study area have been ranked according to their overall ecological value and summarised in **Table 13-19** below. Within the study area, the recognised sites of marine conservation importance including San Tau Beach SSSI, SCLKCMP, planned BMP and potential SWLMP have high ecological values. In addition, the mangroves and intertidal mudflats at San Tau also have high ecological value. Sites with moderate-high ecological value include mangoves and intertidal mudflats at Tai Ho Wan, Tung Chung Bay and Sham Wat Wan, and marine waters within the HKIAAA. Sites with moderate ecological value include the sandy shores at Hau Hok Wan and Sha Lo Wan, mangrove and intertidal mudflat at Yan O, marine waters outside the HKIAAA within the project footprint and northern Lantau outside project footprint. Generally, artificial seashores, rocky shores, sandy shores (at Shau Chau and Yan O), sub-tidal habitats (both soft and hard bottoms) and artificial reefs have low or moderate-low ecological values.

Table 13-19 Summary of the Ecological Value of Habitats within the Study Area

Habitat	Ecological Value
San Tau Beach SSSI	High
SCLKCMP	High
Planned BMP	High
Potential SWLMP	High
Hard shores habitats including artificial and rocky shores	Variable from Low to Moderate-low (Low for all artificial seashores and Moderate-Low for all rocky shores)
Soft shores habitats including sandy shores, intertidal mudflats and mangrove areas	Variable from Low (Sha Chau sandy shore) to High (San Tau mangroves and intertidal mudflats)
Sub-tidal habitats comprising soft substrates (benthos) and hard substrates (with and without corals)	Variable from Low to Moderate-low (soft bottom habitats in project footprint, northern Lantau and potential SWLMP; hard bottom habitat in SCLKCMP)
Artificial Reefs at SCLKCMP	Moderate-low
Marine waters	Variable from Moderate (project footprint outside HKIAAA) to High (Marine Parks)

13.5.2 Species of Conservation Importance

13.5.2.1 Based on literature review and surveys conducted during this study, species recorded within the study area were evaluated with reference to Annexes 8 and 16 of EIAO-TM. Evaluation on species of conservation importance that are likely to be affected by this project were summarised in the following tables.

13.5.2.2 Identification of species of conservation importance for this study generally conducted with reference to the criteria in Annex 16 Appendix A Note 3. However, it is acknowledged that those criteria are quite general and not all species that falls within one of those criteria would be automatically regarded as species of conservation importance. For instance, some species that are listed in IUCN Red List do not imply that they are under real threat if their status is “Data Deficient” or “Least Concern”. This process relies on professional judgement. The following tables are prepared with a view to give prominence and emphasis on concerned species that are likely to be affected by the project.

Table 13-20 Evaluation of Floral Species of Conservation Importance within the Study Area

Species	Protection status / Conservation status[1]	Distribution	Recorded by other studies	Recorded in 3rd Runway study	Rarity
Seagrass					
Halophila beccarii	IUCN Red List (Vulnerable)	Tai Tam Bay, Sheung Pak Nai, Ha Pak Nai (Hong Kong Herbarium and South China Botanical Gardens, 2011)	HZMB-HKBCF & HKLR: recorded at coastal habitat of Tai Ho Wan AFCD Biodiversity Survey: Sham Wat	Recorded at Sham Wat Wan and Tai Ho Wan	Rare (Xing et al. 2000)
Halophila minor	Seagrass bed designated as SSSI	Tai Tam, Ho Chung, To Kwa Peng, Hoi Ha, Tsam Chuk Wan, Sunny Bay (Hong Kong Herbarium and South China Botanical Gardens, 2011)	HZMB-HKBCF & HKLR: along the mangrove fringe within the San Tau SSSI	No	Rare (Xing et al. 2000)
Halophila ovalis	Seagrass bed designated as SSSI	Tai Tam Bay, Ho Chung, Hoi Ha Wan, Wu Shek Kok, Lai Chi Wo, Tung Chung (San Tau) (Hu et al. 2003)	AFCD Biodiversity Survey, HZMB-HKBCF & HKLR: recorded at San Tau Beach SSSI AFCD Biodiversity Survey, Kwok et al., 2005: Yan O	Recorded at San Tau Beach SSSI	Locally Rare (Xing et al. 2000)
Zostera japonica	Seagrass bed designated as SSSI	Sheung Sze Wan, Tung Chung (San Tau), Lai Chi Wo (Hu et al. 2003)	AFCD Biodiversity Survey, HZMB-HKBCF & HKLR: recorded at San Tau Beach SSSI	Recorded at coastal habitat along the mangrove fringe within the San Tau SSSI	Classified as rare (Hu, 2003)

Table 13-21 Evaluation of Fauna Species of Conservation Importance within the Study Area

Species	Protection status / Conservation status[1]	Distribution	Recorded by Other Studies	Recorded in 3rd Runway Study Area	Rarity
Coral					
Balanophyllia sp. (ahermatypic cup coral)	Wild Animals and Plants Protection Ordinance (Cap. 586)	Cold temperate waters and artic seas (AECOM, 2009a)	HZMB, HKBCF & HKLR, TM-CLKL: northeast and southeast shores of airport island, the Brothers, Sha Lo Wan, San Shek Wan, Sham Wat, Tai Ho Wan, Yam Tsai Wan Mouchel, 2001: Sham Tseng and Tsing Lung Tau	Northeast shore of the airport island Sha Chau, Tai O, Tung Chung, Tai Ho, Yan O, the Brothers, SCLKCMP.	Common in Hong Kong Waters (AECOM, 2009a)

Species	Protection status / Conservation status[1]	Distribution	Recorded by Other Studies	Recorded in 3rd Runway Study Area	Rarity
Paracyathus rotundatus (ahermatypic cup coral)	Wild Animals and Plants Protection Ordinance (Cap. 586)	Indo-West Pacific (WoRMS, 2013)	TM-CLKL: Pillar Point, Tai Mo To and outside Tai Ho Wan	SCLKCMP	Recorded all around Lantau Island (AECOM, 2009b)
Hard coral (Faviidae)	Wild Animals and Plants Protection Ordinance (Cap. 586)	-	ERM, 1995: SCLKCMP	No	Local population unknown
Horseshoe crabs					
Carcinoscorpius rotundicauda	China Species Red List (Vulnerable) (Wang and Xie, 2004)	Central Indo-Pacific (WoRMS, 2013)	HZMB-HKBCF & HKLR: San Tau, Pak Mong, Hau Hok Wan and Tai Ho Wan; TM-CLKL: Tung Chung Bay CMP EM&A 2012 - 2013 SCLKCMP Shin et al. (2009): Tai Ho Wan, Tung Chung and Yi O	Tung Chung Bay, San Tau, Sham Wat Wan,Tai Ho Wan, Northern Chek Lap Kok waters	Declining in range due to water pollution/loss of nursery grounds (Morton and Lee, 2003)
Tachypleus tridentatus	China Species Red List (Endangered) (Wang and Xie, 2004)	Central Indo-Pacific (WoRMS, 2013)	HZMB-HKBCF & HKLR: San Tau, Hau Hok Wan, Sham Wat and Tung Chung Bay TCNTE- Tung Chung Bay CMP EM&A 2012 - 2013 Western Chek Lap Kok waters and SCLKCMP AFCD Biodiversity Survey: Tai Ho Wan and Yan O Shin et al. (2009): San Tau, Tung Chung, Sham Wat Wan and Yi O	San Tau, Tung Chung Bay, Sham Wat Wan and Tai Ho Wan	Declining in range due to water pollution/loss of nursery grounds (Morton and Lee, 2003)
Estuarine Fish					
Awaous melanocephalus (Largesnout goby)	Regional concern (Fellowes et al., 2002)	Asia and Oceania (Fishbase, 2013)	AFCD Biodiversity Survey:Tung Chung Bay	No	Rare in Hong Kong. (Lee et al., 2004. Field Guide to the Freshwater Fish of Hong Kong)

Species	Protection status / Conservation status[1]	Distribution	Recorded by Other Studies	Recorded in 3rd Runway Study Area	Rarity
*Eugnathogobius polylepis (*mangrove goby*)*	China Species Red List (Endangered) (Wang and Xie, 2004)	Restricted in mangrove area and has only been found in several locations. (KFBG, 2013)	Tung Chung Bay (KFBG, 2013)	No	Restricted to mangrove areas and only found in several locations in very low numbers (KFBG, 2013)
Hemigobius hoevenii (Banded mulletgoby)	Not protected	A few streams and estuaries on Lantau Island (AFCD, 2013e)	Tung Chung Bay (KFBG, 2013)	Tai Ho	Rare (AFCD, 2013e)
Kuhlia marginata (Dark-margined flagtail)	Regional Concern (Fellowes et al., 2002)	Asia and Oceania: Taiwan, Philippines and Indonesia to islands in the Pacific. (Fishbase, 2013)	HZMB-HKBCF San Tau	No	Status unknown (Lee *et al.* 2004)
Takifugu ocellatus (Archpatch puffer)	Local Concern (Fellowes et al., 2002)	Asia: China and Vietnam (Fishbase, 2013)	HZMB-HKBCF Pak Mong, San Tau, Sham Wat, Tai Ho, Tung Chung CMP EM&A 2006-2013: Northern and western water of Chek Lap Kok, SCLKCMP	Sha Lo Wan, Sham Wat, Hau Hok Wan	Rare (AFCD, 2013e)
Other Estuarine Fauna					
Chiromantes sereni (Sesarmine Crab)	Not protected	Only found at four sites in a recent territory-wide Sesarmine Crab survey (Kwok & Tang 2005).	HZMB-HKBCF Hau Hok Wan, Sha Lo Wan	No	Endemic (Kwok & Tang 2005)
Seahorse and Pipefish					
Hippocampus kuda (Spotted seahorse)	IUCN Red List (Vulnerable); China Species Red List (Endangered) (Wang and Xie, 2004)	Indo-Pacific: Pakistan and India to southern Japan, Hawaii, and the Society Islands (Fishbase, 2013)	TCNTE- Tung Chung Bay	1 individual recorded each in Tai Ho, northern Chek Lap Kok waters and the Brothers respectively	Uncommon (To et al., 2013)
Syngnathoides biaculeatus (Alligator pipefish)	China Species Red List (Vulnerable) (Wang and Xie, 2004)	Indo-Pacific: Red Sea and Knysna, South Africa to Samoa, north to southern Japan, south to New South Wales (Fishbase, 2013)	Tung Chung Bay, Yan O, Hau Hok Wan and Sha Lo Wan (Green Power & EERC, 2012)	No	Local population unknown (Green Power & EERC, 2012)
Syngnathus schlegeli (Seaweed	Not protected	Northwest Pacific: around Vladivostok, Russia Federation	TCNTE- Tung Chung Bay CMP EM&A 2006-	Tung Chung Bay, Tai Ho, Sha Lo Wan, Hau Hok	Rare (To et al., 2013)

Species	Protection status / Conservation status[1]	Distribution	Recorded by Other Studies	Recorded in 3rd Runway Study Area	Rarity
pipefish)		southward to the Gulf of Tonkin (Fishbase, 2013)	2012: Northern and western water of Chek Lap Kok, SCLKCMP Tung Chung Bay and Sha Lo Wan (Green Power & EERC, 2012)	Wan and Sham Wat	
Marine fishes					
Aetobatus flagellum (Longheaded eagle ray)	IUCN Red List (Endangered)	Indo-West Pacific: Red Sea, India, East Indies, and southern China (Fishbase, 2013)	No	Recorded in project footprint	Local population unknown
Clupanodon thrissa (Chinese gizzard shad)	China Species Red List: Vulnerable	Northwest Pacific: China, apparently south to Viet Nam Specimens were recorded from Phuket Island, Thailand Fishbase, 2013)	CMP EM&A 2006-2013: SCLKCMP and western Chek Lap Kok water	No	Local population unknown
Dasyatis akajei (red stingray)	IUCN Red List (Near Threatened); China Species Red List (Endangered) (Wang and Xie, 2004)	Brackish and marine waters of Western Pacific: Japan to Thailand, Fiji, Tuvalu (Fishbase, 2013)	CMP EM&A 2006-2013: Northern and western waters of Chek Lap Kok and SCLKCMP.	Tai Ho, Sha Lo Wan and Sham Wat	Local population unknown
Dasyatis zugei (Pale-edged stingray)	IUCN Red List (Near Threatened)	Brackish and marine waters of Indo-West Pacific: India to southern Japan, Myanmar, Malaya, Indonesia, China and Indo-China (Fishbase, 2013);	CMP EM&A 2006-2013: Northern and, western waters of Chek Lap Kok and SCLKCMP.	Recorded in northern and western Chek Lap Kok waters, project footprint	Local population unknown
Dendrophysa russelii (Goatee croaker)	China Species Red List: Vulnerable	Indo-Pacific: India and Sri Lanka extending eastward, including southern China, Philippines and Indonesia (Fishbase, 2013)	No	The Brothers, SCLKCMP, northern and western Chek Lap Kok waters, project footprint	Local population unknown
Epinephelus bruneus (Long-tooth grouper)	IUCN Red List (Vulnerable)	Marine waters and reef-associated in northwest Pacific: Korea, Japan (north to Hegura-jima Island), China (south to Hong Kong and Hainan Island), and Taiwan (Fishbase, 2013)	CMP EM&A 2006-2013: Northern and western waters of Chek Lap Kok, SCLKCMP	Recorded in northern Chek Lap Kok waters, project footprint, the Brothers.	Rare (To et al., 2013)
Epinephelus coioides	IUCN Red List (Near	Marine, brackish waters and reef-associated in	CMP EM&A 2006-2013: Northern	Recorded in proposed footprint	Rare (To et al., 2013)

Species	Protection status / Conservation status[1]	Distribution	Recorded by Other Studies	Recorded in 3rd Runway Study Area	Rarity
(Orange-spotted grouper)	Threatened)	Indo-west Pacific (Fishbase, 2013)	waters of Chek Lap Kok		
Inimicus japonicus (Devil stinger)	China Species Red List: Vulnerable	Western Pacific: South China Sea (Fishbase, 2013)	CMP EM&A 2006 – 2013: SCLKCMP, northern and western Chek Lap Kok waters	No	Local population unknown
Larimichthys crocea (Yellow croaker)	China Species Red List: Vulnerable	Northwest Pacific: Yellow and East China seas (Fishbase, 2013)	CMP 2006 – 2013: Western Chek Lap Kok waters	Western Chek Lap Kok waters	Disappeared as a local major catch (Cheung and Sadovy, 2004)
*Nemichthys scolopaceus (*Slender snipe eel)	China Species Red List: Vulnerable	Worldwide in tropical and temperate seas.	CMP 2006 – 2013: SCLKCMP, northern and western Chek Lap Kok waters	No	Local population unknown
Nemipterus virgatus (Golden threadfin bream)	IUCN Red List (Vulnerable)	Western Pacific: southern Japan to northwestern Australia and the Arafura Sea (Fishbase, 2013)	SCLKCMP Monitoring Programme: SCLKCMP	No	Local population unknown
Otolithes ruber (Tiger-toothed croaker)	China Species Red List: Vulnerable	Indo-West Pacific: East Africa, including Madagascar (absent in the Red Sea), eastward to southern China Sea and Queensland, Australia (Fishbase, 2013)	CMP 2006 – 2013: Northern and western Chek Lap Kok waters	SCLKCMP, project footprint	Local population unknown
Scomberomorus commerson (Banded tuna)	IUCN Red List (Near Threatened) China Species Red List (Least Concern)	Marine waters in Indo-West Pacific: Red Sea and South Africa to Southeast Asia, north to China and Japan and south to southeast Australia, and to Fiji (Fishbase, 2013)	No	Northern Chek Lap Kok waters, the Brothers.	Local population unknown
Zebrias crossolepis	China Species Red List: Endangered	Northwest Pacific: Guangdong, China.	CMP 2006 – 2013: SCLKCMP	No	Local population unknown
Other Marine fauna					
Oliva mustelina (Sea snail)	China Species Red List (Endangered)	-	CMP 2006 – 2013: SCLKCMP and western Chek Lap Kok waters	No	Local population unknown
Benthic organisms					
Branchiostoma belcheri	Class II protected	Eastern waters of Hong Kong according to	No	1 individual recorded in	Locally rare (Hyder-

Species	Protection status / Conservation status(1)	Distribution	Recorded by Other Studies	Recorded in 3rd Runway Study Area	Rarity
(Amphioxus)	species in China (Huang 2006) China Species Red List (Endangered)	previous benthic surveys, especially close to the Sai Kung Peninsula (CCPC 2002; Chan 2007)		northern Lantau waters, at the mid-way of proposed footprint and Sha Chau.	Meinhardt JV, 2013)
Marine Mammals					
Sousa chinensis Chinese White Dolphin (Indo-pacific Humpback Dolphin)	Wild Animals and Plants Protection Ordinance (Cap. 586); CITES App. 1; Chinal Class I protected; IUCN Red List (Near Threatened); China Species Red List (Endangered) (Wang and Xie, 2004)	Outer Deep Bay, around Lantau Island, Tuen Mun, Sha Chau and Lung Kwu Chau (Hung, 2013)	AFCD long term monitoring programme: areas of importance include northeastern Chek Lap Kok waters, waters around the Brothers and SCLKCMP and western waters around Fan Lau	Recorded in western, northern and northeastern Chek Lap Kok waters and waters around Sha Chau	Locally recorded in west Lantau and northwest Lantau, with 61 CWDs recorded in 2012 but with declining trends from 2001 to 2012 (Hung 2013; **Appendix 13.2**).

Note: (1) Reference is made to Wild Animals and Plants Protection Ordinance (Cap. 586), IUCN Red List, Fellowes et al. (2002), China Species Red List, China Red Data Book and State Protected Species in China.
(2) This is a non-exhaustive list, whilst species listed as 'Data Deficient' in IUCN Red List of Threatened Species are not included.

13.6 Impact Assessment Methodology

13.6.1 Background

13.6.1.1 The objective of the marine ecological assessment is to predict the direct and indirect, primary and secondary, on-site and off-site impacts of the project on the marine environmental and ecological resources and habitats. The significance of any predicted ecological impacts have been evaluated based on the criteria stipulated in Table 1, Annex 8 of the TM using the following criteria:

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

13.6.1.2 Impacts are ranked as “low”, “low-moderate”, “moderate”, “moderate-high” or “high”, although in a few cases, “insignificant” (less than “low”) or “extremely high” may also be given. The ranking of a given impact will vary based on the criteria listed above. The methods for determination of the “habitat quality”, “species affected” and “size/abundance of habitats affected” for quantifying the impacts as far as possible will be based on the ecological baseline developed under **Section 13.4** and evaluation of ecological importance under **Section 13.5**. The “duration of impacts” and “reversibility of impacts” will be determined based on the impact nature. If the impact will have a long term effect or permanent upon the completion of the construction, more significant weighting will be given. If the habitat will be reinstated upon completion of the specific works, the impact is considered as temporary and reversible. The “magnitude of environmental changes” will be weighted greater if it predicted to significantly change from the environmental baseline conditions. The methods for assessing indirect impact as a result of changes in water quality or hydrodynamic condition at the ecological sensitive habitats will be evaluated based on the water quality model results. The major factors giving rise to a ranking of “moderate” or “high” are spelled out in the text as far as possible. As noted in Annex 16 of the TM, a degree of professional judgment is involved in the evaluation of impacts.

13.6.1.3 If ecological impacts are found to be moderate, moderate-high or high mitigation needs to be carried out in accordance with the EIAO-TM. Mitigation measures are not required for “low” or “insignificant” impacts although precautionary and /or enhancement measures may be recommended if desirable. The policy for mitigating moderate, moderate-high or high impacts on habitats and wildlife is to seek to achieve impact avoidance, impact minimisation and impact compensation in that order of priority. Impact avoidance typically consists of modifications to the project design, but may in extreme cases require abandonment of the project (the “no-go” alternative). Impact minimisation includes any means of reducing the scope or significance of a given impact, e.g., through timing of construction works, modification in design, or ecological restoration of disturbed areas following the completion of works. Impact compensation assumes that an irreversible impact will occur upon a given habitat or species and attempts to compensate for it elsewhere, for example, by enhancement or creation of suitable habitat. Compensation may take place on-site or off-site.

13.6.1.4 The evaluation of feasibility and effectiveness of recommended mitigation measures to alleviate the impact significance to environmentally acceptable levels, will make reference to the ecological baseline survey findings, local or overseas experience where appropriate.

13.6.2 Cumulative Impacts

13.6.2.1 In order to assess the potential ecological impacts from other activities in the study area, cumulative impacts have also been examined. There are numerous other construction/ operation activities in the overall study area that could potentially lead to cumulative impacts and these include disposal of contaminated dredged material at the new CMPs at East Sha Chau and airport east and the on-going construction works for the three HZMB project, HKBCF, HKLR and TM-CLKL and other neighbouring works in Tung Chung that may result in cumulative ecological impacts. There is also the potential for impacts due to dredging of the Kwai Chung Terminal and Container Terminal 10. Details of the concurrent projects are provided in **Chapter 4** and **Drawing No. MCL/P132/EIA/4-008.** The cumulative impacts are, therefore, wider in

scope than the potential impacts attributable to the project and are discussed in **Section 13.15** below.

13.7 Identification and Prediction of Potential Marine Ecology Impacts

13.7.1 General

13.7.1.1 Potential impacts to marine ecology can arise directly or indirectly and during both the construction and operation phases. A summary of the potential impacts that may arise as a result of the construction and operation of proposed 3RS project are presented below.

13.7.2 Construction Phase

Direct Impacts

13.7.2.1 Direct construction related impacts relate specifically to the formation of the proposed 3RS land platform. A summary of the potential direct construction phase impacts on the marine environment, habitats and species is detailed as follows:

- Permanent and temporary habitat loss of subtidal and intertidal zones, and open marine waters, due to land formation works, site investigation for fuel pipeline diversion within SCLKCMP and associated works and diversion of 11 kV cables;
- Reduction of species abundance/diversity of marine life due to land formation and associated works;
- Loss of carrying capacity;
- Habitat fragmentation; and
- Loss of CWD travelling areas and connectivity between core CWD habitat areas.

Indirect Impacts

13.7.2.2 Indirect construction related impacts are associated with the construction of the land formations and the associated changes to water quality, noise impacts and increase and changes to marine traffic in the study area. A summary of the potential indirect construction phase impacts on the marine environment, habitats and species is detailed as follows:

- Loss of prey resources for CWD as a result of temporary loss of benthic habitat;
- Disturbance to the CWD use of travelling areas and connectivity between core CWD habitat areas;
- Changes in species distribution, abundance and patterns of habitat use including breeding, foraging, calving, milling and nighttime activities for the CWD as a result of the construction works;

- Elevation in suspended solids during ground stabilisation and land formation, bored piling for the new approach lights and marker beacons, diversion of the existing aviation fuel sub-marine pipeline at the AFRF in the SCLKCMP, diversion of the electricity cables including minor excavation works at the field joint locations, which can cause smothering of corals and sessile benthos and changes to prey resources for the CWD;

- Reduction in dissolved oxygen in marine waters due to presence of elevated suspended solids;

- Release of contamination (from sediments) during ground stabilisation and land formation, bored piling for the new approach lights and marker beacons and water jetting and minor excavation works at the field joint location for the re-alignment of the existing 11 kV electricity cables and bioaccumulation in the CWDs;

- Risk of oil or chemical spills, including from construction phase vessels accidents, on marine life and bioaccumulation in CWDs;

- Release of contaminants during Deep Cement Mixing (DCM) process for land formation;

- Impacts to marine life from the importation and transportation of marine fill and filling activities;

- Increased acoustic disturbance to marine life, specifically the CWD, due to bored piling works for the construction of the new runway approach lights, re-alignment of fuel pipeline, laying of electrical cables and general construction works, and from construction vessels and barges during the land formation and other works;

- Increased acoustic disturbance to marine life, specifically the CWD, due to nighttime construction works;

- Increased acoustic disturbance from changes to marine vessels and ferry traffic routes / navigation channels, including from the SkyPier;

- Increased risk of injury / mortality to CWDs from construction phase marine traffic and changes to marine vessels and ferry traffic routes/navigation channels;

- Changes to CWD movement patterns as a result of construction phase marine traffic and changes to marine vessels and ferry traffic routes / navigation channels;

- Disturbance to the function and quality of the existing SCLKCMP and the proposed Marine Parks at the Brothers and South-west Lantau and SSSIs.

13.7.3 Operational Phase

Direct Impacts

13.7.3.1 Direct operation phase impacts relate to the presence of the new airport 3RS platform and its potential effect on the hydrology of surrounding marine waters. A summary of the potential

direct operation phase impacts on the marine environment, habitats and species is detailed as follows:

- Permanent habitat loss due to land formation works, diversion of submarine pipelines by HDD involving a landing point, and construction of approach light and marker beacons;
- Reduction of species abundance / diversity of marine life due to land formation;
- Loss of carrying capacity;
- Habitat fragmentation; and
- Permanent loss of CWD travelling areas and connectivity between core CWD habitat areas.

Indirect Impacts

13.7.3.2 Indirect operation phase impacts would be associated with fuel, oil or chemical spills from the operation of the airport, the increase in numbers of marine vessels and changes to their travel routes and speeds. A summary of the potential indirect construction phase impacts on the marine environment, habitats and species is detailed as follows:

- Permanent loss of prey resources for CWD as a result of permanent loss of benthic habitat;
- Changes in species distribution, abundance and patterns of habitat use including breeding, foraging, calving, milling and nighttime activities for the CWD as a result of the new land formation;
- Changes in the hydrodynamic regime and water quality as a result of the new land formation;
- Impingement and entrainment due to an increase in cooling demand from the existing seawater pumping house (SWPH-1 and new SWPH-7);
- Risk of oil or chemical spills, including from operation phase aircraft and marine vessels accidents, on marine life and bioaccumulation in CWDs;
- Increased acoustic disturbance to marine fauna from aircraft noise;
- Increased acoustic disturbance from increased marine traffic and changes to traffic routes/navigation channels, including from SkyPier;
- Increased risk of injury / mortality to CWDs from marine traffic and changes to marine vessels and ferry traffic routes / navigation channels;
- Changes in CWD movement patterns as a result of marine traffic and changes to marine vessels and ferry traffic routes / navigation channels; and
- Impacts to the function and quality of the existing SCLKCMP and the planned BMP and potential SWLMP and SSSIs.

13.7.4 Secondary Impacts

13.7.4.1 The secondary impacts from any proposed mitigation measures on the marine habitat and species, specifically the CWD and its habitat, including the existing and proposed marine parks, will also be assessed.

Table 13-22: Summary of Potential Marine Ecological Impacts

Potential Impacts	Potential Receivers												
	Sites of Conservation Interest		Sub-tidal Habitats		Artifical Reefs	Intertidal Habitats						Marine Open Waters	
	Marine Parks	SSSIs	Benthos	Corals		Artificial Shore	Rocky Shore	Sandy Shore	Man-grove/ Mudflat	Sea-grass Beds	Estuarine Fish	Crusta-ceans/ Marine fishes	Marine Mammals
Construction Phase – Direct Impacts													
Temporary habitat loss	SCLKC MP	N/A	Project footprint and HKIAAA	Project footprint and HKIAAA	N/A	within HKIAAA	N/A	N/A	N/A	N/A	N/A	Project footprint and HKIAAA	Project footprint and HKIAAA
Reduction of species abundance / diversity of marine life	N/A	N/A	Project footprint and HKIAAA	Project footprint and HKIAAA	N/A	within HKIAAA	N/A	N/A	N/A	N/A	N/A	Project footprint and HKIAAA	N/A
Loss of carrying capacity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Project footprint and HKIAAA	N-W Marine waters
Habitat fragmentation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Project footprint and HKIAAA	N-W Marine waters
Loss of CWD travelling areas and connectivity between core CWD habitat areas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N-W Marine waters

Potential Impacts	Potential Receivers												
	Sites of Conservation Interest		Sub-tidal Habitats		Artifical Reefs	Intertidal Habitats						Marine Open Waters	
	Marine Parks	SSSIs	Benthos	Corals		Artificial Shore	Rocky Shore	Sandy Shore	Man-grove/ Mudflat	Sea-grass Beds	Estuarine Fish	Crusta-ceans/ Marine fishes	Marine Mammals
Construction Phase – Indirect Impacts													
Loss of prey resources for CWD as a result of temporary loss of benthic habitat	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N-W Marine waters
Disruption to the CWD use of travelling areas and connectivity between core CWD habitat areas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N-W Marine waters
Changes in species distribution, abundance and patterns of habitat use including breeding, foraging, calving, milling and nighttime activities for the CWD	N/A	N/A	N/A	N/A	N/A	N/A	SC	N/A	N/A	N/A	N/A	Project footprint and HKIAAA	N-W Marine waters
Elevation in suspended solids	SCLKC MP; Planned BMP and potential SWLMP	ST Beach SSSI	N/A	BI, SC, North Lantau	SCLKC MP	N/A	N/A	SC, YO, HHW, SLW	TH, TC, ST, YO, SW	ST, SW, TH, TC, YO	TH, TC, ST, HHW, SLW, SW	N. CLK waters Outside Project footprint,	N-W Marine waters
Reduction in dissolved oxygen in marine waters due to presence of elevated suspended solids	SCLKC MP Planned BMP and potential SWLMP	ST Beach SSSI	N/A	BI, SC, North Lantau	SCLKC MP	N/A	N/A	SC, YO, HHW, SLW	TH, TC, ST, YO, SW	ST, SW, TH, TC, YO	TH, TC, ST, HHW, SLW, SW	N. CLK waters Outside Project footprint,	N-W Marine waters

Potential Impacts	Potential Receivers												
	Sites of Conservation Interest		Sub-tidal Habitats		Artifical Reefs	Intertidal Habitats						Marine Open Waters	
	Marine Parks	SSSIs	Benthos	Corals		Artificial Shore	Rocky Shore	Sandy Shore	Man-grove/ Mudflat	Sea-grass Beds	Estuarine Fish	Crusta-ceans/ Marine fishes	Marine Mammals
Release of contamination (from sediments) during ground stabilisation and land formation and minor excavation works at the field joint location for the re-alignment of the existing aviation fuel sub-marine pipeline at the Aviation Fuel Receiving Facility (AFRF) in the Sha Cha and Lung Kwu Chau Marine Park and bioaccumulation in the CWDs	N/A	N/A	N. CLK waters Outside Project footprint	BI, SC, North Lantau	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N. CLK waters Outside Project footprint	N-W Marine waters
Risk of oil or chemical spills, including from construction phase vessels accidents, on marine life and bioaccumulation in CWD	N/A	N/A	N/A	BI, SC, North Lantau	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N. CLK waters Outside Project footprint	N-W Marine waters
Release of contaminants during Deep Cement Mixing (DCM) process for land formation	N/A	N/A	N/A	BI, SC, North Lantau	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N. CLK waters	N-W Marine waters
Impacts to marine life from the importation and transportation of marine fill and filling activities	N/A	N/A	N/A	BI, SC, North Lantau	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N. CLK waters	N-W Marine waters

Potential Impacts	Potential Receivers												
	Sites of Conservation Interest		Sub-tidal Habitats		Artifical Reefs	Intertidal Habitats						Marine Open Waters	
	Marine Parks	SSSIs	Benthos	Corals		Artificial Shore	Rocky Shore	Sandy Shore	Man-grove/ Mudflat	Sea-grass Beds	Estuarine Fish	Crusta-ceans/ Marine fishes	Marine Mammals
Increased acoustic disturbance to marine life, specifically the CWD, due to bored piling works for the construction of the new runway approach lights, cable and pipeline diversion and from construction vessels and barges during the land formation and other works	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N. CLK waters	N-W Marine waters
Increased acoustic disturbance to marine life, specifically the CWD, due to nighttime construction works	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N. CLK waters	N-W Marine waters
Increased acoustic disturbance from changes to marine vessels and ferry traffic routes / navigation channels, including from the Sky Pier	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N. CLK waters Outside Project footprint	N-W Marine waters
Increased risk of injury/mortality to CWDs from construction phase marine traffic and changes to marine vessels and ferry traffic routes/navigation channels	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N-W Marine waters

Potential Impacts	Potential Receivers												
	Sites of Conservation Interest		Sub-tidal Habitats		Artifical Reefs	Intertidal Habitats						Marine Open Waters	
	Marine Parks	SSSIs	Benthos	Corals		Artificial Shore	Rocky Shore	Sandy Shore	Man-grove/ Mudflat	Sea-grass Beds	Estuarine Fish	Crusta-ceans/ Marine fishes	Marine Mammals
Changes in CWD movement patterns as a result of construction phase marine traffic and changes to marine vessels and ferry traffic routes / navigation channels	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N-W Marine waters
Disturbance to the function and quality of the existing SCLKCMP and the planned BMP and potential SWLMP and SSSIs	SCLKC MP Planned BMP and potential SWLMP	ST Beach SSSI	N/A	BI, SC, North Lantau	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CWD in SCLKCM P, Planned BMP and potential SWLMP
Operational Phase – Direct Impacts													
Permanent habitat loss due to land formation works	N/A	N/A	Project footprint and HKIAAA	Project footprint and HKIAAA	N/A	within HKIAAA	N/A	N/A	N/A	N/A	N/A	Project footprint and HKIAAA	Project footprint and HKIAAA
Reduction of species abundance / diversity of marine life due to land formation and associated works	N/A	N/A	Project footprint and HKIAAA	Project footprint and HKIAAA	N/A	within HKIAAA	N/A	N/A	N/A	N/A	N/A	Project footprint and HKIAAA	N/A
Loss of carrying capacity	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Marine fish species of conser-vation importanc e	N-W Marine waters

Potential Impacts	Potential Receivers												
	Sites of Conservation Interest		Sub-tidal Habitats		Artifical Reefs	Intertidal Habitats						Marine Open Waters	
	Marine Parks	SSSIs	Benthos	Corals		Artificial Shore	Rocky Shore	Sandy Shore	Man-grove/ Mudflat	Sea-grass Beds	Estuarine Fish	Crusta-ceans/ Marine fishes	Marine Mammals
Habitat fragmentation	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Marine fish species of conser-vation importanc e	N-W Marine waters
Permanent loss of CWD travelling areas and connectivity between core CWD habitat areas	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N-W Marine waters
Operational Phase – Indirect Impacts													
Loss of prey resources for CWD as a result of permanent loss of benthic habitat	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N-W Marine waters
Changes in species distribution, abundance and patterns of habitat use including breeding, foraging, calving, milling and nighttime activities for the CWD as a result of the new land formation	N/A	N/A	N/A	Along new seawall and footings of Appro-ach Lights	N/A	New habitat along 3RS	N/A	N/A	N/A	N/A	N/A	Project footprint and N. CLK waters	N-W Marine waters

Potential Impacts	Potential Receivers												
	Sites of Conservation Interest		Sub-tidal Habitats		Artifical Reefs	Intertidal Habitats						Marine Open Waters	
	Marine Parks	SSSIs	Benthos	Corals		Artificial Shore	Rocky Shore	Sandy Shore	Man-grove/ Mudflat	Sea-grass Beds	Estuarine Fish	Crusta-ceans/ Marine fishes	Marine Mammals
Changes in the hydrodynamic regime and water quality as a result of the new land formation;	SCLKC MP; Planned BMP and potential SWLMP	ST Beach SSSI	N/A	BI, SC, North Lantau	SCLKC MP	TC, TH	SC, TMT, CLK, ST, HHW, SW, TO	SC, YO, HHW, SLW	TH, TC, ST, YO, SW	ST, SW, TH, TC, YO	TH, TC, ST, HHW, SLW, SW	N. CLK waters outside Project footprint	N-W Marine waters
Risk of oil or chemical spills, including from operation phase aircraft and marine vessels accidents, on marine life and bioaccumulation in CWDs	SCLKC MP; Planned BMP and potential SWLMP	ST Beach SSSI	N/A	BI, SC, North Lantau	SCLKC MP	TC, TH	SC, TMT, CLK, ST, HHW, SW, TO	SC, YO, HHW, SLW	TH, TC, ST, YO, SW	ST, SW, TH, TC, YO	TH, TC, ST, HHW, SLW, SW	N. CLK waters outside Project footprint	N-W Marine waters
Increased acoustic disturbance from increased marine traffic and changes to traffic routes / navigation channels, including from Sky Pier	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N. CLK waters	N-W Marine waters
Increased risk of injury/mortality to CWDs from marine traffic and changes to marine vessels and ferry traffic routes / navigation channels	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N-W Marine waters

Potential Impacts	Potential Receivers												
	Sites of Conservation Interest		Sub-tidal Habitats		Artifical Reefs	Intertidal Habitats						Marine Open Waters	
	Marine Parks	SSSIs	Benthos	Corals		Artificial Shore	Rocky Shore	Sandy Shore	Man-grove/ Mudflat	Sea-grass Beds	Estuarine Fish	Crusta-ceans/ Marine fishes	Marine Mammals
Changes in CWD movement patterns as a result of marine traffic and changes to marine vessels and ferry traffic routes / navigation channels	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N-W Marine waters
Impacts to the function and quality of the existing SCLKCMP and the planned BMP and potential SWLMP and SSSIs	SCLKC MP; Planned BMP and potential SWLMP	ST Beach SSSI	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	CWD in SCLKC MP; Planned BMP and potential SWLMP

Note: SCLKCMP – Sha Chau and Lung Kwu Chau Marine Park; BMP – Brothers Marine Park; BI – the Brothers; SWLMP – Southwest Lantau Marine Park; HKIAAA – Hong Kong International Airport Approach Areas; SSSI – Site of Special Scientific Interest; ST – San Tau; CLK – Chek Lap Kok; TC –Tung Chung; TH – Tai Ho; SC – Sha Chau; YO – Yan O; HHW – Hau Hok Wai; SLW – Sha Lo Wan; SW – Sham Wat; TO – Tai O; FCZ – Fish Culture Zone; and CWD – Chinese White Dolphin.

13.7.5 Prediction and Evaluation of Impacts

13.7.5.1 As noted above, there is the potential for direct and indirect impacts on the marine wildlife groups and habitats identified within the study area during both the construction and operation phases of the project. The proposed land formation works of the 3RS project, the proposed diversion of submarine cables and pipelines and associated site investigation works within the SCLKCMP may cause potential disturbance and destruction and loss of habitats, reduction of species abundance / diversity, loss of feeding and breeding grounds, reduction of ecological carrying capacity, habitat fragmentation and changes in water quality and consequential impacts to other habitats / species. The potential impacts to various habitats and species have been presented above in **Table 13-22** and these potential impacts are evaluated in **Sections 13.8** and **13.9** for overall marine ecology and marine mammals, respectively. The description of the 3RS project is detailed in **Chapter 4** of this EIA report for reference.

13.8 Evaluation of Impacts to Marine Ecology (Excluding Marine Mammals)

13.8.1 Construction Phase – Direct Impacts

Habitat Loss and Reduction in Species due to Land Formation and Associated Works

13.8.1.1 The land formation for the airport expansion, the seawall extension, the approach lights, lighted markers and beacons construction will cause total permanent loss of approximately 672 ha (the loss due to construction of approach lights, lighted markers and beacons is only 0.011 ha) of sea bed and its water column upon completion of marine works construction. There will be progressive increase in direct impact on the marine soft-bottom habitat and open marine waters due to the phasing of land formation works, in which the marine fishes will be displaced to adjacent marine waters. There will be a permanent loss of approximately 5.9 km artificial seawall upon completion of land formation. The extension of seawall to approximate 13 km of design similar to the existing setting, with suitable locations enhanced with eco-friendly design to facilitate recolonization of intertidal and sub-tidal flora and fauna will be re-provided. **Table 13-23** summarises the areas of marine habitat loss for construction phase.

Table 13-23: Summary of Areas of Marine Habitat Loss for Construction Phase

Proposed Construction Works	Approximate Size of Marine Habitat Affected	Nature of Impact
Land formation and seawall construction(1)	672 ha marine habitat(2) (650 ha land formation + 22 ha seawall – 10 ha existing seawall to be demolished + 10 ha scour apron)	Permanent loss upon completion of marine filling works by late 2021
Diversion of submarine aviation fuel pipelines - site investigation	0.12 m^2 sub-tidal soft bottom habitat (0.03 m^2 x 4)	Temporary between 2015 and 2016
Diversion of submarine 11 kV cables – excavation at the field joint area by open trench(3)	0.38 ha sub-tidal soft bottom habitat (120 m x 32 m = 3,840 m^2)	Temporary between 2015 and 2016
Diversion of submarine 11 kV cables – laying of new cable by water jetting(3)	0.27 ha marine habitat (6 km x 0.45 m = 2,700 m^2)	Temporary between 2015 and 2016

Proposed Construction Works	Approximate Size of Marine Habitat Affected	Nature of Impact
Approach lights construction with ground improvement followed by bore piling	108 m^2 marine habitat (4.9 m^2 x 11 x 2)	Permanent loss upon completion of construction works by 2021
Lighted marks and beacons for future HKIAAA with ground improvement followed by bore piling	3.1 m^2 marine habitat (0.34 m^2 x 9 = 3.1 m^2)	Permanent loss upon completion of construction works by 2021
Floating temporary platform for diversion of submarine aviation fuel pipelines(4)	225 m^2 marine habitat (7.5 m x 30 m = 225 m^2)	Temporary

Note (1): While a works area for the land formation works will be designated (see **Figure 3**, **Appendix 13.13**), the temporary works area will be demarcated by floating booms, not expected to cause significant obstruction to the water column. Activities within the works area will include construction vessel traffic and working barges operating close to active works areas within the construction footprint. Thus, much of the area of marine waters within the temporary works area will remain available for use by marine fauna and is not considered as habitat loss.

(2): Proposed land formation footprint: 650 ha. The net seawall toe construction is 12 ha (22 ha proposed seawall toe minus 10 ha of the existing seawall toe). Approximate 10 ha scour apron of varying widths (subject to detailed design) will be constructed beyond the seawall toe for scour protection. Therefore, the total open water to be lost is 650 ha, but seabed habitat to be lost would be 672 ha.

(3): Other less disturbed construction methods for submarine cable diversion e.g. horizontal directional drilling (HDD) has been explored, but considered not feasible due to the highly fragile property of the cabes that pulling of cables from a long distance will cause damage.

(4): The diversion of submarine aviation fuel pipelines by using floating platform will not affect sub-tidal soft bottom habitat as it consists of a series of interlocking barges.

Intertidal and Sub-tidal Hard Bottom Habitats

13.8.1.2 As summarised in **Table 13-23** above, there will be a direct loss of approximate 5.9 km in length of artificial seawall along the northern coast of the existing airport island due to the land formation works. Around 146 m of artificial seawall at the western coast of the existing airport island will be temporary affected by the submarine 11 kV cable diversion works and will be reinstated upon completion of the construction. The rocky shore of approximate 100 m^2 in area at the proposed daylighting point of submarine aviation fuel pipeline diversion at Sha Chau will also be affected. The intertidal and sub-tidal flora and fauna associated in these habitats will also subject to direct impact.

13.8.1.3 The existing artificial seawall along the northern airport island was formed by rock boulders. The intertidal species recorded are common in Hong Kong, and no rare or species of conservation importance was recorded. The species diversity is moderate-low, similar to other locations on Chek Lap Kok. The species composition and species diversity (32 species) are similar to those recorded at the artificial seawalls of reference sites at Tung Chung North (31 species) and Tai Ho Wan (41 species), though the seawalls to be directly affected are within the marine exclusion zone or as HKIAAA. Only the gorgonians in very low coverage (<1%) was recorded at the sub-tidal hard substrates. No ahermatypic cup corals were recorded within the land formation footprint as shown in Table 9 of **Appendix 13.5 Annex A1**, but one ahermatypic cup coral *Balanophyllia* sp. was recorded at the northeastern coast of the existing airport island. These species were also commonly recorded in other rocky shores and artificial seawall along the North Lantau coasts.

13.8.1.4 *Balanophyllia* sp. was recorded along the north-eastern subtidal habitats along the artificial seawall of the airport island and identified in **Table 13-21** as a species requiring further impact

assessment. This is an ahermatypic cup coral protected under the Wild Animals and Plants Protection Ordinance (Cap.586). This species was recorded in isolated colonies and in very low coverage of less than 1% (**Appendix 13.5**). Other locations within the study area with this species recorded including northeast and southeast shores of airport island, SCLKCMP, Tai O, Tung Chung, the Brothers, Sha Lo Wan, San Shek Wan, Sham Wat, Tai Ho Wan, Yam Tsai Wan, Sham Tseng and Tsing Lung Tau. Although *Balanophyllia* sp. was not recorded within the project footprint during the coral dive survey for this project, due to its close proximity to the project footprint and within the temporary works area boundary, as a conservative approach, it is considered the species recorded at the northeastern seawall of the existing airport island may subject to direct impact. In view of the potential direct impact on this species of conservation importance, with dominant corals and intertidal species to be affected are common, similar to those recorded in other northern and western Lantau coasts and in low to moderate-low abundance respectively, it is considered the direct loss of 5.9 km artificial seawall is of low-moderate significance.

13.8.1.5 The daylighting locations and pipeline connection to the existing offshore receiving platform at Sha Chau will cause direct loss of approximate 100 m^2 rocky shore habitat. According to **Table 13-8** of the ecological evaluation of rocky shores, the rocky shore to be affected at Sheung Sha Chau is of moderate species diversity, moderate-low species abundance, low species richness and of overall moderate-low ecological value. The sub-tidal habitat that potentially be affected is restricted to the daylighting location with *Balanophyllia* sp. recorded at less than < 5% coverage. In view of the small area to be affected and the species composition is similar to those recorded in other northern and western Lantau coasts, and the low species abundance, it is considered the direct loss of rocky shore is of low significance.

Sub-tidal Soft Bottom Habitats

13.8.1.6 There will be a direct permanent loss of 672 ha of soft-bottom habitats (650 ha land formation footprint + 22 ha of seawall construction – 10 ha of existing seawall to be demolished + 10 ha of scour apron) with partial construction over CMPs for the land formation, construction of runway approach lights, markers light and beacons for the third runway and for the construction of seawall toe. Beyond the seawall toe at the seabed, varying widths of scour aprons of approximate 10 ha will be constructed (the actual width required for scour protection is subject to detailed design). The scour aprons will be in the form of stone or gravels. These habitats will provide hard substrates for the re-colonisation of benthic fauna.

13.8.1.7 The main areas of marine habitat loss will be as a result of the land formation for the airport platform extension. The 3RS additional seawalls and land platform will be formed over a period of several years starting in late 2015 / early 2016 to mid-2022, noting that the third runway and taxiway sections (which accounts for the majority of the land formation) would be completed by 2020 for closure of the existing north runway and opening of the third runway by 2021. Based on the construction planning, the land formation works has been primarily divided into three main stages, as shown in **Drawing No. MCL/P132/EIA/8-003**, the snapshots for key land formation sequence is shown in **Appendix 8.4** of **Chapter 8** and described below:

- **Stage 1** has a T-shaped footprint and consists mainly of the land formation works for the third runway, the associated west taxiways, the western support area and other supporting

facilities. Construction of this stage is anticipated to commence in 2016 Q1 by installation of geotextile, sand blanket and ground improvement. Ground improvement for this stage will only be completed around 2017 Q4. Marine and land filling is anticipated to commence around 2016 Q4. It is expected that the marine works will be completed by early 2018.

- **Stage 2** consists of land formation works for the new third runway concourse and aprons supported by facilities within the east support area. Construction of the southern portions of this stage by installation of geotextile, sand blanket and ground improvement is anticipated to commence in 2016 Q1. Ground improvement for this stage will only be completed around 2018 Q2. Marine and land filling at southern portions of this stage is anticipated to commence around 2016 Q4. It is expected that the marine works will be completed by end 2018.

- **Stage 3** is the land formation area at both ends of the existing north runway associated with the new wrap-around taxiways, whereby construction activities are restricted by the need to maintain operation of the existing north runway until completion of the third runway. Construction of this stage is anticipated to commence around 2016 Q2 by installation of geotextile and sand blanket. Marine and land filling of this stage is anticipated to commence in 2017 Q2 and the marine works will not be completed until end 2021.

13.8.1.8 A temporary loss of seabed will also be resulted for the diversion of submarine 11 kV cables at the west of Chek Lap Kok waters. The use of HDD method has been considered for diversion of submarine 11 kV cables, but due to the highly fragile property of the cables, pulling of cables from a long distance by HDD method will cause damage to the cables. Therefore, the submarine cable diversion will be via direct bury (water jetting) method, to minimise the need for open excavation. The length will be around 1 m for each jetting with a width of around 0.45 m for a total length of around 6 km. A section of the submarine cables diversion will require excavation in open water to perform a field joint area after exposing existing cables. The area to be exposed is approximate 120 m in length and 32 m wide and will use open trench excavation.

13.8.1.9 For the submarine aviation fuel pipelines, marine SI will first be conducted along the proposed HDD alignment to provide the necessary geotechnical information for construction of the submarine pipelines. Within the SCLKCMP, a total of four SI boreholes (each approx. 200 mm in diameter) will be drilled to the bedrock level by drilling vessel / jack-up platform within the Marine Park. Subsequent drilling operations for both pipelines will be carried out simultaneously. Drilling works will proceed from the HDD launching site at the airport island and is expected to be completed in about a year. Upon completion the drilling and reaming of the HDD holes, the permanent aviation fuel pipes will be pulled from Sha Chau to the HDD launching site. The installation of the pipelines including testing and commissioning is anticipated to take another year. The works area for pipeline diversion will be reinstated upon completion of construction. Benthic fauna is anticipated to recolonise to the seabed upon reinstatement.

13.8.1.10 From the construction of approach light and marker beacons, about 0.011 ha of subtidal soft bottom habitat with moderate-low quality would be lost. As the area affected is negligible, the impact significance is considered as insignificant.

13.8.1.11 The soft-bottom benthic fauna recorded within the project footprint and at SCLKCMP are common and typical to the western Hong Kong waters associated with silt and clay. The

dominant species recorded within the project footprint are polychaetes, with most common species the amphipod *Byblis* sp. and Pea crab *Neoxenophthalmus obscurus*. No species of conservation importance was recorded for the soft-bottom habitat within the project land formation footprint. The species diversity for soft-bottom benthic fauna is considered of low to moderate. Occasion records of invertebrates associated with rock outcrops including sea anemone, crabs and green mussels recorded within the land formation footprint are common and in very low abundance. The sub-tidal soft-bottom habitat is considered to be of moderate-low ecological value within the project footprint and northern Lantau waters, but considered of low ecological value for the SCLKCMP because of the low species diversity and abundance records.

13.8.1.12 Sand blanket will be provided prior to the ground improvement works and subsequent land formation. In view of the large area to be permanently lost, the impact significance is considered as moderate and requires mitigation.

13.8.1.13 The ahermatypic cup corals species and gorgonians recorded along the proposed pipeline diversion alignment within the SCLKCMP are common in western Hong Kong waters, with less than 5% coverage and the estimated percentage of partial mortality for the corals is approximate 20%. With the avoidance of SI works at the recorded rock outcrops at soft-bottom coral survey station SC2, the potential direct impact on these species will be insignificant.

13.8.1.14 One single individual of Amphioxus *Branchiostoma belcheri* of conservation importance was found in sampling location B19 during the wet season survey, in north Chek Lap Kok waters outside the project footprint but along the proposed submarine pipeline diversion alignment. The species recorded is in very low abundance compared with the abundance recorded in its preferred habitat in Tai Long Wan (see Section 4 in **Appendix 13.1**). The north Chek Lap Kok waters covered by the present survey were mainly muddy sediment, different from the sandy substrate preferred by amphioxus as reported by previous study (Chan, 2007). The proposed submarine aviation fuel pipeline diversion will be constructed by the use of horizontal directional drilling through bedrock from a launching site located at the west of the airport island to the landing point adjacent to the offshore receiving platform at Sha Chau to minimise the direct impact to the site of conservation importance. The horizontal installation depth ranges from -90 mPD to -120 mPD that dredging at seabed is not required, thus avoid the direct impact on soft-bottom marine habitats and the location where the single individual of Amphioxus was recorded. The potential direct impact on this species of conservation importance will be insignificant.

<u>Open Marine Waters</u>

13.8.1.15 The water column of the proposed land formation footprint will be directly disturbed during land formation and seawall construction. There will also be a temporary works area of approximately 981 ha for the land formation works (**Drawing No. MCL/P132/EIA/4-008**). The temporary works area will be demarcated by floating booms, not expected to cause significant obstruction to the water column. Activities within the works area will include construction vessel traffic and working barges operating close to active works areas within the construction footprint. Thus, much of the area of marine waters within the temporary works area will remain available for use by marine fauna and is not considered as habitat loss. Apart from CWDs which are assessed in detail

under the subsection, other marine fauna may be affected including marine fishes and various other marine fauna.

13.8.1.16 In general, species richness, average abundance and yield, *H'* and *J'* were similar between project footprint and other areas (i.e. planned BMP, SCLKCMP, northern Chek Lap Kok waters) based on the result of fisheries surveys (including fish trawl, purse seine, gill net and hand line). These parameters recorded by trawl survey were generally higher within the project footprint during both wet and dry season, as compared to northern and western Chek Lap Kok waters only as trawl survey was not conducted in the planned BMP or SCLKCMP (**Appendix 13.5**). For results of purse seine, gill net and hand line, no observation trend could be discerned across different survey areas, therefore the project footprint has moderate species diversity, abundance and species richness of marine fauna.

13.8.1.17 Six fish species of conservation importance were recorded in waters within the project footprint during the fisheries surveys, including Longheaded eagle ray *Aetobatus flagellum*, Pale-edged stingray *Dasyatis zugei*, Goatee croaker *Dendrophysa russelii*, Long-tooth grouper *Epinephelus bruneus*, Orange-spotted grouper *Epinephelus coioides*, and Tiger-toothed croaker *Otolithes ruber* (**Drawing No.MCL/P132/EIA/13-014**). Except for *Aetobatus flagellum* which was recorded within the project footprint only by trawl survey at a relatively low density of 0.17 individuals per transect, the other five fish species of conservation importance were all recorded in other survey areas both by literature review and fisheries surveys (**Drawing No. MCL/P132/EIA/13-027**).

13.8.1.18 The abundance of each species recorded was also comparable across different areas. For *Dasyatis zugei*, the density recorded by trawl survey within project footprint, western and northern Chek Lap Kok waters were 2.17, 2 and 2.5 individuals per transect respectively. For *Dendrophysa russelii*, the combined density recorded by purse seine, gill net and hand line surveys within project footprint, the Brothers waters, SCLKCMP, western and northern Chek Lap Kok waters were 4, 3, 6.5, 5.5 and 8.5 individuals per station respectively. For *Epinephelus bruneus*, the density recorded by trawl survey within project footprint, western and northern Chek Lap Kok waters were 1.5, 0 and 0.75 individuals per transect respectively, while for hand line survey 1 individual per station was recorded for the Brothers waters but none at project footprint. For *Epinephelus coioides*, trawl survey only recorded a low 0.17 individual per transect within project footprint but not for other survey areas, however it had also been recorded in northern Chek Lap Kok waters by the CMP EM&A. For *Otolithes ruber*, trawl survey only recorded a low 0.33 individual per transect within project footprint but not for other survey areas, however hand line and purse seine survey had also recorded a combined 1.5 individual per station at SCLKCMP while none was recorded within project footprint.

13.8.1.19 In view of the above, the density of species of conservation importance within project footprint was not shown to be comparatively higher than other survey areas. Where they were recorded in project footprint by fisheries survey, the density was often low. Due to the high mobility of these marine fish species, small population to be affected (as demonstrated by their relatively low density within the project footprint), and availability of suitable habitats in other areas such as the Brothers, SCLKCMP, northern and western Chek Lap Kok waters (as demonstrated by the relatively uniform species richness and diversity of marine fauna across the study area), the impact of direct habitat loss of 650 ha of open marine water on these marine fauna and species of conservation importance is considered as moderate significance.

13.8.1.20 The fuel pipeline to the AFRF, located on Sha Chau, would require to be diverted. A temporary floating working platform will be constructed between Sha Chau Island and the offshore receiving platform, where the water depth is around 4 m and as such the marine fauna could still utilise the marine waters underneath the platform. It will also be temporarily in nature for about one year while the diversion works are on-going and no impacts to the marine fish species would be expected from this structure.

13.8.1.21 From the construction of approach light and marker beacons, about 0.011 ha of marine water with moderate quality would be lost. As the area to be affected is negligible, the impact significance is considered as insignificant.

Loss of Carrying Capacity

Marine Fauna

13.8.1.22 Ecological carrying capacity refers to the ecological resource that a habitat or an area can sustain. The project is situated in the north western waters of Hong Kong, which is heavily influenced by the massive freshwater flows from the Pearl River Estuary which carries heavy suspended sediment and nutrient loads. From the fisheries surveys (fish trawl, purse seine, gill net and hand line), a total of 148 species including 12 crabs, 104 fish, 6 mantis shrimps, 10 shrimps and 16 others (including clam, sea snail, sea urchin, sand slug, peanut worm, squid, mussel, octopus, sea pen and cuttlefish) were recorded within the project footprint (**Appendix 14-5**). Most of these species are common in Hong Kong and generally of low ecological importance, and only six fish species are identified to be of conservation importance. All of these species except for *Aetobatus flagellum* were also recorded outside of the project footprint by the 3RS EIA fisheries surveys. However, this species has also been recorded along the Tonggu Waterway (Scott Wilson, 1999). Therefore the carrying capacity of the project footprint does not appear to be significant in the context of marine ecosystem in Hong Kong. Moreover the habitat to be lost permanently is open water that is common in western Hong Kong, in which the relative species richness, abundance and diversity are not significantly different from surrounding waters, the loss of ecological carrying capacity due to permanent and irreversible habitat loss is considered as low.

Habitat Fragmentation

Marine Fauna

13.8.1.23 Habitat fragmentation can happen by splitting a single community in two by some disturbance in the middle. There is a concern that habitat fragmentation might be occurred and affecting the associated fauna as a result of the land formation for the 3RS project. For fish species recorded in this study, most of the fishes with conservation importance were recorded with wide-spreaded locations in northern Lantau waters from literature review and survey findings. Only one fish species of conservation importance, the Longheaded eagle ray *Aetobatus flagellum* was recorded only in the project footprint in this study. It is listed as “Endangered” in IUCN Red List. The protection status is due to the high level of exploitation where the demersal fisheries activities of marine resources are extremely high. This is not the case for Hong Kong as supported by the fisheries interview survey findings that the project area is not the major fishing

ground for capture fisheries. As a result of the implementation of the ban on fishing with trawl nets since end 2012, the fishing pressure on this species was further reduced. *Aetobatus flagellum* is of high mobility and with a diverse habitats range including marine water, brackish water and benthopelagic zone. Therefore, it is unlikely to be affected by habitat fragmentation due to the 3RS land formation works, where the proposed footprint will be connected with the existing airport island to the north.

13.8.1.24 Due to the high mobility and the wide distribution of fish species of conservation importance recorded, the connection of proposed footprint with existing airport island is unlikely to cause habitat fragmentation for marine fishes, the direct impact of habitat fragmentation towards marine fauna is considered of low significance.

13.8.2 Construction Phase – Indirect Impacts

Changes in Species Distribution, Abundance and Patterns of Habitat Use

Indirect Disturbance to Intertidal Habitats

13.8.2.1 There will be an above ground pipeline section of length approximately 45 - 110 m (which will be located as far away from the Sha Chau Egretry as practicable), for connecting the new pipeline at the daylighting point (where location proposed is to avoid the close proximity to the Sha Chau egretry) to the adjacent offshore receiving platform at Sha Chau. The new pipeline will be constructed along the shoreline in the terrestrial habitat, but may cause temporary indirect disturbance to the rocky shore. As mentioned in **Section 13.8.1.5**, the rocky shore to be affected at Sheung Sha Chau is of moderate species diversity (H' = 1.46 – 2.06), moderate-low species abundance and of overall moderate-low ecological value. No species of conservation importance was recorded along the shore. It is anticipated that the duration of the pipeline connection work above ground would be short. The indirect disturbance on this habitat and associated species is considered temporary and reversible. The impact significance is considered as low.

Indirect Disturbance to Marine Fauna

13.8.2.2 During land formation works, the increased marine traffic due to construction vessels around the project area, the ground improvement works as well as the construction activities for the approach lights, lighted marks and beacons for the proposed third runway by bored piling may generate underwater sound that may cause disturbance to the marine fauna and cause them to avoid areas with high levels of anthropogenic underwater noise.

13.8.2.3 The underwater noise emitted by marine vessels is in the frequency range of 0.02 kHz to 10 kHz (BMT, 2009). Anthropogenic noises generated by marine construction (including piling) and vessels activities are generally in the frequency range of 30 Hz – 5 kHz (Slabbekoorn et al., 2010). The hearing range of fishes is around 50 Hz to 1.5 kHz, while some species with special adaptations can detect sounds up to 3 kHz – 5 kHz (Popper and Hastings, 2009; Slabbekoorn et al., 2010).

13.8.2.4 During the construction phase, increase in marine traffic from construction vessels may cause disturbance to fishes in the study area through the generation of underwater noise. Some effects caused by sound on fishes include mortality, physical injury, auditory tissue damage, temporary threshold shift, behavioural changes, egg viability and larval growth (Popper and Hastings, 2009). However, Slabbekoorn et al. (2010) advised that there are few studies suggesting negative correlations between the presence of noise and the presence of fish. There are also limited studies indicating the potential reproductive consequences of anthropogenic noise on fish spawning activities, masking effects on communicative sounds and predator-prey relationships. Fishes sometimes congregate, seeking shelter or food at places with artificially high noise levels. The greater impact on fishes will be from less intense sounds that are of longer duration.

13.8.2.5 Underwater percussive piling work will not be adopted for the project, but some vibratory sheet piling may be needed for some aspects of the construction. Information on noise produced by percussive piling is available (Würsig et al., 2000), but very little information has been published about noise and effects of vibratory piling. However, vibratory piling is undoubtedly much quieter than percussive piling and has less potential to cause disturbance to marine fishes. The potential impact is considered as not likely to be significant.

13.8.2.6 Four species of conservation importance were recorded in the Brothers, including Spotted Seahorse *Hippocampus kuda*, Goatee Croaker *Dendrophysa russelii*, Long-tooth grouper *Epinephelus bruneus*, Banded tuna *Scomberomorus commerson* (Drawing No. **MCL/P132/EIA/13-016**). These species were also recorded in other survey areas outside the Brothers.

13.8.2.7 Eleven marine fishes species, two horseshoe crabs and one sea snail of conservation importance were recorded in SCLKCMP, including Chinese gizzard shad *Clupanodon thrissa*, Red stingray *Dasyatis akajei*, Pale-edged stingray *Dasyatis zugei*, Goatee croaker *Dendrophysa russelii*, Long-tooth grouper *Epinephelus bruneus*, Devil stinger *Inimicus japonicus*, Slender snipe eel *Nemichthys scolopaceus* Goldern threadfin bream *Nemipterus virgatus*, Tiger-toothed croaker *Otolithes ruber*, *Zebrias crossolepis*, Seaweed pipefish *Syngnathus schlegli, Carcinoscorpius rotundicauda*, *Tachypleus tridentatus and* Sea snail *Oliva mustelina* (Drawing Nos. **MCL/P132/EIA/13-007** and **MCL/P132/EIA/13-015**). Except for *Nemipterus virgatus* and *Zebrias crossolepis*, all other species were also recorded in other survey areas outside SCLKCMP. However, *Nemipterus virgatus* has also been reported outside of the study area, such as at Tolo Harbour (Choi, 2006).

13.8.2.8 Eleven species of conservation importance were recorded in western Chek Lap Kok waters, including *Tachypleus tridentatus*, *Syngnathus schlegli*, *Clupanodon thrissa, Dasyatis akajei*, *Daysatis zugei*, *Dendrophysa russelii*, *Epinephelus bruneus*, *Inimicus japonicas,* yellow croaker *Larimichthys crocea*, *Otolithes ruber and Oliva mustelina* (Drawing Nos. **MCL/P132/EIA/13-002** and **MCL/P132/EIA/13-014**). Except for *Larimichthys crocea*, all other species were also recorded in other survey areas outside western Chek Lap Kok waters. However, *Larimichthys crocea* has also been recorded along the Tonggu Waterway (Scott Wilson, 1999).

13.8.2.9 Twelve species of conservation importance were recorded in northern Chek Lap Kok waters, including *Dasyatis akajei*, *Dasyatis zugei, Dendrophysa russelii*, *Epinephelus bruneus*, Orange-

spotted grouper *Epinephelus coioides, Inimicus japonicus*, *Nemichthys scolopaceus*, *Scomberomorus commerson*, *Otolithes ruber*, *Hippocampus kuda*, *Syngnathus schlegeli* and *Carcinoscorpius rotundicauda* (Drawing Nos. **MCL/P132/EIA/13-002** and **MCL/P132/EIA/13-014**). All these species were recorded in other survey areas outside northern Chek Lap Kok waters.

13.8.2.10 The proposed bored piling activities for the construction of approach lights, lighted marks and beacons will last for several weeks. The bored piling areas are very small – a total of approximately 108 m^2 for 11 approach lights and approximately 3.1 m^2 for nine lighted marks/ beacons. In view of the temporary effect of disturbance caused by passing construction vessels, mobility of the species which allow them to avoid the marine traffic, the very small bored piling areas and the availability of suitable marine habitats nearby, the indirect disturbance to marine fauna is considered to be of low significance.

Release of Suspended Solids and Associated Changes in Water Quality

Indirect Disturbance to Intertidal and Sub-tidal Hard Bottom Habitats

13.8.2.11 The marine works that could result in perturbation of water quality include modification and integration of the existing seawall, ground improvement, seawall construction, filling and surcharge. These activities can cause sediment plumes which cause increase in turbidity and sedimentation, decrease in dissolved oxygen levels along with potential release of nutrients and contaminants (especially around the contaminated mud pit area) to the water column.

13.8.2.12 The release of suspended solids and associated changes in water quality on sites of conservation importance and associated species were assessed based on the predicted changes in the water quality model for the Year 2016 and 2017 with project only (unmitigated) scenarios. The predicted values are compared to widely adopted water quality criteria as detailed in **Section 8.4** of this EIA, for assessing the impact significance on marine habitat and fauna. For details on water quality modeling results refer to **Section 8.7** of this EIA study.

13.8.2.13 The Year 2016 scenario is based on a period of construction that is tentatively programmed to occur during the first quarter (between January and March) and represents the dominant construction activities of sand blanket laying and ground improvement prior to commencement of seawall construction (i.e. when local flow conditions remain unaltered and sediment plume spreading is unrestricted).

13.8.2.14 The Year 2017 scenario is based on a period of construction that is tentatively programmed to occur during the first quarter (between January and March) and represents the period with the overall highest sediment loss due to the highest number of plant undertaking ground improvement (via DCM) and marine filling activities. This scenario takes into account the partial seawall completion along mainly the western edge, which consequently impedes local flow conditions, thereby altering the sediment plume dispersion effect.

Suspended Solids

13.8.2.15 Seagrass may be affected by the increase in sedimentation that blocks the sunlight and indirectly affect the photosynthesis process and eventually lead to mortality. *Halophila ovata*

(also as *Halophila ovalis*) and *Zostera japonica* population at San Tau had been reduced significantly during the commencement of HKIA reclamation works back in 1992 and almost disappeared in 1995, but was recorded to be recovered gradually after the completion of the reclamation works (Fong, 1998). The indirect impact caused by water pollution on seagrass bed may also affect the horseshoe crabs that associated with this habitat. The crustaceans or bivalves that rely on filter feeding may suffer from an increase in metabolic rate to clear suspended solids.

13.8.2.16 Four seagrass species of conservation importance were recorded within the study area, including *Halophila beccarii, Halophila minor, Halophila ovalis* and *Zostera japoinica.* These species are either considered as rare or locally rare by Xing et al. (2000) and Hu (2003). *Halophila beccarii* is also listed under the IUCN Red List as "Vulnerable". Locations that with seagrass recorded within the study area including Yan O, Tai Ho Wan, San Tau Beach SSSI, and Sham Wat Wan. Based on the recent verification field survey, the seagrass beds at San Tau with species *Z. japonica* and *H. ovalis* recorded were found along the mangrove fringe with a length of approximately 30 m of area about 90 m^2 and 60 m^2 respectively. *H. ovalis* was found in abundant, covering the mudflats in dense patches with a maximum area of about 1,190 m^2. The seagrass beds of *H. beccarii* at Tai Ho Wan were in small patches, with estimated area of the larger patch up to 2.34 m^2.

13.8.2.17 Apart from the seagrass beds, other soft shores habitats, including sandy shores, intertidal mudflats, mangroves areas as well as the estuarine region may also be indirectly affected by the increase in sedimentation. The suspended solids may smother the intertidal flora and fauna including the estuarine fishes and other sessile and non-sessile animals associated with these habitats.

13.8.2.18 Two horseshoe crab species of conservation importance *Tachypleus tridentatus* and *Carcinoscorpius rotundicauda* were recorded within the study area. The mudflat/sandy shore/seagrass habitats along Tai Ho Wan, San Tau, Tung Chung Bay and Sham Wat Wan are considered as nursery grounds for these horseshoe crabs, as juveniles and sub-adults of significant number were recorded (See Section 4.5.2 of **Appendix 13.5**).

13.8.2.19 Mangroves and intertidal mudflats were recorded in Tai Ho Wan, Tung Chung Bay, San Tau, Yan O and Sham Wat Wan. The species richnesses of intertidal species associated with these sites are high (See Section 4.4 of **Appendix 13.5**). The species diversities are generally moderate, except for Sham Wat Wan with a relatively lower diversity for the mangrove habitat but moderate diversity at the sandy shore. The ecological value considered as moderate to high.

13.8.2.20 The estuarine macroinvertebrates recorded along the Sorth Lantau estuarine region are generally of moderate diversity for Tai Ho, Tung Chung, Sha Lo Wan, Hau Hok Wan and Sham Wat (H'= 2.14 – 2.92) and moderate-low for San Tau (H' = 1.14 – 1.96). The estuarine fish species recorded are of similar diversity trend, i.e. moderate diversity for the former 5 estuarine habitats (H'= 1.96 – 2.83) and moderate-low for San Tau (H'= 1.65 – 1.84). The dominant species recorded in dry season was *Chelon* sp. (784 individuals) while that recored in wet season was *Mugil cephalus* (514 individuals). Among the 59 species recorded, five are of conservation importance including Red Stingray *Dasyatis akajei* recorded in Tai Ho, Sha Lo Wan and Sham Wat; Spotted Seashorse *Hippocampus kuda* recorded at Tai Ho; Seaweed

Pipefish *Syngnathus schlegeli* recorded in Tung Chung Bay, Tai Ho, Sha Lo Wan, Hau Hok Wan and Sham Wat; *Hemigobius hoevenii* recorded in Tai Ho; and *Takifugu ocellatus* recorded in Sha Lo Wan, Sham Wat and Hau Hok Wan (**Drawing No. MCL/P132/EIA/13-014 to Drawing No. MCL/P132/EIA/13-020**). Other estuarine fauna and fish species of conservation importance recorded within the study area by other studies that may have potential impact by this project including an endemic Sesarmine crab *Chiromantes sereni* recorded in Hau Hok Wan and Sha Lo Wan; Largesnout goby *Awaous melanocephal* in Tung Chung Bay; and Dark-margined flagtail *Kuhlia marginata* recorded in San Tau (**Drawing No. MCL/P132/EIA/13-002 to Drawing No. MCL/P132/EIA/13-007**).

13.8.2.21 The increase in suspended solids in the water column will also cause indirect impact to the coral communities recorded along the northeastern shore of airport island, the natural rocky shores in the northern Lantau coast, the SCLKCMP and at the Brothers. Reef building corals depend on zooxanthellae for growth and sun light penetration to water column for photosynthesis, thus the increase in sedimentation rate and suspended solids will lead to change in water turbidity, reduce growth success of hard corals or even mortality. According to Hawker and Connell (1992), a sedimentation rate higher than 200 $g/m^2/day$ would introduce moderate to severe impact upon all corals. Non-reef building corals (or ahermatypic cup corals) will also be affected by the change in water quality and hydrology that caused by the construction of seawall and land formation works. The artificial reefs deployed in SCLKCMP may also be affected by the sediment laden that inhabited the colonization of corals and invertebrates, thus the subsequent function of marine resources enhancement to the area could not be achieved.

13.8.2.22 Gorgonian and hard corals were recorded mainly at the SCLKCMP, planned BMP, Tai Ho Wan, Tung Chung, Tai O and Sham Wat. The species diversity for all the sites is low with low coverage, except for SCLKCMP with moderate-low coverage. Coral species of conservation importance that may potentially receive indirect impact including *Balanophyllia* sp. and *Paracyathus rotundatus,* recorded along the northern Lantau coast from the west of Sham Wat to east of San Shek Wan, east of Chek Lap Kok, Tai Mo To, outside Tai Ho Wan and SCLKCMP (**Table 13-21**). The coverage is considered to be low. *Balanophyllia* sp. was also recorded in very low coverage (<1%) at the northeastern shore of the airport island outside the land formation footprint (**Appendix 13-5**).

13.8.2.23 Another site of conservation importance recorded within the study area is the potential Southwest Lantau Marine Park. According to **Section 13.4.3.19** above, this site supports a diverse community of intertidal and sub-tidal fauna, including soft corals and patches of encrusting faviid corals.

13.8.2.24 As described in **Section 3.6**, non-dredge methods will be adopted for land formation which will substantially reduce the environmental impacts compared with the conventional dredging method, thereby minimising the potential water quality impacts associated with land formation from the outset. Nevertheless, the sand blanket provision, seawall construction, marine filling works, the water jetting activities and the field joint excavation associated with the submarine cable diversion will also directly disturb the seabed. These activities may generate suspended sediment that can adversely impact marine water quality.

13.8.2.25 According to the water quality modelling for the Year 2016 unmitigated scenario, sediment plumes arising from the project appear to generally reside at or near the release points, with very limited spreading to nearby areas. The results indicated that both the sedimentation rate and maximum SS elevations at the northern Lantau coast where seagrass bed, horseshoe crab, mangroves and mudflat are present at (E11) Tai Ho Bay, (E2) San Tau Beach SSSI, (E6) Hau Hok Wan, (E7) Sha Lo Wan and (E8) Sham Wat Wan are insignificant (not detectable). For the Year 2017 unmitigated scenario, the same observation of no detectable increase in sedimentation rate and maximum SS elevations occurred along the northern Lantau coast.

13.8.2.26 The water quality modelling result for the Scenario 2016 (unmitigated) showed that the predicted maximum level of elevation in suspended sediment at coral communities recorded at the Brothers (CR3) may cause 1.41 mg/L exceedance at bottom depth level during wet season. The frequency of exceedance is about 0.1%, which is considered as very small. No exceedance of the principle depth-averaged criterion is observed for both wet and dry season. For Scenario 2017, no SS exceedance is predicted at bottom and depth average levels. The maximum SS elevation levels at SCLKCMP Artificial Reefs (CR2) are within the assessment criterion of SS levels under the WQO (i.e. <30% of ambient baseline conditions) at all depth levels in both wet and dry seasons. The highest sedimentation rate estimated at the Brothers (CR3) and SCLKCMP (CR2) are 11.21 g/m^2/day and 10.76 g/m^2/day respectively, which are both below 200 g/m^2/day specified that may cause moderate to high impact on corals (Hawker and Connell, 1992). The maximum SS elevations at (E3) potential marine park for Southwest Lantau is estimated to be up to 0.44 mg/L, with sedimentation rate not detectable.

13.8.2.27 The impact significance of indirect disturbance on sites of conservation importance including SCLKCMP, planned Brothers Marine Park, the potential South Lantau Marine Park and San Tau Beach SSSI due to the increase in suspended solids on the intertidal and sub-tidal habitats and associated organisms is anticipated to be of insignificant to low impact. This is due to the refinement of the sediment plume with insignificant exceedance of the assessment criterion, the short duration and the potential of habitat re-habilitation for the recruitment of similar intertidal and sub-tidal species to the coastal habitats. The indirect disturbance on ahermatypic cup corals recorded at the northeastern shore of airport island is considered as low - moderate, precautionary coral dive survey at pre-construction phase is proposed to review the status of the corals and the feasibility for translocation.

Dissolved Oxygen Depletion

13.8.2.28 Dissolved oxygen (DO) depletion due to the release of sediment from the water jetting and excavation activities associated with the submarine cable diversion was calculated in Chapter 8 Water Quality and summarised in **Table 8.65**.

13.8.2.29 The predicted maximum DO depletion levels due to elevated SS release at the intertidal and subtidal habitats along the North Lantau coast (E11) Tai Ho Bay, (E2) San Tau Beach SSSI, (E6) Hau Hok Wan, (E7) Sha Lo Wan, (E8) Sham Wat Wan are 4.40E-03 mg/L, 8.32E-03 mg/L, 6.30E-03 mg/L, 3.95E-02 mg/L and 8.20E-03 mg/L respectively. These are considered insignificant. The predicted lowest depth averaged DO levels at the above sites are 5.8 mg/L, 6.1 mg/L, 6.1 mg/L, 6.1 mg/L and 6.3 mg/L respectively. These are all above the DO criterion of >4 mg/L at depth averaged.

13.8.2.30 The predicted maximum DO depletion levels due to elevated SS release at the sites of conservation importance: (CR2) artificial reef at SCLKCMP, (CR3) hard corals at the planned Brothers Marine Park, (E3) the potential South Lantau Marine Park and (E2) San Tau Beach SSSI are 9.79E-03, 5.64E-03, 9.46E-04 and 8.32E-03 respectively. These are considered insignificant. The predicted lowest depth averaged DO level due to elevated SS release at the above sites are 6.1 mg/L, 5.3 mg/L, 6.3 mg/L and 6.1 mg/L respectively. These are also well above the DO criterion of >4 mg/L at depth averaged.

13.8.2.31 Therefore, the impact significance of potential reduction of dissolved oxygen level at sites of conservation importance due to the increase in suspended solids on the intertidal and sub-tidal habitats and associated organisms is anticipated to be insignificant.

Nutrients and Other Contaminants

13.8.2.32 To assess the potential release of nutrients and other contaminants during water jetting and excavation activities associated with the submarine cable diversion, elutriate tests were conducted for sediment samples collected along the new cable alignment and at the field joint location. The criteria taken for metals and non-nutrients are from **Table 8.27**, which are based on relevant overseas water quality criteria on environmental quality standards for shellfish waters, criterion maximum concentration (CMC) and criterion continuous concentration (CCC). The CMC and CCC are estimates of the highest concentration of a material in ambient water to which an aquatic community can be exposed briefly (for CMC) or indefinitely (for CCC) without resulting in an unacceptable adverse effect. For nutrients, the 90th percentile values from baseline monitoring results of EPD's marine water quality monitoring stations in the North Western WCZ were adopted, which indicated 90% of the time, the concentrations are below these levels. Detailed findings at individual sensitive receivers are presented in **Section 8.7.1** and **Tables 8.67 and 8.68**. The modelling results show that concentrations of all contaminants at the (CR3) hard corals at the Brothers, (CR2) artificial reefs and hard corals at the SCLKCMP and representative coral sites recorded along North Lantau coast at (E8) Sham Wat and (E11) Tai Ho Bay are below the relevant criteria or baseline. It is thus anticipated that there will be no unacceptable adverse water quality impact on marine fauna due to the potential release of nutrients and other contaminants during water jetting and excavation activities associated with the submarine cable diversion.

Release of Contaminants from Pore Water during DCM Process and Surcharge

13.8.2.33 Pore water is defined as the water occupying the spaces between sediment particles. Contaminants in the pore water and in the solid phase are expected to be at thermodynamic equilibrium. The testing of pore waters release is useful for assessing contaminant levels and associated toxicity. The ground improvement process may release pore water with contaminants, especially at the contaminated mud pit area, during the Deep Cement Mixing (DCM) process and surcharge. The potential contaminants release from the above process may cause carcinogenic or acute impacts on marine fauna.

13.8.2.34 The criteria considered for evaluating the impact significance for metals and non-nutrients contaminants are from **Table 8.27**, which are based on relevant overseas water quality criteria on environmental quality standards for shellfish waters, criterion maximum concentration (CMC)

and criterion continuous concentration (CCC). The CMC and CCC are estimates of the highest concentration of a material in ambient water to which an aquatic community can be exposed briefly (for CMC) or indefinitely (for CCC) without resulting in an unacceptable adverse effect. For nutrients, the 90th percentile values from baseline monitoring results of EPD's marine water quality monitoring stations in the North Western WCZ were adopted, which indicated 90% of the time, the concentrations are below these levels.

13.8.2.35 The findings from the tracer dilution model show that even with the assumption of 100% release of pore water during the DCM process, the concentrations of all contaminants observed at the (CR3) hard corals at the Brothers, (CR2) artificial reefs and hard corals at the SCLKCMP and representative coral sites recorded along North Lantau coast at (E8) Sham Wat and (E11) Tai Ho Bay would still well below the relevant criteria derived from overseas guidelines or baseline. It is thus anticipated that there will be no unacceptable adverse water quality impact on marine fauna due to pore water release from the CMPs during ground improvement.

13.8.2.36 Potential release of contaminants from pore water during the surcharge process was estimated according to the approximate volume of pore water that would be extruded. Details of the calculations were presented in **Section 8.6.5** of **Chapter 8**. The findings summarised that the dilution potential at the seawall will bring all contaminant concentrations from the pore water results well below existing baseline or criteria limits, and contributions to the existing baseline / criteria limits would be less than 1 %. Based on the above considerations, it is considered that the rate of pore water release during surcharge is insignificant compared to the typical flow speeds that can be expected in the vicinity of the land formation. Consequently, any contaminant release from the seawall will be rapidly diluted at source to below criteria limit / baseline levels, and the potential for background build-up of contaminants would similarly be insignificant. Therefore, no unacceptable adverse water quality impact and subsequent impact on marine fauna during the surcharge process is anticipated.

Indirect Disturbance to Open Waters Marine Fauna

Suspended Solids

13.8.2.37 The increase in suspended solids in the water column may clog the gills of the fishes and cause suffocation in extreme cases. The water quality modeling results showed that the predicted maximum level of suspended solids (SS) elevation at planned BMP (CR3) may cause 1.41 mg/L exceedance at bottom depth level during wet season, although there is no exceedance of the principle depth-averaged criterion during both wet and dry season, and frequency of exceedance is very small (0.1% of the time only). The maximum SS elevation predicted at another sensitive receiver (E4) did not exceed the SS criterion.

13.8.2.38 At SCLKCMP, SS is predicted to increase at M4d (maximum level: 39.48 mg/L), M4e (maximum level: 27.53 mg/L), E5 (maximum level: 2.43 mg/L), CR2 (maximum level: 4.22 mg/L). For the former two, the predicted SS elevation at M4d is 3.64 – 32.49 mg/L higher than the surface, mid-depth, bottom and depth-averaged criteria used for WQO at station NM6 (**Table 8.21**) during 2016 wet season and 2017 dry season, all of which are of low frequency (0.1 – 3.9%). Similarly results were observed for M4e, for which the worse-case SS elevation is 0.10 – 20.54 mg/L higher than the criteria used for WQO at station NM6, all of which are of low frequency

(0.1 – 0.5%) also. It should be noted that M4d and M4e are only considered as observation points and not representative water sensitive receivers, and hence are not assessed in **Table 8.48** and **Table 8.49**. As other monitoring stations within the SCLKCMP (e.g. E5 and CR2) do not show particularly high elevations or exceedances in SS criteria, the relatively higher SS levels at M4d and M4e are probably limited to a small area at the southern boundary which is closest to the construction activities of the project. Given that the other monitoring stations in SCLKCMP are not affected, the marine fauna found within would not be significantly affected by the localised elevations predicted at these locations.

13.8.2.39 At northern Chek Lap Kok water (F2), the predicted maximum level of suspended solids (SS) elevation may cause 4.32 mg/L exceedance at mid-depth level during 2016 wet season at only 0.1% of the time, For western Chek Lap Kok (M3), no exceedance of the SS criteria will occur.

13.8.2.40 From the Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment, based on the international marine water quality guidelines for the protection of ecosystems, the SS elevations are also below 50 mg/L for protection of marine fishes (which was derived from half of the "no observable effect concentrations") (CCPC, 2001). Therefore, the indirect disturbance to marine fauna / marine fishes of conservation importance at open waters habitat is considered to be low. In addition, It has been demonstrated that exposure to SS at 50 mg/L for 6 weeks did not affect the feed intake or growth in *Epinephelus coioides* (Au et al., 2004).

Dissolved Oxygen Depletion

13.8.2.41 Dissolved Oxygen Depletion means the reduction of dissolved oxygen in marine environment, which could cause detrimental effect to marine level if the depletion level is high. The change of depth average dissolved oxygen (DO) due to the release of sediment was calculated and presented in **Table 8.65** of **Section 8.7.1.** From the results of water quality modeling, The maximum depthed averaged dissolved oxygen (DO) depletion in SCLKCMP (M4c, M4d and M4e), BMP (CR3 and E4), western Chek Lap Kok water (M3) and northern Chek Lap Kok water (F2) are 3.19E-02 mg/L, 6.02E-03 mg/L, 3.11E-02 mg/L and 7.03E-03 mg/L respectively, which are insignificant. The minimum DO level in SCLKCMP, BMP, western Chek Lap Kok water and northern Chek Lap Kok water are 6.1 mg/L, 5.3 mg/L, 6.1 mg/L and 5.3 mg/L respectively, which are all within the DO criterion of >4 mg/l. Therefore, no appreciable changes in the baseline depth-average DO concentration would be anticipated due to elevated SS arising from the water jetting and excavation works.

13.8.2.42 For the change of bottom layer DO, the results were presented in **Table 8.66** of **Section 8.7.1**. For bottom layer dissolved oxygen (DO) depletion, the maximum depletion in SCLKCMP, BMP, western Chek Lap Kok water and northern Chek Lap Kok water are 2.33E-02, 9.65E-03, 3.31E-02 and 1.3E-02 respectively, which are also insignificant. The minimum DO level in SCLKCMP, BMP, western Chek Lap Kok water and northern Chek Lap Kok water are 5.5 mg/L, 5.2 mg/L, 5.7 mg/L and 4.6 mg/L respectively, which are all within the DO criterion of >2 mg/l. Therefore, no appreciable changes in the baseline bottom layer DO concentration would be anticipated due to elevated SS arising from the water jetting and excavation works.

Nutrients and Other Contaminants

13.8.2.43 The release of excess nutrients such as nitrogen and phosphorus causes eutrophication which contributes to several harmful effects to the marine environment. The release of other contaminant such as metals and non-nutrient can threaten marine life once the concentration attains a high level. To assess the potential release of nutrients and other contaminants during water jetting and excavation activities associated with the submarine cable diversion, elutriate tests were conducted for sediment samples collected along the new cable alignment and at the field joint location. The criteria taken for metals and non-nutrient contaminant are from **Table 8.27**, which are based on relevant overseas water quality criteria on environmental quality standards for shellfish waters, criterion maximum concentration (CMC) and criterion continuous concentration (CCC). The CMC and CCC are estimates of the highest concentration of a material in ambient water to which an aquatic community can be exposed briefly (for CMC) or indefinitely (for CCC) without resulting in an unacceptable adverse effect. For nutrients, the 90th percentile values from baseline monitoring results of EPD's marine water quality monitoring stations in the North Western WCZ were adopted, which indicated 90% of the time, the concentrations are below these levels. Detailed findings at individual sensitive receivers are presented in **Table 8.67** and **Table 8.68** in **Section 8.7.1**. The modelling results show that concentrations of all contaminants at SCLKCMP (M4c, M4d and M4e), BMP (CR3 abd E4), western Chek Lap Kok water (M3) and northern Chek Lap Kok water are below the relavent criteria or baseline.

Release of Contaminants from Pore Water during DCM Process and Surcharge

13.8.2.44 Pore water is defined as the water occupying the spaces between sediment particles. Contaminants in the pore water and in the solid phase are expected to be at thermodynamic equilibrium. The testing of pore waters release is useful for assessing contaminant levels and associated toxicity. The ground improvement process may release pore water with contaminants, especially at the contaminated mud pit area, during the Deep Cement Mixing (DCM) process and surcharge. The potential contaminants release from the above process may cause carcinogenic or acute impacts on marine fauna.

13.8.2.45 The criteria considered for evaluating the impact significance for metals and nutrients contaminants are from **Table 8.27**, which are based on relevant overseas water quality criteria on environmental quality standards for shellfish waters, criterion maximum concentration (CMC) and criterion continuous concentration (CCC). The CMC and CCC are estimates of the highest concentration of a material in ambient water to which an aquatic community can be exposed briefly (for CMC) or indefinitely (for CCC) without resulting in an unacceptable adverse effect. For nutrients, the 90th percentile values from baseline monitoring results of EPD's marine water quality monitoring stations in the North Western WCZ were adopted, which indicated 90% of the time, the concentrations are below these levels.

13.8.2.46 The findings from the tracer dilution model (**Table 8.69** in **Section 8.7.1**) show that even with the assumption of 100% release of pore water during the DCM process, the concentrations of all contaminants observed at the ecological sensitive receivers would still well below the relevant criteria derived from overseas guidelines or baseline. It is thus anticipated that there will be no unacceptable adverse water quality impact on marine fauna due to pore water release from the CMPs during ground improvement.

13.8.2.47 Potential release of contaminants from pore water during the surcharge process was estimated according to the approximate volume of pore water that would be extruded. Details of the calculations were presented in **Section 8.6.5** of **Chapter 8**. The findings summarised that the dilution potential at the seawall will bring all contaminant concentrations from the pore water results well below existing baseline or criteria limits, and contributions to the existing baseline / criteria limits would be less than 1 %. Based on the above considerations, it is considered that the rate of pore water release during surcharge is insignificant compared to the typical flow speeds that can be expected in the vicinity of the land formation. Consequently, any contaminant release from the seawall will be rapidly diluted at source to below criteria limit / baseline levels, and the potential for background build-up of contaminants would similarly be insignificant. Therefore, no unacceptable adverse water quality impact and subsequent impact on marine fauna during the surcharge process is anticipated.

Oil/ Chemical Spillage

13.8.2.48 Spillage of oil and chemicals from construction vessels accidents or leakage of petroleum from construction plants, such as offshore platforms and drilling rigs, could release liquid petroleum hydrocarbon into the marine environment and cause pollution. Oil spills may cause short term and long term impact on corals or marine fishes and also coastal habitats. It may cause large-scale death of fish by poisoning or bioaccumation of toxic materials in the internal organ of the fish and build up along the food chain that may cause indirect interference with breeding process. The impacts may also include affecting the photosynthesis process of corals by blockage of sunlight and cause clog up of fish gills and suffocate to die. The risk of oil / chemical spillage will increase with marine traffic. However, as the construction vessels will be travelled at slow speed, and will mostly routed to travel from west and south around Lung Kwu Chau instead of through Urmston Road, the risk of vessel collision and cause oil / chemical spillage will be lowered. Therefore, the impact oil and chemical spillage is anticipated to be insignificant.

Importation and Transportation of Marine Fill and Filling Activities

13.8.2.49 According to **Appendix 13.13**, the existing and projected marine traffic activities during construction and operation phases, the importation and transportation of marine fill will be principally come from the west of the airport to minimise the impact on existing marine traffic (Figure 4 and Figure 5 of **Appendix 13.13**). There may be a potential of fill materials runoff to the marine waters during transportation and cause indirect impact along the transportation routes and adjacent waters. However, as part of the general good housekeeping, the barges or hoppers shall not be filled to a level which will cause overflow of materials or pollution of water during loading or transportation. Plants should not be operated with leaking pipes and adequate freeboard shall be maintained on barges to reduce the likelihood of decks being washed by wave action. All vessels shall also be sized with adequate clearance maintained between vessels and the seabed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash. With the implementation of this good site practices, the potential impact of fill materials runoff due to importation and transportation of marine fill on corals and marine fishes is considered be low.

Piling Activities for Construction of New Runway Approach Lights

13.8.2.50 Marine piling activities would only be required for the construction of new runway approach lights, lighted marks and beacons. No other marine piling works are required for land formation and seawall construction. At the two ends of the new runway, approach lights are required. The approach light structures will consist of rows of sequence flashing lights (approximately 11 nos.) supported by piers extending approx. 300 m offshore along the centerline from the runway threshold (**Drawing No. MCL/P132/EIA/8-010**). At the western end of the runway, the approach lights will be constructed using pre-bored H piles. The piles will be bored to a depth of approx. 50-60 m below seabed level, and approx. 12 m^3 of spoil will be excavated for each pile. The bored piling areas are very small, total of approximately 108 m^2 for the 11 approach lights. Other bored piling activities will include the construction of approximately 3.1 m^2 of 9 lighted marks/ beacons for the proposed third runway (**Drawing No. MCL/P132/EIA/8-011**). The duration of piling activities for complete set of approach lights, lighted marks and beacons is anticipated to be completed in several weeks. Based on these considerations, the anticipated SS release from construction of the approach lights, lighted marks and beacons are anticipated to be very small. Silt curtains will be deployed to completely enclose the pile installation works. By adopting this preventive measure, the impacts of the marine pile installation works on water quality and associated impact on marine fauna are expected to be low.

13.8.2.51 The piling activities for the construction of new runway approach lights will cause underwater noise disturbance to the marine fishes. The mobile fauna will swim away from the works area and cause temporary loss of habitat. It is anticipated that the future approach lights, lighted marks and beacons structures will provide hard substrates for the recolonisation of intertidal and sub-tidal fauna and may benefit to other fish fauna. In view of the short duration of piling activities, the small area to be affected, the available of suitable habitats in adjacent waters for the marine fishes, the temporary disturbance impact on marine fauna is considered of low significance.

13.8.3 Operational Phase – Direct Impacts

Permanent Loss of Habitat due to Airport Expansion

13.8.3.1 As discussed in **Sections 13.8.1** and **13.8.2** under construction phase impacts, the newly formed land footprint for the airport expansion, the seawall extension, the approach lights, lighted markers and beacons construction will cause total permanent loss of approximately 672 ha (the loss due to construction of approach lights, lighted markers and beacons is only 0.011 ha, which is negligible) of sea bed and its water column during the operation phase and the marine fishes will be displaced to adjacent marine waters permanently. There will be a permanent loss of approximately 5.9 km artificial seawall upon completion of land formation. The extension of seawall to approximate 13 km of design similar to the existing setting, with suitable locations enhanced with eco-friendly design to facilitate recolonization of intertidal and sub-tidal flora and fauna would also benefit to the marine fishes. **Table 13-24** summarises the areas of marine habitat loss upon completion of construction of marine works.

Table 13-24: Summary of Areas of Marine Habitat Loss upon Completion of Marine Construction Works

Proposed Construction Works	Approximate Size of Marine Habitat Affected	Nature of Impact
Land formation and seawall(1)	672 ha marine habitat	Permanent loss upon

Proposed Construction Works	Approximate Size of Marine Habitat Affected	Nature of Impact
	(650 ha land formation + 22 ha seawall – 10 ha existing seawall to be demolished + 10 ha scour apron)	completion of marine filling works by late 2021
Approach lights	108 m^2 marine habitat ($4.9\ m^2 \times 11 \times 2$)	Permanent loss upon completion of construction works by 2021
Lighted marks and beacons	3.1 m^2 marine habitat ($0.34\ m^2 \times 9 = 3.1\ m^2$)	Permanent loss upon completion of construction works by 2021

Note (1): Proposed land formation footprint: 650 ha. The net seawall toe construction is 12 ha (22 ha proposed seawall toe minus 10 ha of the existing seawall toe). Approximate 10 ha scour apron of varying widths (subject to detailed design) will be constructed beyond the seawall toe for scour protection. Therefore, the total open water to be lost is 650 ha, but seabed habitat to be lost would be 672 ha.

13.8.3.2 The direct loss of the 5.9 km artificial seawall will affect common and widespread species of intertidal fauna of moderate-low diversity and abundance that is comparable to other reference sites at Tai Ho and Tung Chung. The sub-tidal habitat to be affected permanently is of very low coverage of gorgonian species. Therefore, the loss of the northern Chek Lap Kok artificial seawall of low ecological value is considered of low to moderate impact upon completion of land formation works. During operation phase, there will be an extension of artificial seawall of length approximately 13 km with substrates similar to the existing seawall to be affected. This will promote the recolonisation of intertidal and sub-tidal communities including gorgonian as recorded along the existing seawall. As this extended seawall will be established within the future extension of HKIAAA, which is restricted to vessel entry, this will provide a limited disturbance environment for the establishment of intertidal and sub-tidal communities. Therefore, the impact significance would be further reduced along with time and mitigation measures are considered not required.

13.8.3.3 The impact on the permanent loss of 672 ha of sub-tidal soft bottom habitats, with common polychaetes and crustacean as dominant species, species diversity ranged from moderate to high, is considered of moderate impact significance upon completion of construction.

13.8.3.4 The marine fish species of conservation importance recorded within the footprint included Longheaded eagle ray, Pale-edged stingray, Goatee croaker, Longtooth grouper, Orange-spotted grouper, and Tiger-toothed croaker (**Drawing No. MCL/P132/EIA/13-027** and **Table 13-21**). Except the one Longheaded eagle ray just recorded within the footprint at a relatively low density of 0.17 individuals per transect, all others species of conservation importance were also recorded in the northern Chek Lap Kok, the Brothers, SCLKCMP and western Chek Lap Kok waters with no significant different in species richness and total abundance. Although the marine fishes could inhabit in adjacent marine waters, in view of the large area of the marine waters to be permanently lost and the irreversible nature, the impact on the loss of marine water of moderate to moderate-high ecological value is considered to be of moderate significance and mitigation measures are considered required.

<u>Diversion of submarine pipelines by horizontal directional drilling involving a landing point</u>

13.8.3.5 As mentioned in the construction phase impact, the daylighting locations and pipeline connection to the existing offshore receiving platform at Sha Chau will cause direct loss of approximate 100 m^2 rocky shore habitat. The sub-tidal habitat that potentially be affected is restricted to the daylighting location with *Balanophyllia* sp. recorded at less than < 5% coverage. In view of the small area to be affected and the species composition is similar to those recorded in other northern and western Lantau coasts, and the low species abundance, it is considered the direct loss of rocky shore is of low significance.

Construction of approach light and marker beacons

13.8.3.6 From the construction of approach light and marker beacons, about 0.011 ha of marine water with moderate quality and 0.011 ha of subtidal soft bottom habitat with moderate-low quality would be lost. As the area to be affected is negligible, and the approach light and marker beacons would provide hard substrates for the marine fauna to recolonize, the impact significance is considered as insignificant.

Loss of Carrying Capacity

Marine Fauna

13.8.3.7 As discussed in **Section 13.8.1.22** construction phase impact, the carrying capacity of the project footprint is not significant in the context of marine ecosystem in Hong Kong. The loss of carrying capacity due to permanent and irreversible habitat loss is considered of low significance.

Habitat Fragmentation

Marine Fauna

13.8.3.8 As discussed in **Sections 13.8.1.23** to **13.8.1.24** construction phase impact, due to the high mobility, diverse habitat range for the fish species of conservation importance recorded within the project footprint and the connection of proposed footprint within the existing airport island that cause habitat fragmentation not likely to occur for marine fishes. Therefore the direct impact of habitat fragmentation towards marine fauna during the operational phase is considered of low significance.

13.8.4 Operational Phase – Indirect Impacts

Change in Hydrodynamics due to Airport Expansion

13.8.4.1 The seawall construction as part of land formation works is scheduled to complete by late 2021, but majority of the marine filling activities would be completed by late 2018. The new land formation will potentially change the hydrodynamics of the local region and indirectly affect the coastal ecology including the Pearl River Estuary.

13.8.4.2 Tidal flow simulations for the Year 2026 has been undertaken to identify the changes resulting from operation of the project versus the base scenario in the absence of the project with details

provided in **Section 8.7.2**. A comparison between the two scenarios provides an indication of how the project will affect the future marine environment, taking into account the operation of concurrent projects.

13.8.4.3 Based on the hydrodynamic model findings, the changes in tidal discharges, including both increases and decreases, are relatively small after implementation of the project as compared to the base scenario.

13.8.4.4 To the west of the airport island with flow across Sha Chau, the findings suggested that the project generally induces a small increase in peak discharges and a tendency towards residual flows in the ebb direction (or a reduction in the residual flows in the flood direction), but compared to the high flow volumes experienced across this area, these changes in peak and residual discharge are unlikely to significantly affect the existing flow regime across this area.

13.8.4.5 Tidal discharges across other major channels in the North Lantau area (i.e. Urmston Road, Kap Shui Mun, Ma Wan Channel and Rambler Channel) show similarly limited changes in peak flood and ebb flow, though there is a similar small tendency towards increasing residual flows in the ebb direction or a reduction in the residual flows in the flood direction. Actual residual flow differences between the base scenario and the project scenario are similar for both wet and dry season. These residual flow changes are nevertheless unlikely to be significant when considered in the context of the much larger tidal flow regime occurring across these sections.

13.8.4.6 More significant changes are identified for the flow through the east of airport channel. In dry season, the peak flood, ebb flow and residual flow through the east of airport channel are shown to reduce by 20.3 % and 8.9 % respectively with an fairly large reduction of 55.0 % in residual flow (from 29 m^3/s to 13 m^3/s); while in wet season, the peak flood and ebb flow decrease by 40.3 % and 8.5 % respectively with an increase in the residual ebb flow by 11.7 %. The high percentage difference in residual flows during dry season is largely due to the very low residual flow volumes that occur in this area and does not represent significant changes in the residual flow (in absolute terms), however, the general reductions in peak flow in both directions during both wet and dry season may indicate a tendency towards reduced flushing and assimilative capacity of the water body.

13.8.4.7 For assessment of local effects due to the project, the results of flow velocities at individual ecological sites of conservation importance ((E4/CR3) planned Brothers Marine Park, (E2) San Tau Beach SSSI, (CR2/E5/M4c/M4d/M4e) SCLKCMP and (E3) potential southwest Lantau Marine Park) show generally minimal changes in flow velocities at most sites of conservation importance (<0.1 m/s), which suggests that the project would not induce significant changes to the hydrodynamic regime in the above ecological sites of conservation importance) (**Table 1** in **Appendix 8.14**). Other areas showing more significant changes in peak velocity (e.g. >0.2 m/s) are generally areas immediately surrounding the project (e.g. the area immediately north and east of the airport, the embayed areas to the west of the airport).

13.8.4.8 At the area immediately west of the existing airport island, the velocity plots show that the new third runway land formation generally creates an area of reduced flows (covering the southern part of the new third runway's west tip), which becomes more 'sheltered' from the dominant Pearl River Delta tidal regime. As a result of the reduced flows, some sedimentation is expected

in this area, but there does not appear to be significant deteriorations in water quality in this area (based on the water quality results).

13.8.4.9 To the immediate north of the project, reductions in peak velocity are also predicted with implementation of the project. The effect is more pronounced during the wet season, when flow velocities in the North Lantau area are generally faster due to the additional freshwater flows from the Pearl River Delta estuaries. With the project in place, reductions in flow velocity to the north of the project would be expected, though these reductions are not anticipated to lead to water quality issues as the peak flow velocity remains relatively high despite the reductions associated with the project.

13.8.4.10 In San Tau SSSI (E2), the temperature results in **Appendix 8.15 (Table 1)** show a maximum of 0.2 degree celsius difference, which is insignificant compared to annual range. Salinity results in **Appendix 8.15 (Table 2)** show at most 3% (0.3 psu) difference, which is insignificant compared with annual range of 11.6 – 29.7 psu in base case. Dissolved oxygen results in **Appendix 8.15 (Table 3-a)** show at most 0.4 mg/L difference compared with base case, which is insignificant when compared to the annual range of approx. 1.8 mg/L. The biological oxygen demand results in **Appendix 8.15 (Table 4)** show at most 0.4 mg/L difference, which is insignificant to annual range of approx. 1.9 mg/L. Suspended solid results in **Appendix 8.15 (Table 5)** show at most 6% (1 mg/L) difference compared to base case, which is insignificant compared with the annual range (9.5 to 19.2 mg/L) in base case. The total inorganic nitrogen results in **Appendix 8.15 (Table 6)** show at most 0.05 mg/L difference compared with base case, which is insignificant when compared to the annual range of 0.23 mg/L in base case. Unionised ammonia results in **Appendix 8.15 (Table 7)** show at most 0.001 mg/L difference compared to base case, which is insignificant when compared to the annual range of approx. 0.003. The *E.coli* results in **Appendix 8.15 (Table 8)** show no change from base case.

13.8.4.11 In SCLKCMP (CR2/E5/M4c/M4d/M4e), temperature results in **Appendix 8.15 (Table 1)** show a maximum 0.1 degree celsius difference, which is insignificant compared to annual range. Salinity results in **Appendix 8.15 (Table 2)** show at most 7% (0.7 psu) difference, which is insignificant compared with annual range of 18 psu in base case. Dissolved oxygen results in **Appendix 8.15 (Table 3-a)** show at most 0.3 mg/L difference compared with baseline case, which is insignificant when compared to the annual range of approx. 2.2 mg/L. The biological oxygen demand results in **Appendix 8.15 (Table 4)** show at most 0.1 mg/L difference, which is insignificant to annual range of approx. 1.1 mg/L. Suspended solid results in **Appendix 8.15 (Table 5)** show at most 9% (approx. 1 mg/L) difference compared to base case, which is insignificant compared with the annual range of approx. 5.5 mg/L in base case. The total inorganic nitrogen results in **Appendix 8.15 (Table 6)** show at most 0.08 mg/L difference compared with base case, which is insignificant when compared to the annual range of approx. 0.38 mg/L in base case. Unionised ammonia results in **Appendix 8.15 (Table 7)** show at most 0.001 mg/L difference compared to base case, which is insignificant when compared to the annual range of approx. 0.006. The *E.coli* results in **Appendix 8.15 (Table 8)** show no change from base case.

13.8.4.12 In the planned Brothers Marine Park (E4/CR3), temperature results in **Appendix 8.15 (Table 1)** show no difference. Salinity results in **Appendix 8.15 (Table 2)** show at most 2% (0.3 psu) difference, which is insignificant compared with annual range of (12 – 30 psu in base case).

Dissolved oxygen results in **Appendix 8.15 (Table 3-a)** show at most 0.1 mg/L difference compared with baseline case, which is insignificant when compared to the annual range of approx. 2 mg/L. The biological oxygen demand results in **Appendix 8.15 (Table 4)** show no difference. Suspended solid results in **Appendix 8.15 (Table 5)** show at most 1% (0.1 mg/L) difference compared to base case, which is insignificant compared with the annual range of 4.3 mg/L in base case. The total inorganic nitrogen results in **Appendix 8.15 (Table 6)** show at most 0.01 mg/L difference compared with base case, which is insignificant when compared to the annual range of approx. 0.39 mg/L in base case. Unionised ammonia results in **Appendix 8.15 (Table 7)** show no difference. The *E.coli* results in **Appendix 8.15 (Table 8)** show no change from base case.

13.8.4.13 In the potential SWLMP (E3), temperature results in **Appendix 8.15 (Table 1)** show no change from base case. Salinity results in **Appendix 8.15 (Table 2)** show at most 1% (0.3 psu) difference, which is insignificant compared with annual range of 18.5 – 32.9 psu in base case. Dissolved oxygen results in **Appendix 8.15 (Table 3-a)** show no change compared with baseline case. The biological oxygen demand results in **Appendix 8.15 (Table 4)** show no change. Suspended solid results in **Appendix 8.15 (Table 5)** show at most 2% (0.1 mg/L) difference compared to base case, which is insignificant compared with the annual range (4.4 to 11.1 mg/L) in base case. The total inorganic nitrogen results in **Appendix 8.15 (Table 6)** show no difference compared with base case. Unionised ammonia results in **Appendix 8.15 (Table 7)** show no difference compared to base case. The *E.coli* results in **Appendix 8.15 (Table 8)** show no change from base case.

13.8.4.14 The predicted changes in water quality due to the changes in hydrodynamics at ecological sites of conservation importance show that overall (including temperature, salinity, dissolved oxygen, BOD_5, suspendied solids, dissolved inorganic nitrogen, unionised ammonia and *E.coli*), implementation of the project will not results in significant changes to the water quality of the study area, and thus insignificant water quality impacts are predicted as a result of implementation of the project.

Indirect Disturbance due to Deterioration of Water Quality

Storm Water Runoff

13.8.4.15 There may be potentially polluted storm water runoff from the expanded airport operation to the adjacent marine waters. Contaminants may include hydrocarbons, chemicals and SS runoff. The amount of these pollutants entering marine waters would be limited, due to good housekeeping and silt-grease traps installation as part of standard drainage system design which will minimise pollutants runoff to surrounding marine waters.

Sewage Effluent Discharge

13.8.4.16 Sewage effluent would be generated from a range of activities at HKIA including from the airport-based workforce, passengers, staff and other visitors using airport facilities, food and beverage outlets, offices and hotels, as well as from certain maintenance activities in HKIA. Foul sewage would be disposed to the public sewerage system and transferred to the Siu Ho Wan Sewage Treatment Works (SHWSTW) for treatment. Wastewater collected from kitchens,

washroom sinks, and aircraft catering and cleaning activities will be treated at the greywater treatment facilities onsite for reuse in landscape irrigation or cleansing related activities and any surplus discharge of treated greywater will divert to the foul sewer as is currently the case at HKIA. As such, there will be no sewage outfall at HKIA and no discharge of sewage effluent from HKIA into the marine environment. No adverse water quality impact on marine fauna due to sewage disposal is anticipated.

Spent Cooling Discharge

13.8.4.17 Cooling water discharges may cause elevation of water temperature, discharge of residual amine and chlorine that may pose impacts on the marine environment and marine fishes. Elevation of water temperature may increase the metabolic rate of the marine fauna and increase the dissolved oxygen depletion rate. Temperature may also affect early development and nutrient dynamics for marine fishes (Wen et al.,2013). Free chlorine and chloramine toxicity may cause behavioral aberrations for marine fishes, including distended gills and erratic swimming behavior and reduction in respiration rates if concentrations approaching lethal levels (Capuzzo et al., 1977).

13.8.4.18 The findings from the hydrodynamic model on spent cooling discharges showed non-exceedances of surface temperature during both wet and dry season with and without the project in place. This confirms there are no impacts due to temperature associated with the spent cooling discharges from the project.

13.8.4.19 The findings on the predicted maximum depth-averaged residual chlorine levels at all marine ecological sensitive receivers show no exceedance on the criteria. Details of the hydrodynamic model results on the predicted residual chlorine levels at marine ecological sensitive receivers in year 2026 are presented in **Section 8.7.2** and **Table 2** of **Appendix 8.16**.

13.8.4.20 The locations with notably elevated residual chlorine levels are at the eastern coast of the airport island adjacent to the outfall No.7, outfall No.14 and outfall No.8 (**Drawing No. MCL/P132/EIA/8-008**). The predicted maximum concentration of the chlorine level is around 0.0563 mg/l. Under the worst case tidal period, the maximum extent of the mixing zone for residual chlorine release is approximately 260 m from outfall No.7 (as shown in **Appendix 8.16 (Figure 21)**) and approximately 550 m from outfall No.14 (as shown in **Appendix 8.16 (Figure 20)**). Discharge from outfall No.8 is due to the concurrent North Commercial District project which is not part of 3RS, hence the mixing zone associated with this outfall is due to the concurrent project only and is not related to the 3RS project.

13.8.4.21 The criteria adopted for assessment is based on the more stringent USEPA Criteria Continuous Concentration (CCC) limit of 0.0075 mg/l, which is a very conservative limit compared to EPD's No Observable Effect Concentration (NOEC) value of 0.02 mg/l for residual chlorine. The water quality model also assumed the very worst case release of maximum permitted 0.5 mg/l of residual chlorine under peak discharge occurring 24 hours a day, seven days a week, with a very conservative decay rate. Thus the worst case residual chlorine plume as predicted in the water quality model is very unlikely to occur in reality.

13.8.4.22 Chlorine decay in seawater through four pathways: oxidation, addition or substitution reaction and light decomposition. The decay rate depends on the initial concentration of chlorine and physicochemical properties of seawater. In a laboratory experiment, 3-4 mg/l chlorine was dispersed in seawater with a total organic carbon content of 4-5 mg/l. The half-lives of chlorine in the seawater with and without light were found to be 9.6 and 13.5 hours respectively, while the chlorine disappeared completely within 3 days (Nadeeshani Nanayakkara et al., 2011).

13.8.4.23 A study on the eggs of estuarine fish *Oryzias javanicus* exposed to residual chlorine (1 mg/L NaOCl) for 14 days indicated that a delay in hatching time was recorded, while other variables such as hatching rate of eggs, survival, body length and body weight of larvae were not affected (Anasco et al., 2008). As there is no exceedance in all marine ecological sensitive receivers, the mixing zone for residual chlorine release is localised with low concentration and during certain tidal conditions only, the fast decay rate, the dilution effect of the seawater and the insignificant effect of residual chlorine on estuarine fish eggs and larvae, the potential impact from spent cooling discharge on marine fauna is considered to be insignificant.

13.8.4.24 The findings on the predicted maximum depth-averaged residual amine levels at all marine ecological sensitive receivers show no exceedance on the criteria. Details of the hydrodynamic model results on the predicted cumulative amine levels at ecological sensitive receivers in year 2026 are presented in **Table 3** of **Appendix 8.16**. Therefore, the potential impact due to the residual amine release from spent cooling is considered to be insignificant.

Fuel Spillage

13.8.4.25 The risk of fuel spillage at the facility was considered extremely low with reference to the approved EIA report for Permanent Aviation Fuel Facility (PAFF) (Application No. EIA-127/2006). Incidences of aviation fuel leakage / spillage into the marine environment that may arise during refueling operations and/ or aircraft-related accidents were also assessed as low risk, in view of the proper measures already in place in the existing HKIA and similar or enhanced measures be put in place for the newly diverted pipelines. Assessment of potential fuel spillage to marine environment and the potential water quality impact is provided in **Sections 8.7.2.49** to **8.7.2.50**. In summary, the risk of jet fuel spillage into the marine environment would be minimal, and therefore the potential impact on marine ecological resources and indirect disturbance to marine habitat is anticipated to be insignificant.

Maintenance Dredging of the Navigable Waters North of HKIA

13.8.4.26 During operation phase, there would be changes to the tidal flow regime resulting from the new land formation which may induce sedimentation along the navigable waters to the north of HKIA, thereby periodical maintenance dredging at the navigable area may be required.

13.8.4.27 According to the sediment transport modelling findings as presented in **Section 8.7.2**, it indicated that there is potential for sediment accretion within the embayed areas and along some of the edges of the airport island. However the output plots suggest limited to no potential for sedimentation along the northern waters of HKIA (particularly outside the boundary of the future HKIAAA where shipping vessels will travel), hence maintenance dredging would not be

required along the navigable waters to the north of HKIA. Therefore, no further assessment of impacts due to possible maintenance dredging is required.

13.8.4.28 For the requirement of routine maintenance of the submarine pipelines and cables, in view of the submarine pipelines to be buried in the bed rock layer and to be protected by the bed rock on top, it is considered not necessary to conduct regular maintenance and thus no maintenance dredging is required. As for the submarine cables, it will be layed by direct bury to a depth of approximately 5 m under the seabed, no regular maintenance is considered necessary. Thus no maintenance dredging is required.

Impingement and Entrainment due to Seawater Intakes

13.8.4.29 The existing eastern seawater pump house (SWPH-1) provided a peak load of 4,255 L/s of water to the existing terminal buildings for cooling in 2012. There will be an increase in cooling demand from the existing seawater pumping house (SWPH-1) as a result of the expanded Terminal 2. In addition, a new seawater pumping house (SWPH-7) and associated seawater intakes for the third runway facilities will likely be situated on the east side of the third runway (**Drawing No. MCL/P132/EIA/8-008**). Based on the cooling demand for the new facilities, associated with the third runway, it is anticipated that the expanded SWPH-1 and the new SWPH-7 will have a peak flow of 7070 l/s and 7400 l/s respectively.

13.8.4.30 The increase in sea water flow in surrounding waters adjacent to the seawater intakes may cause physical damage of marine fauna especially juvenile fishes and crustaceans by collisions with the screen and cause impingement or die. Fish eggs or larvae of smaller size will pass through the screen but might subject to exposure to vaporization and cause entrainment or desiccation.

13.8.4.31 The location of the seawater pumping house (SWPH-1) and future pumping house (SWPH-7) are located either further away or at the boundary of the identified spawning ground for marine fishes. It is anticipated that the increase in water flow in the eastern Chek Lap Kok waters will not cause unacceptable adverse impacts to the marine fishes population caused by impingement and entrainment of larvae and fish post-larvae. The impact significance is considered to be low.

Indirect Disturbance of Marine Fauna due to Aircraft Noise

13.8.4.32 Some of the marine fauna communicate by means of acoustic, including produce sounds for defensive and courtship purposes. Marine invertebrates including most crustaceans (e.g. crabs and shrimps) cannot detect sound directly, but they detect the vibrations that transferred from the sound through the water media by means of the extensive array of sensory hairs or by statoycysts located on their antennae (University of Rhode Island, 2013). The detection of vibrations may help the animals to detect the movements of other nearby organisms to avoid predators. However, acoustic communication in marine invertebrates has not been studied in details as it has been for other marine fauna such as marine mammals, reptiles and fishes. There were also no detailed studies examining the disturbance by aircraft noise to marine fauna. The indirect disturbance of marine fauna due to aircraft noise will focused on the review of potential impact on marine fishes, while the potential impact for marine mammals to be

discussed in **Sections 13.9.4.38 – 13.9.4.41**. Anthropogenic noise may affect fish distribution, reproduction, communication and predation abilities (Slabbekoorn et al., 2010). The effect of aircraft noise is not well investigated. It has been reported that aircraft noise did not have any effect on fish at a hatchery near airport frequented by commercial jets; mild sonic boom did not have any effect on fish eggs, and only intense sonic boom might startle and cause jumping reactions in fish (Gladwin et al., 1987). Although fish has been reported to respond to noise such as those generated by underwater explosions and vessels, airborne sound such as those generated by aircraft is usually reflected off the water's surface, with only a small proportion actually penetrating the air-water boundary (ACRP, 2008). Therefore they are not likely to be affected by the sound generated by aircrafts. The impact significance is considered to be insignificant.

13.9 Evaluation of Impacts to Marine Mammals

13.9.1 Construction Phase – Direct Impacts

Temporary Habitat Loss

13.9.1.1 Although much has been written in general terms, there has been little detailed, quantitative study of the effects of habitat loss from land formation and other construction activities that physically remove habitat for CWDs that live in marine waters (see Kemp 1996).

13.9.1.2 However, Sheehy (2009), based on a general assessment, suggested that dolphins in Taiwan would likely be negatively affected by construction of a man-made island off Taiwan's west coast. In Hong Kong, there has been much marine construction work over the last several decades, which has destroyed and/or degraded CWD habitat in the north Lantau area. Jefferson et al. (2009) reviewed such work and suggested that while there have been impacts on the CWD population, mitigation measures have served to minimise the impacts.

13.9.1.3 The 3RS project involves the formation of land and ancillary works that will result in the loss of seabed and the water column. **Table 13-25** below provides details of the expected seabed loss as a result of the construction works.

Table 13-25: Summary of Areas of Marine Habitat Loss due to Construction Works

Proposed Construction Works	Approximate Size of Marine Habitat Affected	Nature of Impact
Land formation and seawall construction(1)	672 ha marine habitat (650 ha land formation + 22 ha seawall – 10 ha existing seawall to be demolished + 10 ha scour apron)	Permanent loss upon completion of marine filling works by late 2021
Diversion of submarine pipelines - site investigation	0.12 m^2 (0.03 m^2 x 4)	Temporary between 2015 and 2016
Diversion of submarine 11 kV cables – excavation at the field joint area by open trench	0.38 ha marine habitat (120 m x 32 m = 3,840 m^2)	Temporary between 2015 and 2016
Diversion of submarine 11 kV cables – laying of new cable by water jetting	0.27 ha marine habitat (6 km x 0.45 m = 2,700 m^2)	Temporary between 2015 and 2016
Approach lights construction with ground	108 m^2 marine habitat	Permanent loss upon

Proposed Construction Works	Approximate Size of Marine Habitat Affected	Nature of Impact
improvement followed by bore piling	(4.9 m^2 x 11 x 2)	completion of construction works by 2021
Lighted marks and beacons for future HKIAAA with ground improvement followed by bore piling	3.1 m^2 marine habitat (0.34 m^2 x 9 = 3.1 m^2)	Permanent loss upon completion of construction works by 2021
Floating temporary platform for diversion of submarine aviation fuel pipelines	225 m^2 marine habitat (7.5 mx 30 m = 225 m^2)	Temporary

Note (1): While a works area for the land formation works will be designated (see **Figure 3**, **Appendix 13.13**), the temporary works area will be demarcated by floating booms, not expected to cause significant obstruction to the water column. Activities within the works area will include construction vessel traffic and working barges operating close to active works areas within the construction footprint. Thus, much of the area of marine waters within the temporary works area will remain available for use by CWD and other vessels and is not considered as habitat loss.

(2): Proposed land formation footprint: 650 ha. The net seawall toe construction is 12 ha (22 ha proposed seawall toe minus 10 ha of the existing seawall toe). Approximate 10 ha scour apron of varying widths (subject to detailed design) will be constructed beyond the seawall toe for scour protection. Therefore, the total open water to be lost is 650 ha, but seabed habitat to be lost would be 672 ha.

13.9.1.4 Based on **Table 13-25**, there are some areas of purely temporary habitat loss that will be utilised for the construction activities in terms of works areas and work platforms. The total area of temporary habitat loss is small, however, at 0.67 ha, and as the works will only last a short duration of a maximum of a year for the cable and pipeline diversions.

13.9.1.5 The impacts of these temporary losses would be small and reversible once the respective construction works have been completed. There is evidence that CWDs can recover quite quickly from such temporary losses of habitat, such as after the construction of the AFRF facility at Sha Chau (see Jefferson and Hung 2004; Jefferson 2007). Based on this, these areas of temporary habitat loss alone would not be expected to result in any significant long term impacts to the CWDs and no mitigation measures would be required for these activities.

13.9.1.6 In addition to the purely temporary habitat losses above, habitat losses from other works will commence in the construction phase but become permanent once the works have been completed. Bored piling for the approach lights and marker beacons would ultimately result in the loss of only 0.011 ha of seabed habitat and the works duration would be a few weeks only. While the impacts would be permanent once the works are complete, the negligible area affected would mean the impact to the CWDs would be low.

13.9.1.7 The main areas of marine habitat loss will be as a result of the land formation for the airport platform extension. The 3RS additional seawalls and land platform will be formed over a period of several years starting in late 2015 / early 2016 to mid-2022, noting that the third runway and taxiway sections (which accounts for the majority of the land formation) would be completed by 2020 for closure of the existing north runway and opening of the third runway by 2021. Based on the construction planning, the land formation works has been primarily divided into three main stages, as shown in **Drawing No. MCL/P132/EIA/8-003**, **Appendix 8.4** and described below:

- **Stage 1** has a T-shaped footprint and consists mainly of the land formation works for the third runway, the associated west taxiways, the western support area and other supporting

facilities. Construction of this stage is anticipated to commence in 2016 Q1 by installation of geotextile, sand blanket and ground improvement. Ground improvement for this stage will only be completed around 2017 Q4. Marine and land filling is anticipated to commence around 2016 Q4. It is expected that the marine works will be completed by early 2018.

- **Stage 2** consists of land formation works for the new third runway concourse and aprons supported by facilities within the east support area. Construction of the southern portions of this stage by installation of geotextile, sand blanket and ground improvement is anticipated to commence in 2016 Q1. Ground improvement for this stage will only be completed around 2018 Q2. Marine and land filling at southern portions of this stage is anticipated to commence around 2016 Q4. It is expected that the marine works will be completed by end 2018.

- **Stage 3** is the land formation area at both ends of the existing north runway associated with the new wrap-around taxiways, whereby construction activities are restricted by the need to maintain operation of the existing north runway until completion of the third runway. Construction of this stage is anticipated to commence around 2016 Q2 by installation of geotextile and sand blanket. Marine and land filling of this stage is anticipated to commence in 2017 Q2 and the marine works will not be completed until end 2021.

13.9.1.8 As all three stages will be constructed concurrently and progressively, the actual construction footprint and associated silt curtain arrangement will change continuously over this period and the amount of open waters and CWD habitat lost will increase progressively to the ultimate amount of 650 ha at completion.

13.9.1.9 As described in **Section 4.2.2 and 4.3.3**, land formation will be carried out by first removing the rock armour from the existing northern seawall at HKIA, followed by sand blanket laying and ground improvement works. The ground improvement methods to be adopted include prefabricated vertical drains, sand compaction piles, stone columns, vertical sand drains and/or DCM method for areas located outside the CMPs, while only DCM will be used for CMP areas. New seawalls will be constructed using rock fill, and steel cells may also be used as part of the seawall core for areas outside the CMPs. Once a leading edge of at least 200 m of seawall is completed (above high water mark), marine filling activities will commence behind the seawall to help minimise SS release.

13.9.1.10 As determined by the project specific surveys (see **Section 13.4.6.113)**, although densities of CWDs are not high in the 3RS formed land area, compared to the CWD known key habitat areas of west Lantau and the SCLKCMP area of northwest Lantau, the densities are comparable to the moderate density area of the Brothers / Siu Ho Wan area and Southwest Lantau (see **Section 13.4.6.113** above). The plots of CWD sightings from the AFCD long-term database (which began in 1995) do show many CWD sightings within the project area of the 3RS (see Jefferson 2000, 2007; Hung 2008, 2013, Figures 2 and 6 of **Appendix 13.2**). The historical and project specific survey data has shown that reproductive female CWDs use this area.

13.9.1.11 The CWDs engage in generally similar behaviours in the area of the proposed 3RS land formation and to the west of the airport as they do elsewhere, with no particular behaviour and social types standing out. For example, while newborn young occur in the survey areas, the

areas are not prime nursery habitat, as has been ascertained further north off Lung Kwu Chau (Hung 2012, 2013). The 3RS project land formation area is considered to comprise part of a travel area and such travel areas have inherently lower densities, since the CWDs typically move through them, as opposed to a feeding or socialising area, where CWDs would stay for extended periods.

13.9.1.12 However, the nighttime EAR data indicates that, there appears to be a greater use of the Study Area during the nighttime than in the daytime, assuming the CWDs are not vocalising markedly more at night than during the day. That there is more vocalization at night is contra-indicated by the data from EAR A1, immediately to the west of the airport, from which no marked difference in vocalisations during the day compared to the night were recorded. The continued and probably expanded use of the immediate footprint of the 3RS at night indicates that the area might be even more important as CWD habitat than had previously been supposed. As has been detailed in the survey results, it is possible that generally low to moderate daytime sightings of CWDs in the immediate area of the 3RS footprint, and the generally lower sound recordings in the day compared to nighttime might be a reflection of daytime use being in large part of travel while at night, the CWDs stay around longer, potentially to feed. Both airport north and airport west would be considered to be of moderate habitat quality, though it should be recognised that airport west would be considered slightly higher in the moderate range, due to the indications that foraging is going on there, in addition to travelling.

13.9.1.13 In addition, evidence gathered from both the AFCD long term monitoring programme and the project specific surveys, as noted in **Section 13.4.6.113,** indicate that the area north of the existing HKIA platform is considered to be part of a travelling area for the CWD, connecting the major CWD feeding areas around Sha Chau and Lung Kwu Chau, west Lantau and the Brothers / Siu Ho Wan areas (see Hung 2008), with approximately 20% of the CWD behaviour in the survey areas being travelling. Hung (2008) demonstrated the importance of travelling areas to the CWD populations in Hong Kong. His analysis indicated that areas can be important habitats to CWD, even if high densities of CWDs are not recorded. Thus, that fact that the areas to the north and west of the current airport appears to function as travelling areas, would add to the conclusion that the area represents an important CWD habitat. As noted, above, the area to the west also showed foraging as well as travelling, and would be, therefore, important to the CWDs.

13.9.1.14 Once land formation for this 3RS project is underway, the CWD will essentially be excluded from this zone but, notably, the area to the west will not be directly affected, with the land formation works just slightly extending the west end land node of the current north runway only as shown in **Drawing No. MCL/P132/EIA/8-003** and could still be utilised. Notwithstanding that the marine waters to the north will only gradually be taken up and, as per the land formation sequence detailed above, there is evidence (Hung 2008) to suggest that the disturbance from the overall construction works in this area, would result in the CWDs avoiding the area. Thus, the use of this area for travelling and other activities would be lost and it is considered this would force the CWDs further north.

13.9.1.15 Further details of the impacts on the travel area are presented in **Sections 13.9.1.25** to **13.9.1.32** below.

13.9.1.16 As indicated above, the area where the 3RS project will be located is presently a preferred travel area (among other activities) during the daytime and also important for nighttime use as well. Thus, the loss of this habitat would be a notable source of disturbance to the CWDs currently utilising this area. Many CWDs have basic core ranges (that is, the areas where CWDs spend the majority of their time) and those with ranges in this area will be particularly impacted. It is recognised that the CWDs also have ranges spread over much greater distances than the area to be affected by the 3RS project (Hung and Jefferson 2004) and these extended ranges would moderate the impact on some individuals and part of the population. Nevertheless, this habitat loss and the slow and encroaching loss of other CWD habitat especially in northern Lantau waters is a concern for the CWDs. The 3RS project will reduce the available area between the existing airport and the Sha Chau Lung Kwu Chau Park and Urmston Road and other projects area affecting other habitat areas, notably HKBCF and TM-CLKL to the east of the airport near the Brothers, a formerly moderate to high quality area of CWD habitat (Jefferson 2000), and HKLR, to the south and southwest of the airport. Therefore, the impacts associated with habitat loss are not solely related to whether the area is used for foraging, travelling or socialising but also how much habitat, and the quality of that overall, for any functions, is still available.

13.9.1.17 This quantity of habitat loss is of a large magnitude and, once the 3RS project has been completed, the habitat loss will be permanent, which notably increases the significance of its ecological impact. While the ultimate land formation area for the 3RS represents a very small proportion (less than 1%) of the total CWD habitat available in the Pearl River Estuary (PRE), which is currently known to cover at least 5,600 km^2 this percentage does not account for differential use of habitat in coastal verses the offshore areas, for which there are little data, meaning that the percentage habitat affected would be underestimated. The total permanent loss of marine water habitat due to the 3RS land formation and seawall construction is 650 ha, which represents about 2.5% of the Hong Kong sub-population's habitat area of 26,500 ha. Again, while this appears relatively small, as for the PRE, it does not account for the preferred areas of habitat and home ranges of the CWDs, the numbers of which has been shown to be declining in all three of its major habitat areas over the last decade or so. In addition, while the habitat quality is deemed as moderate, the area to be lost is large, as noted above, thereby increasing the impact of the loss.

13.9.1.18 Thus, the impact significance to the Hong Kong sub-population would be considered moderate to high during the construction phase and as the land formation progresses and mitigation would be required. This takes into account the fact that the loss of the total footprint area will be complete at the end of the contruction phase and the potential value of this habitat as a travel area to the Hong Kong sub-population of CWDs. Although not as important as a feeding or calving area, and despite the relatively small percentage of habitat to be lost compared to the total available, this travel area does link the feeding areas of the Brothers area and areas to the west and many CWDs appear to use it for travelling back and forth among their critical habitat areas in Hong Kong.

Loss of Carrying Capacity

13.9.1.19 The carrying capacity of the Hong Kong / Pearl River Estuary population of CWDs is the maximum number of dolphins that the habitat can sustain. It is determined by the size and

quality of their habitat, and will vary with changes in the habitat area and quality caused by anthropogenic and natural factors. While measures of habitat size are relatively straightforward to develop and estimate, measures of habitat quality are much more difficult to account for and to factor into carrying capacity calculations. However, it is generally accepted that a part of an animal's habitat that is used as a prime feeding or breeding / calving area would be of higher quality than an area that is used just for travelling. This is not to say that travelling is not an important activity, but, in general, the loss of such a travelling area would likely to be of less significance to CWDs as it would be easier for them to find an alternate route, than a prime feeding or calf-rearing area, for instance.

13.9.1.20 The size of the population is currently estimated to number approximately 2,500 individuals (Chen et al. 2010), by far the largest population known for the species or genus *Sousa chinensis*. Their distributional range covers a very large area of the western part of Hong Kong, Macao and virtually all of the Pearl River Estuary (including all eight of the Pearl River exits) within the mainland Chinese waters of Guangdong Province (Chen et al. 2010).

13.9.1.21 The construction works and land formation area for the 3RS project represents a very small proportion (less than 1%) of this total CWD range area, a small proportion even if it is taken into account that the CWDs may have preferred habitat within this area. Thus, it is unlikely that the loss of this amount of CWD habitat would have a significant impact on the overall carrying capacity for the population. However, it could result in a reduction in the carrying capacity of the segment of the population that occurs in Hong Kong, that is, the Hong Kong sub-population.

13.9.1.22 The area occupied as habitat by CWDs in Hong Kong is currently about 26,500 ha (the area of lower Deep Bay, northeast Lantau, northwest Lantau, west Lantau, and southwest Lantau). The total permanent loss of habitat due to the 3RS land formation is 672 ha of seabed and 650 ha of marine water, which represents about 2.5 % of the Hong Kong sub-population's habitat area. However, it is important to note that this does not account for differential use of habitat in coastal and offshore areas, which is currently poorly-known, particualry in PRE waters. Although the loss represents a small proportion, it could be significant in light of the demonstrated declining numbers of CWDs in Hong Kong over the last decade or so.

13.9.1.23 The loss of carrying capacity for the Hong Kong CWD habitat would have an unknown impact on the overall population, but it is likely that it would result either in a very small overall reduction in population size or a shift in range of individuals to lower-quality habitat. Since the main use of the 3RS construction area habitat is for travelling area (see results presented above), alternative habitats would likely be easier to find than if it were used as major feeding for prime breeding habitat, for instance. While there is some indication that the CWDs are present at several areas north of the airport more at night than during the daytime, and thus hypothetically there might be more feeding activity at this time, this is for only a part of the daily cycle and represents a small area.

13.9.1.24 Based upon a precautionary approach, the loss of carrying capacity in the construction phase would be considered to be of moderate impact significance to CWD population and mitigation would be required.

Habitat Fragmentation

13.9.1.25 Habitat fragmentation and loss of travelling areas are similar topics, but not exactly the same from a CWD perspective. For instance, habitat fragmentation can happen by splitting a single community in two by some disturbance in the middle. Loss of connectivity / travel area is more specific, referring to the loss of a known connection channel between two pre-existing segments (or communities) of CWDs. There is the potential for CWD habitat fragmentation to occur as a result of the land formation for the 3RS project. This is a concern in that fragmentation can disrupt natural social groupings of CWDs and limit reproductive capacity by reducing opportunities for mating and genetic exchange. Habitat fragmentation has often been discussed as a threat to small cetaceans, but other than for some river dolphin species, it has not been much studied in terms of its actual effects on cetaceans. One exception is for the harbour porpoise (*Phocoena phocoena*), for which evidence of habitat fragmentation due to past changes in climate (some anthropogenic and others natural) has been gathered (Fontaine et al. 2010). This is even thought to have been a factor in the near-disappearance of harbour porpoises from the Mediterranean Sea over the last few hundred years.

13.9.1.26 As discussed in **Section 13.4.6.113** above, CWDs actively feed in areas to the west of the airport (especially around Sha Cha and Lung Kwu Chau and along the coast of west Lantau) and to the east of the airport (especially around the Brothers and Siu Ho Wan), although survey data shows the use of this latter area is declining (Hung 2013). It is known that CWDs move back and forth among these foraging areas and currently the only feasible direct route for them to use is the channel between the northern part of the airport and the New Territories coastline. The formation of the 3RS new land platform will result in the gradual permanent loss of 650 ha of this area immediately to the north of the existing airport island.

13.9.1.27 Recently two distinct social clusters of CWDs have been identified in Hong Kong (Figure 9 of **Appendix 13.2**), one centered along the west coast of Lantau Island and one centered in the north Lantau area (Dungan et al. 2012), and inter-mixing of CWDs from these two communities is considered important for a healthy level of gene flow in the population. There is an area of overlap of the two communities, especially along the western side of Lantau Island, and the main way that interaction of these communities might be affected by the 3RS project would be through loss or constraint of travel areas. The interaction between the community areas around Lung Kwu Chau and to the west Lantau would not be significantly affected but inter-mixing between the eastern part of the northern community and the rest of this community and also the western community could be affected.

13.9.1.28 During the construction works for the 3RS project, the passage between the existing airport island and the Tuen Mun coastline would be gradually reduced in width by around 40% at its narrowest point. It is not known if CWDs would continue to move back and forth in this reduced channel or whether this would result in some fragmentation of the habitats on the east and west sides of the airport, as the CWDs could stop or significantly reduce their travel through this area. Such fragmentation of the habitat could result in loss of some genetic diversity to the population, although it would be expected that any such effect would be very minor considering the potential availability of the remaining northern access route.

13.9.1.29 However, while the reduction on the size of the overall travel area would be eventually permanent, any fragmentation that might occur would be considered to be temporary during the construction phase, and partial as there would still be an area for movement and CWDs could use an alternative, more northern route. Fragmentation of populations generally requires nearly complete separation and given the alternative travel area available, it is not judged that this would occur. Despite these facts, some partial loss of connectity of the two social clusters is possible. Therefore taking a precautionary approach, the impact from construction phase fragmentation is considered to be of moderate impact significance to the Hong Kong subpopulation, and therefore mitigation would be required.

Loss of Travelling Areas and Connectivity between Core Use Areas

13.9.1.30 It should be noted that CWDs, unlike fish, do not have exclusive use areas for feeding, nursery etc. However, as noted in the literature review (**Appendix 13.2**) and the project specific surveys, the area to the north of the existing airport appears to be a preferred travel area for the CWDs, noting that the CWDs travel quickly through the area (see **Section 13.4.6.81** on swimming speeds), and that the results of the focal follow surveys have noted that the CWDs do not appear to use this area extensively for other critical activities such as feeding and socio-sexual behaviour. The CWDs use this area mainly for travelling between the main feeding areas at the Brothers and west Lantau area. Other areas including further north, closer to the Urmston Road and Tuen Mun coastline, and from the northwest to the west Lantau, are also used by the CWDs for travelling but critically they also use these areas for a variety of activities and their importance is shown by the moderate to high CWD densities (Figure 6, **Appendix 13.2**). The airport west area is used for both travelling and foraging.

13.9.1.31 As discussed above, as a result of the gradual formation of new land for the airport expansion, the travelling area north of the existing airport is expected to be directly affected. While the sequential construction of the land would minimise the impact overall, east to west CWD movements through this area would be gradually constricted (to about 40% its current width at its narrowest point), as the construction of the new land platform progresses to ultimately form a relatively narrow zone between the northern part of the new 3RS airport platform and the New Territories coastline, much of which is taken up by the Urmston Road shipping channel. Although CWD are currently found in high densities in the Urmston Road and use this area as part of their feeding range, the construction of the 3RS land platform would concentrate them further into the shipping channel, potentially increasing opportunities for conflicts with vessel and thus leading to an increased likelihood of CWD collisions with marine vessels, as further discussion below. The airport west area would not be directly affected, however, with only some minor land formation works around the west end land node of the current north runway only as shown in **Drawing No. MCL/P132/EIA/8-003** and would stil be able to be used for travelling and foragingThe effect of the direct loss of the travel area on the interaction between the two identified communities is likely to be a lessening of interaction between the communities and therefore a loss of mating opportunities and potential loss of genetic diversity in the overall population. Such losses of diversity make the population more vulnerable to processes that can cause population declines.

13.9.1.32 In conclusion, the assessment of the field data indicates that a travel area does exist to the north of the airport platform and this would be directly affected as a result of the land formation

for the project. As such, impact from the direct loss of this travel area to the CWDs is predicted to represent a moderate impact significance and mitigation measures would be required.

13.9.2 Construction Phase – Indirect Impacts

Loss of Prey Resources Through Loss of Benthic Habitat

13.9.2.1 CWDs in Hong Kong feed on a wide variety of prey items and appear to be rather opportunistic in their feeding habits (Jefferson 2000; Barros et al. 2004). Stomach contents of stranded CWDs have shown at least 24 species of estuarine fish and one species of cephalopod are consumed by these animals (Barros et al. 2004).

13.9.2.2 As shown in **Drawing No. MCL/P132/EIA/13-026**, the fish prey for the CWDs in Hong Kong are distributed throughout the western waters. However, according to the latest fisheries survey findings for the 3RS project, the dominant marine fish species recorded within the land formation footprint are *Johnius belangerii* (Belanger's croaker), *Leiognathus brevirostris* (shortnose ponyfish), *Sardinella melanura* (blacktip sardinella), *Alepes djedaba* (shrimp scad) and *Stolephorus indicus* (Indian anchovy), *Konosirus punctatus* (Konoshiro gizzard scad) and *Nematalosa nasus* (Bloch's gizzard shad), two of which (*Johnius belangerii* and *Sardinella melanura*) are main preys for CWDs. The dominant marine fish species composition recorded in the western and northern Chek Lap Kok waters outside the project footprint are similar, comprising *Sardinella melanura*, *Nematalosa nasus*, *Leiognathus brevirostris, Alepes djedaba* and *Thryssa kammalensis* (Kammal thryssa) which include two main fish preys (*Sardinella melanura* and *Thryssa kammalensis*) of the CWDs. Although other prey species for CWDs are recorded within the project footprint (**Drawing No. MCL/P132/EIA/13-026**), the findings show that the prey species for CWDs within the project footprint are not the dominant species.

13.9.2.3 In contrast, the fisheries studies within the SCLKCMP commissioned by AFCD (Put et al., 2004 – 2006; Tsang et al. 2000 – 2003), show that the most dominant species present were *Thryssa hamiltonii* (anchovy), *Johnius belangerii, Ilisha elongate, Gerres oyena, Johnius amblycephalus, Sillago japonica, Arius maculatus* and *Rhynchopelates oxyrhynchus,* five of which are CWD prey. This suggests why the SCLKCMP is a known feeding ground for the CWDs. As demonstrated by the purse seine survey data (trawl survey data were not used as it did not include SCLKCMP and Brothers), the abundance of two of CWD prey species were all greater at areas outside the project footprint than within the project footprint. For *Sardinella melanura*, the abundance at proposed footprint, the Brothers, SCLKCMP, western Chek Lap Kok and northern Chek Lap Kok were 96, 345, 323, 338 and 283 respectively, while for *Thryssa kammalensis* the abundance at these five areas were 18, 288, 54, 23 and 32 respectively.

13.9.2.4 As detailed above, the land formation work for the 3RS project would result in the gradual loss of benthic habitat that could be used by CWD prey species, with a total loss of 672 ha once the construction was complete. There would also be a purely temporary loss of 0.67 ha, but the area of habitat is small and the impacts negligible and reversible.

13.9.2.5 However, while the area to be taken up by the 3RS land formation is used by the CWD, the project specific surveys, and AFCD data presented in Hung 2013, have noted that this area does not appear to be a major CWD feeding habitat, with travelling appearing to be a key

activity (over 20% of the time). This observation would concur with the findings of the fisheries assessment which noted a lack of abundance of CWD prey species in this area. Major recognised feeding areas for CWDs in Hong Kong are around the Brothers / Siu Ho Wan, Sha Chau and Lung Kwu Chau and in west Lantau. None of these areas would be directly affected by the land formation of the 3RS project.

13.9.2.6 Thus, the loss of any prey resources from the 3RS land formation area would not likely result in malnutrition of individuals nor result in somewhat lower feeding success for the CWDs. CWDs in Hong Kong are opportunistic feeders and there is currently no evidence that reduction in prey resources or malnutrition are significant threats to the CWDs (as indicated by AFCD long-term monitoring data and photographic records in which no evidence of malnutrition or starvation has been noted). In addition, as detailed above and in **Chapter 14 Fisheries**, the impacts to fish resources, specifically those favoured by the CWD, from the construction works for the 3RS project would be low.

13.9.2.7 Therefore, the loss of prey species for the CWD as a result of loss of benthic habitat loss is considered to be of low impact significance and no mitigation measure would be required.

Disturbance to Travelling Areas and Connectivity between Core Habitat Areas

13.9.2.8 As noted in **Sections 13.9.1.30** to **13.9.1.32** above, there will be direct loss of the area north of the existing airport island which has been identified as a preferred travel area for the CWD between key feeding areas to the east and west. The travel and foraging area to the west of the airport will not subject to any land formation, except for the portion to the west of the existing North Runway (**Drawing No. MCL/P132/EIA/8-005**).

13.9.2.9 However, CWDs do not have exclusive use areas and there are other areas that are used for travelling as well as other activities. These main areas are located further north, closer to the Urmston Road and Tuen Mun coastline, and from the northwest to the west Lantau, and these areas, including the area to the west of the airport, could be indirectly affected by the 3RS project construction works.

13.9.2.10 In terms of the marine waters from the northwest to the west Lantau, the 3RS project construction works are unlikely to significantly affect the use of this area for travelling, as the diversion of submarine cable from the west of the airport to the connecting location is at least 500 m outside the boundary of Sha Chau and Lung Kwu Chau Marine Park and will use a direct bury (water jetting) method to avoid the need for trench excavation. The jetting trench is approximately 0.45 m in width and 1 m long for a 6 km length, with a burial depth of 3 m to 5 m below seabed level (**Drawing No. MCL/P132/EIA/8-004**). The cable diversion works will be implemented as an advanced works between 2015 and 2016, the seabed will be reinstated upon completion of each cable laying section.

13.9.2.11 With respect to the area to the north of the 3RS project, although CWD are currently found in high densities in the Urmston Road and use this area as part of their feeding range, the construction of the 3RS land platform would force the CWDs to move from the preferred travel area close to the existing airport island and probably concentrate them further into the Urmston Road, potentially causing indirect impacts by increasing opportunities for noise disturbance and

an increased likelihood of CWD collisions with marine vessels, as further discussed below. The potential acoustic disturbance impacts associated with the construction works and ferries and marine traffic are discussed separately in **Sections 13.9.2.76 - 13.9.2.90** and **13.9.2.91-13.9.2.102**, respectively. The airport west area would not be directly affected by significant construction phase marine traffic and notably high speed vessels do not pass through this area and therefore it could still be utilised for travelling and foraging by the CWDs as the land formation works to the north are about 1-2 km away. However, potential disturbance associated with the construction of the 3RS project could result in a reduction of the CWDs use of the travel area to the north for the duration of the construction works.

13.9.2.12 The main issue would relate to potential increases in vessel disturbance and collision on the more vulnerable members of the population, young calves and nursing females, and older or weakened individuals. It is expected that under normal circumstances, healthy adults would be able to adapt, but these more vulnerable members would be more susceptible to impacts.

13.9.2.13 Based upon the above the indirect impact to travelling activities by the CWDs would be considered to be a moderate impact and mitigation measures would be required to ameliorate this impact.

Changes in Distribution, Abundance and Patterns of Habitat Use

Distribution

13.9.2.14 The construction of the 3RS project is expected to cause changes in CWD distribution gradually, as construction work areas are established, firstly forming a "T" shape land formation for the third runway and western support area before moving eastwards. Thus, there is expected to be a gradual shift north and then east and west of CWD use of the area north of the airport, and this will likely also be affected by the noise of construction activities and vessel traffic working in this area. This will ultimately be a permanent loss of this area of habitat for CWDs affecting the distribution of the Hong Kong sub-population. The airport west area will not the directly affected by the 3RS land formation and given the land formation works are about 1-2 km away, with the water quality modelling not predicting any elevated suspended solids in this area, and the fact that the area is not signcificantly used by marine traffic and HSFs, it is not predicted to be significantly affected by the construction activities in the area, allowing continued use by the CWDs.

Abundance

13.9.2.15 As the area to be lost during the construction of the 3RS project land formation has been shown by the survey and literature review to be a preferred travel area with low densities and abundance of CWDs (as assessed above), and the fact the CWDs should be able to shift their existing travel route to the north as construction progresses, a significant reduction in CWD abundance is not expected. However, if the new travel area is not used as extensively as the existing travel area, then CWDs may travel less to the Brothers area, and this will likely result in a negative impact on CWD abundance in that specific area.

Patterns of Habitat Use

13.9.2.16 Since the 3RS project would mainly be affecting a travel area there would not be expected to be significant direct effects on foraging or breeding / calving, such as in the airport west area which is used for both travelling and more foraging. However, lessened contact between the two CWD communities (see **Section 13.9.1.25** above) could result in less breeding opportunities and therefore negatively affect calf production.

13.9.2.17 CWD are present throughout the footprint area of the 3RS project at night and in some cases with even more acoustic contacts at night than daytime, suggesting that:

- more CWDs are present at night than daytime;
- that the CWDs are staying in the area for longer periods at night, such as for foraging for example;
- that they vocalise more during night than daytime; or
- a combination of these possibilities.

13.9.2.18 Results of the project-specific field surveys indicate that the CWDs use the 3RS project footprint and works area primarily as a travel area in the daytime for moving between key feeding grounds to the east and west, and possibly more intensively for feeding at night. While CWD breeding activity does occur in this area, there is no indication that this area is key for the segregation of females with nursing calves (as for instance, west Lantau appears to be). The passive acoustic monitoring survey results suggest that nighttime activity in the area is more extensive than daytime studies have indicated, and therefore implications for disturbance and loss of area are higher than daytime use alone would indicate.

13.9.2.19 Overall, due to the fact that the project footprint area is primarily a travel area with moderate density and low abundance of CWDs and taking into account the potential indirect effects on the travel / foraging area to the west of the airport, the construction phase impacts to the distribution, abundance and patterns of habitats use would be considered to be a moderate impact on the Hong Kong sub-population, requiring mitigation. This impact significance comes in large part, due to the small size and declining status of the Hong Kong sub-population of CWDs. These facts mean that, even though impacts on the overall population of CWDs that extends into PRC waters (>2,500 animals) would be considered to be very minor; it is noted that their decline is partly as a result of CWDs shifting their movements to the portions of their individual ranges outside of Hong Kong waters, in addition to mortality. Therefore the particular impacts on the segment of the population that occurs in Hong Kong and affects the Hong Kong sub-population would be considered moderate.

Effects of Elevations in Suspended Solids

13.9.2.20 Generally, degradation of water quality from increased SS would not be considered a key concern for marine mammals, as they would not have the risk of gill blockage by high levels of SS as would be the case with fish. In addition, CWDs use echolocation and sight to navigate and find food and are thus less susceptible to sedimentation effects than are other marine mammals that filter prey from the water. However, increases in SS concentrations may potentially influence the CWD's prey and affect the CWDs indirectly by the loss of food supply,

due to disturbance of the seabed and increased sedimentation and, therefore, result in reduced use of the area by CWDs (Hung 2008). However, it should be noted that the Pearl River carries very heavy loads of suspended sediment and nitrates and as a consequence concentrations of these parameters within Hong Kong's northwestern waters are variable but generally far higher than in the more oceanic influenced waters to the south and east of Hong Kong. In a review of the suspended sediment loading in the PRE, and levels up to 10,000 mg/L have been noted. As such, the fisheries and CWD are likely habituated to high and fluctuating levels of SS, and there is no evidence that this is a significant threat to CWDs in Hong Kong.

13.9.2.21 A number of commitments have been made during the construction of the 3RS to minimise the potential for disturbance to the seabed and the associated release of suspended solids (SS), for example the adoption of a non -dredge land formation techniques such as Deep Cement Mixing (DCM), Stone Columns, Sand Compaction Piles, Vertical Sand Drains, Steel Cells, Prefabricated Vertical Drains (PVD), which allow the area of the 3RS land formation, both above the CMPs and in the other areas adjacent, to be improved (i.e. stiffened) sufficiently for allowing on filling activities to minimise the release of suspended solids, contained contaminants and interstitial water out of the CMPs and other marine sediment into surrounding waters.

13.9.2.22 The potential disturbance to the seabed and release of SS from the DCM method is discussed in detail in **Sections 13.9.2.63** to **13.9.2.69.**

13.9.2.23 The other ground improvement works including Stone Columns, Sand Compaction Piles, Vertical Sand Drains, Steel Cells and Prefabricated Vertical Drains (PVD) are generally not associated with significant SS release into the water column.

13.9.2.24 Backfilling activities for the land formation and seawalls will use different fill materials including rock fill, public fill, sand fill, rock armour and graded filter. Backfilling activities for main land formation will be undertaken behind a 200 m advance of seawall to minimise the dispersion of fine materials. Seawalls will be constructed using rock fill and as only rockfill will be used in construction of the seawall core, the potential SS release during seawall construction is considered to be insignificant.

13.9.2.25 In addition to the land formation techniques discussed above, construction works that could disturb the marine seabed would comprise the following:

- the re-alignment of the existing aviation fuel sub-marine pipeline to the Aviation Fuel Receiving Facility (AFRF) in the Sha Cha and Lung Kwu Chau Marine Park;
- the diversion of the sub-marine electric cable; and
- the construction of the New Runway Approach Lights and HKIAAA Marker Beacons.

13.9.2.26 Diversion of the existing submarine aviation fuel pipeline is required in order to maintain continuous fuel supply to HKIA and will use a horizontal directional drilling (HDD) method. In order to facilitate the detailed design for diversion of the submarine aviation fuel pipelines, marine site investigation (SI) will first be conducted along the proposed horizontal directional drilling (HDD) alignment to provide the necessary geotechnical information. A total of four SI boreholes (each about 0.03 m^2 in area) will be drilled within the SCLKCMP to bedrock level

below the seabed by drilling vessel / jack-up platform. The drill holes will be backfilled after completion of the SI work. There will be a small temporary loss of seabed area of approximately 0.12 m^2 (0.03 m^2 x 4) due to this SI works but the proposed SI works will be completed within a few months.

13.9.2.27 The HDD method will form two rock drill holes by drilling through the bedrock from a launching site located on the west of existing airport island to the landing point adjacent to the offshore receiving platform at Sha Chau. As the proposed use of HDD will drill through bedrock (around of 90-120 m below the seabed), this technique will not result in any loss of seabed habitat, disturbance to the seabed or release of SS into the marine waters.

13.9.2.28 The pipeline diversion will require the construction of an off-shore receiving platform and a floating works platform and marine site investigation. A temporary floating platform formed by two to three barges is proposed to be set up between the Sha Chau Island and the AFRF to provide a working platform for pipeline welding and fabrication in order to minimise direct impacts to Sha Chau Island. However, this construction method for the temporary platform would also not require any removal or disturbance of marine sediments from the seabed.

13.9.2.29 The new 11 kv submarine cables will be laid by water jetting method, which will occupy a total area of around 6 km in length and about 0.45 m in width. The excavation rate will also be very slow at only 300 m^3/day to avoid damaging the existing buried cable. Water jetting activities will result in localised disturbance to the seabed surface and release of sediments and approximately 0.27 ha of marine habitat will be temporary affected. The diversion of submarine 11 kV cables will also require excavation of seabed in the field joint area, using an open trench method, to expose a section of the existing cable for connection to the newly laid cable. The habitat loss due to the excavation of the field joint area is approximately 0.38 ha but the seabed will be reinstated upon completion of the diversion works. Sediment loss associated with these activities would be expected to be small and localised and have been assessed in **Chapter 8** which concludes that in the 2016 unmitigated scenario with the concurrent land formation works, the sediment loss will not exceed the WQO criterion at any of the ecological sensitive receivers identified.

13.9.2.30 At the two ends of the new runway, approach lights will be required, as shown in **Drawing No. MCL/P132/EIA/8-009.** It is also proposed to install eleven light beacons along the northern edge of HKIAAA. The indicative locations of these beacons are shown in **Drawing No. MCL/P132/EIA/8-010**. An additional nine markers would be required along the western side of the northern HKIAAA edge, and depending on the requirements by Marine Department, these additional markers may also be provided as fixed beacons. The runway lights and marker are proposed to be constructed using pre-bored H piles and rock socketed H piles, respectively, all of approximately 50-60 m below seabed level. Approximately 12 m^3 of spoil will be excavated for each runway light pile and 20 m^3 of spoil excavated for each marker beacon pile.

13.9.2.31 However, in both cases, the piling activities would be completed within a few weeks and, based on the recommendations of the Water Quality Impact Assessment (**Chapter 8**), silt curtains will be deployed to completely enclose the pile installation works. Based on the above considerations, the anticipated SS release from construction of the approach lights and marker

beacons would be minimal. The acoustic effects of the bored piling are discussed in **Sections 13.9.2.76 to 13.9.2.81** below.

13.9.2.32 As detailed above, the selection of construction methods and incorporation of water quality protection measures has been carefully made to minimise disturbance to the seabed and overall, the release of suspended solids into the marine waters is expected to be minimal. This is supported by the water quality modelling results (see **Section 8.7.1**), which shows that for an unmitigated project only scenario, SS levels at Brothers is 3.50 mg/L or below, which are within WQO criteria of no more than 30% elevation from the baseline.

13.9.2.33 Based on the fisheries impact assessment (**Chapter 14**) and water quality modelling findings, the SS elevation levels at spawning ground of commercial fisheries resources at northern Lantau waters, SCLKCMP and the Brothers are all within the WQO criteria or below 50 mg/L (based on international marine water quality guidelines for the protection of ecosystems (CCPC, 2001)). In view of the wide distribution range of the fish species that are suitable for CWD to prey on, the confinement of the sediment plume and no exceedances of SS levels and associated water quality parameters (including dissolved oxygen concentration and contaminant levels) at sites of fisheries importance, the potential impact on CWD preys due to deterioration of water quality is anticipated to be insignificant.

13.9.2.34 Overall, the water quality assessment indicates that plumes of elevated SS would not affect the core dolphin areas around the Brothers / Siu Ho Wan, SCLKCMP and west Lantau and it has predicted that the unmitigated impacts to CWD, in terms of SS elevations or contaminant release, are expected to be low.

13.9.2.35 Furthermore, based upon the fact that the water quality impacts can be effectively mitigated to within acceptable levels overall, the potential impact from suspended solids on the CWD would be expected to be adequately mitigated with application of the water quality mitigation measures. The water quality modelling and fisheries assessment in **Chapter 14**, also concluded that the CWD prey abundance would not be significantly affected by the 3RS project.

13.9.2.36 Based upon the above, it is concluded that the impact to CWDs from elevations in suspended solids would be a low impact and no specific mitigation would be required, although measures to protect water quality as discussed in **Chapter 8** would also provide benefits to the marine ecology.

Reduction in Dissolved Oxygen Levels in Marine Waters

13.9.2.37 Where disturbance to the seabed through excavation or backfilling leads to elevations in SS in the water column, concerns about possible release of nutrients or organically rich sediments, which could result in water column oxygen depletion, can arise.

13.9.2.38 The findings from the water quality impact assessment (**Chapter 8**) showed the Dissolved Oxygen (DO) levels during the construction phase of the works would be above 5 mg/l at all sensitive receiver locations. This is well within the WQO criteria of greater 4 mg/L.

13.9.2.39 As noted above, the results of the water quality modelling did not predict any exceedances of the WQOs with respect to DO. In addition, there is no available information on the effects of oxygen depletion in the water on CWDs but as CWDs are air breathing mammals and do not obtain oxygen from the water itself and are, also, tolerant of natural variations in the study area, including SS levels as noted in **Section 13.9.2.20** above, there is no evidence that any reductions of dissolved oxygen levels would have any significant effect on CWDs and the impact would be considered to be insignificant and mitigation measures would not be required.

Release of Sediment Contamination

13.9.2.40 Contamination within marine sediments has the potential to be released if the marine sediment is disturbed during activities such as dredging and excavation. Contaminants such as heavy metals and organochlorines (OCs) may be desorbed from the sediment substrate and redistributed into the water column. This resuspension of environmental contaminants may increase the bioaccumulation in CWDs through the intake of prey items in the vicinity of the work area. The main class of pollutants of concern is the organochlorines (also referred to as persistent organic pollutants (POPs), although some heavy metals and organotins may also be an issue (Jefferson et al. (2006).

13.9.2.41 As noted in **Appendix 13.2**, there has been work conducted on examining the concentrations of various environmental contaminants (heavy metals, organochlorines, organotins, PBDEs, and even sewage-borne bacteria) in Hong Kong CWD tissues since the mid-1990s (Parsons 2004; Jefferson et al. 2006). The organochlorine classes of dichloro diphenyl trichloroethane (DDTs) and polychlorinated biphenyl **(**PCBs) have been the focus of the work and there is evidence that these contaminants are having a negative effect on the CWDs. Organochlorines have been reported to interfere with reproductive capacity, cause immunosuppression (lowered resistance to disease) and may have carcinogenic (cancer-causing) and teratogenic (development) effects (Tanabe & Tatsukawa, 1991; Busbee *et al*., 1999; Jefferson et al. 2006). Exposure during early development can affect the endocrine, reproductive, immune, and nervous systems, sometimes not expressing their effects until adulthood. Clear evidence showed that high levels of OCs suppressed the immune response of bottlenose dolphins in the southeastern USA (Lahvis *et al*., 1995). Cockcroft (1989) suggested that OC concentrations in South Africa may be high enough to impair reproductive function of male humpback dolphins, and to prove fatal to neonates of primiparous females. Finally, high concentrations of OCs are suspected to have been a causal factor in the die-offs of dolphins in the Mediterranean Sea and northeastern USA in recent years (see Kannan *et al*., 1993; Reijnders 1996; Aguilar, 2000). While the link between OCs and marine mammal die-offs has not yet been clearly and unequivocally proven, there is good reason to be concerned about such factors (Kennedy, 1999, Jefferson et al. 2006). Pathways of contaminant release to the CWDs include ingestion of contaminated sediment, ingestion of dissolved and suspended contaminants in water or ingestion of organisms containing contaminant residues.

13.9.2.42 As noted under **Sections 13.9.2.20** to **13.9.2.36** above (Elevation of Suspended Solids), the 3RS project construction methods have been selected such as to minimise any disturbance to the seabed which could result in elevated SS and release of contaminants. This is particularly the case for seawall and land formation works being proposed over the CMPs where DCM is proposed. The impacts from the DCM process and the potential for contamination release is

discussed below (**Sections 13.9.2.63 to 13.9.2.69).** However, there is the potential for some disturbance of the seabed sediments and contaminants, as discussed above, from the following sources:

- Open trench excavation at the field joints for part of the diversion of the sub-marine electric cable; and
- Piling for the construction of the new runway approach lights and HKIAAA marker beacons, specifically over the CMPs.

13.9.2.43 There is an abundance of sediment quality data pertaining to the Study Area for this 3RS project which indicates that the sediments are overall not contaminated with only a few exceptions (see **Section 10.4.1**). In addition, site specific ground investigation and sediment quality data has been collected (**Chapter 10**), which has concurred with this overall finding. Sediment sampling and elutriate testing for organochlorines at proposed submarine cable field joint area (vibrocore locations RV12 and RV13 (Drawing No. **MCL/P132/EIA/10-002**)) for all samples results shown the concentration of OCs are below detection level (i.e. <0.05 mg/kg for sediment quality and <0.1 µg/L for elutriate test). Based upon this, release of sediment contamination during the open trench and minor excavation works at the field joint location for the diversion of the sub-marine electric cable would be considered to be low.

13.9.2.44 The potential exception to this would be the area above the CMPs, which has the largest potential for the release of contaminated materials if disturbed. About 30% of the 3RS land formation will be built over the CMPs to the north of HKIA. Operations involving bottom disturbance during site preparation and construction of the platform for the 3RS have the potential to result in the release of contained toxic contaminants (e.g., persistent organic pollutants, toxic metals, and butyltins) from within these CMPs. There would be concern, therefore, that the loss of moderately contaminated material to suspension could adversely affect water quality. However, the data obtained from the previous and on-going monitoring programmes for the disposal operation at East Sha Chau CMPs, does not indicate that the contaminated mud disposal is having an impact on marine water quality. In addition, a risk assessment conducted for the ecological monitoring programme of CMP IV (Mouchel 2002a) which examined pollutants in trawling catches from the mud pit area and two reference sites, one near SCLKCMP and the other to the southwest of the airport island, confirmed that only three contaminants could be of potential risk to the CWDs. However, TBT and MBT were found to be only marginally in excess of the risk index (RQ, Risk quotient) and thus only a very slight concern to CWDs health. The third contaminant, arsenic, showed no significant difference in concentrations in fish at the reference sites versus those at the mud pits, and as arsenic is naturally occurring in north Lantau, would not cause any project specific impacts.

13.9.2.45 In addition, based upon a DCM trial (detailed below and in **Section 8.7.1**), the findings from the tracer dilution model showed that even with the assumption of 100% release of pore water during the DCM process, the concentrations of all contaminants observed at the ecological sensitive receivers would still be well below the relevant criteria or baseline. It is therefore anticipated that any release of contaminants during the land formation process there not have any unacceptable adverse impact on marine fauna due to pore water release from the Contaminated Mud Pits (CMP).

13.9.2.46 The findings of the DCM field trial over the CMPs demonstrated that the DCM installation process is not expected to result in pore water contaminant release would also mean that construction of the bored piles for the approach lights and the marker beacons would also not be expected to result in the significant release of contaminated materials.

13.9.2.47 Based upon this, and the proposed deployment of silt curtains to completely enclose the pile installation works to prevent the release of SS, as recommended by the Water Quality Assessment (**Chapter 8**), any SS released would be contained and contamination release would be minimal and would not be expected to have any significant ecotoxicological impact on the CWDs. Thus, it is concluded that the impact to CWDs from the release of suspended solids could be an insignificant impact and specific mitigation measures would not be required given appropriate water quality mitigation measures would be taken.

Oil / Chemical Spillage

13.9.2.48 Spillage of oil and chemicals during the construction phase could release key pollutants such as oils and fuels and possibly the organochlorine classes of PCBs into the marine environment which could be included in hydraulic oils, paints, plastics, and rubber products. While basic oils and fuels, have not been recognised as the major pollutants affecting CWDs in Hong Kong, they do indeed have the potential to harm the animals (Jefferson et al. 2006). However, PCBs have been reported to interfere with the health and reproduction of the CWDs (Jefferson et al. 2006).

13.9.2.49 By far the most serious environmental consequences of a major fuel spill would occur in the early stages when the split material may form extensive slicks on the sea surface. Direct contact with the oil or chemicals may affect many types of marine organisms.

13.9.2.50 CWDs themselves are able to metabolise and excrete hydrocarbons and, thus, elevated accumulation within the CWD tissue is most unlikely. However, cetaceans are known to have a very limited ability to metabolise organic contaminants, such as DDTs, PCBs, etc., and these substances appear to bioaccumulate in their tissues (Jefferson et al. 2006). Hong Kong sediments have been found to contain significant quantities of PAHs and other petroleum hydrocarbons, which suggest that dolphins are being exposed to certain levels of these contaminants at low background levels (Zheng and Richardson 1999).

13.9.2.51 However, marine mammals have the ability to detect hydrocarbon spills and can take evasive action although the available evidence is not conclusive. Studies on captive bottlenose dolphins (*Tursiops truncates*), a species that is related to, and shares many ecological characteristics with the CWDs, showed that the dolphins can detect and avoid crude oil and mineral oil slicks (Smith et al., 1983; Geraci and St. Aubin, 1987). CWDs in coastal areas, and especially those that inhabit bays and estuaries, are potentially more vulnerable to oil spill effects than are more oceanic species (Geraci 1990; Wursig 1990).

13.9.2.52 The most detailed observations of dolphins' responses to spills and oil spills in particular, and those most pertinent to the Hong Kong situation, are those of Smultea and Wursig (1992,1995) after the Mega Borg oil spill in 1990 in nearshore waters off Galveston Bay, in the Gulf of Mexico. Bottlenose dolphins were observed for several days from aircraft in the area around the

oil spill. The dolphins consistently detected and avoided mousse oil, although group structure appeared to break down as dolphins moved around it.

13.9.2.53 In addition, biomagnification of spilled hydrocarbons through the marine food chain is unlikely to be a particular concern for CWDs. The principal food species of the CWDs are estuarine fish although squid and crustaceans (shrimp) are occasionally preyed upon (Jefferson, 1998; 2000). Both fish and crustaceans are able to metabolise petroleum hydrocarbons (Capuzzo and Lancaster, 1981; Whipple et al., 1981; Brzorad and Burger, 1994) relatively efficiently although there is some risk from species including molluscs (for example, squid that can form part of the CWDs' diet) which can store hydrocarbon pollutants.

13.9.2.54 In addition, demersal fish species swim predominantly under the surface and are very unlikely to come into direct contact with oil should a spill occur (with the fuel floating on the surface once spilt and evaporating rapidly). The chance of contaminated fish being subsequently eaten by a dolphin is very minimal. Dolphins do not lick themselves and as any spilled material would be in extremely small quantities and would not persist in the environment to cause any long term impacts, the likelihood of dolphins getting enough toxic chemicals into their systems through the food chain to do serious harm is small (Jefferson, pers comm.).

13.9.2.55 However, spills from land and construction vessels accidents may cause oil or chemical spillage and any large scale spill could potentially have an impact on CWDs. Any works on land that could result in construction run off or spillage of oils or chemicals will be controlled through good practice measures as detailed in **Chapter 8** and ProPECC PM 1/94 "Construction Site Drainage". All Contractors will prepare an oil/chemical spillage response plan to ensure that should any leakage or spillage occur it will be contained and appropriately cleaned-up before entering the drainage system and the marine environment.

13.9.2.56 In terms of construction phase vessels, a series of measures are under development that are intended to ensure that vessels working on the 3RS project during the construction stage are effectively managed and coordinated such that any risks of collision between works vessels and between construction traffic and other marine traffic incidents in and near the works area as well as elsewhere in Hong Kong are minimised. A works area for the 3RS project is expected to be demarcated by floating booms, as shown in Figure 3 of **Appendix 13.13**. Although full details on construction marine traffic management arrangements in and near the works area are not expected to be finalised until closer to commencement of construction, measures are expected to include but not be limited to:

- Designated works area to be marked out by floating booms, identified vessel routes within the works area, designated site entrances;
- A system to monitor and control the movement of construction vessels; and
- A vessel speed limit within the works area anticipated to be 10 knots or less

13.9.2.57 These measures would mean that the risk of any marine accidents within the construction works area would be negligible. Thus, oil and chemical spillages would occur only under rare accidental events. However, should an incident occur, an emergency call-out procedure to deal

with the spillage would be in place to ensure it is rapidly contained and cleaned as far as possible to minimise the risk to the marine waters and marine life.

13.9.2.58 Notwithstanding, the capacity of the fuel tanks for the construction barges and vessels would be only relatively small but assuming all the spill did enter the marine waters, as the fuels all have a specific gravity of less than 1 (water), they would all float on water. In respect of any petrol and diesel, the natural process of the spill spreading would reduce its thickness and allow the process of wind and wave action in breaking up the spill to increase as well as evaporation and dissolution. Dispersion of any spill will occur more rapidly in high energy waters which occur in the works area for the 3RS project but in lower flow areas, dispersion could take longer. Notwithstanding, it is likely that any spill would disperse in region of 3-4 days without any long term effects on water quality (ERM 1995) and diluation rates would be large.

13.9.2.59 In addition, behavioural studies of local CWD suggests that the normal swimming speed of the dolphins is about 1-2 m/s although as high as 4-6 m/s has been reported. The mean diving time is about 29 seconds although as long as 270 seconds has been recorded (Jefferson, 2000). Thus, given the rapid dispersion/dilution and small quantity of material involved, it would, thus, appear that a CWD could easily swim away from a spill without difficulty even if a spill did occur in its vicinity.

13.9.2.60 Overall, it would appear that, there is evidence to suggest that CWDs are able to detect oil and outrun a spill without difficulties, notwithstanding the fact that the probability of a CWD actually coming into a contact with a spill in the first instance would be very low. As such, the likelihood of any actual exposure would be very small and of short duration.

13.9.2.61 In terms of the potential to affect the food chains and accumulation in CWDs, it should be noted that the vast majority of the spilled hydrocarbons (HCs), in the case of an oil spill, will be lost through evaporation and other weathering processes in a very short time (that is, 2-3 days even for a large spill) and the amount remaining in the marine environment will be extremely low thereafter. Thus, the remaining amount of HCs which would ultimately become bio-available will be very small. As noted above, fish and crustaceans have the capability to metabolise/detoxify/excrete the petroleum hydrocarbons.

13.9.2.62 While it is evident that certain pollutants can be extremely harmful to CWDs, based on the above, the risk of the spillage during the construction of the 3RS project is expected to the negligible, or will be rapidly contained or dispersed by natural wave actions if such an incident did occur. In addition, the CWD have the ability to avoid such spills and thus, this issue is considered of low impact significance to the CWDs and no specific mitigation would be required, although the Contractor(s) would prepare a spill response plan as a precautionary measure.

Release of Contaminants during Deep Cement Mixing

13.9.2.63 Deep cement mixing (DCM) has been proposed for the formation of land for the airport platform and runway and for the seawall construction both within the area of the CMPs at East of Sha Chau just north of the existing airport platform, as well as particularly for some works outside the CMPs.

13.9.2.64 The DCM method requires that cement is used to mix with the marine deposits to improve the shear strength of the bearing stratum and to reduce the consolidation settlement of the bearing stratum under load and has the advantage of avoiding marine sediment dredging. The broad process of DCM is described below.

13.9.2.65 Cement slurry is mixed with the sediment by a rotating paddle inside a metal casing. When the mixing system reaches the seabed and is no longer contained, the injected cement has the potential to leak into the environment. Leakage of cement slurry in the last section of the column formation can be as much as 5% of the application, and could affect water quality in terms of suspended solids and local changes to pH, potentially leading to an increase of ammonia toxicity to sensitive species such as juvenile fish which could in turn affect the prey of the CWDs. The waters in the study area are nitrogen enriched and the Water Quality Objective (WQO) of 0.021 mg/l for un-ionised ammoniacal nitrogen level could potentially be exceeded by the leaked cement even though any impact would likely be localised to the leakage area. There is also the possibility of this construction method disturbing the marine sediment, and in the case of the areas above the CMPs, release contaminants into the water column which could affect marine life including the CWDs. In addition, underwater noise from the use of DCM could cause disturbance to the CWDs and could be a potential source of impacts.

13.9.2.66 The DCM method has been widely used in Japan (though it has not been previously adopted in Hong Kong). Based on past DCM operations for marine construction work in Japan, there is no appreciable SS release or other water quality impacts attributed to the DCM works (refer to **Appendix 8.2**).

13.9.2.67 In addition, a trial study of the use of the DCM method above the CMPs was undertaken in February 2012 (Mott MacDonald 2012) and included extensive water quality monitoring and assessment and underwater noise measurements to determine the potential impact to water quality and marine life from the DCM method. The DCM Trial Report findings are summarised below:

- The use of DCM did not result in any appreciable deterioration of water quality;
- No leakage of contaminants from the CMPs where the trial was undertaken were detected;
- There was no significant elevation of turbidity or suspended solids as a result of the use of the DCM method;
- The DCM trials were relatively quiet, compared to other marine construction techniques;
- There was almost no detectable increase to the background noise levels beyond a distance of 250 m; and
- The noise that was generated was typically below 200 Hz, which is a frequency of low sensitivity for CWDs.

13.9.2.68 Based on the above, the DCM method is not expected to release any contaminants into the marine waters, either as a result of cement leakage or disturbance to the seabed sediments, or create underwater noise to a level that would cause any impacts to the marine environment or

the CWDs. As such, any impacts from the use of DCM on the CWDs are considered to be low and no specific mitigation would be required.

13.9.2.69 Notwithstanding, there will be barges and other support vessels and traffic related to DCM and it is envisaged that these activities will themselves be somewhat noisy (such as in the noise associated with lowering and raising of anchors), and that CWDs are likely to temporarily avoid the immediate area. The potential impacts from these construction works are discussed in the 'Acoustic Disturbance from Construction Works' section**, Sections 13.9.2.76** to **13.9.2.88** below.

Impacts from the Importation/Transportation of Marine Fill and Filling Activities

13.9.2.70 The importation or transportation of marine fill will follow the good site practices to be adopted for marine works, with barges or hoppers not filling to a level which will cause overflow of materials or pollution of the marine waters during loading or transportation, and adequate freeboard shall be maintained on barges to reduce the likelihood of decks being washed by wave action. With the implementation of these measures, the impacts of potential sediment runoff from marine barges due to importation and transportation of marine fill is anticipated to be low. It should also be noted that, as detailed in **Appendix 13.13** (Figures 4 and 5) the barges for the delivery of marine fill will be routed from the north, east and west of Lantau. However, they will not pass through the waters south of Lantau and through the key habitat of the Indo-Pacific Finless Porpoise and therefore, this species of conservation importance will not be affected by these activities in this area.

13.9.2.71 The land formation area will be divided into a number of works areas with the general sequence of methods comprising the placement of the sand blanket on the seabed, conducting ground improvement works, constructing a minimum of 200 m leading seawall to confine the works area and depositing marine fill. The sand blanket laying/ marine filling works will be carried out in phases from late 2015/ early 2016 to late 2021, with majority of the works completed by late 2018.

13.9.2.72 The release of SS from the proposed land formation works is expected to be a temporary situation, that is between years 2015 and 2017, as substantial completion of the seawall surrounding the land formation footprint is scheduled to be completed by the end of 2017 (see the construction programme in **Appendix 4.1**). As a result the potential dispersion of sediment plumes to the surrounding marine environment would be limited to that period. In addition, the filling operations will only be undertaken behind a minimum of 200 m of leading seawall to prevent the dispersion of suspended solids and the water quality modelling has shown this to be effective and all SS from the filling operations to be within acceptable levels as discussed below.

13.9.2.73 As detailed in **Section 8.6.3**, two worst case scenarios, namely, scenarios A and B, have been selected for modelling of the SS levels in the marine environment during the construction phase of the 3RS project. The worst case scenario A refers to Q1 of year 2016 when the key construction activities would be sand blanket laying and ground improvement at open sea conditions (seawall yet to be built). The worst case scenario B refers to Q1 of year 2017 when the highest sediment loss would be expected due to the highest number of vessels undertaking ground improvement (via DCM) and marine filling activities with partial seawall completion.

13.9.2.74 Based on the water quality modelling results (see **Section 8.7.1**), it is predicted that the unmitigated SS levels (due to the project only) at the Brothers and SCLKCMP CWD habitats would be up to 3.50 mg/L and 1.95 mg/L respectively under the worst case scenario A, and up to 3.00 mg/L and 2.43 mg/L respectively under the worst case scenario B. All such predicted SS levels are within the WQO for SS, that is no more than 30% elevation from the ambient conditions.

13.9.2.75 The release of SS is not a key concern for the CWD that habitat waters subject to high fluctuations in sediment concentrations as noted above. However, some disturbance can occur with elevanted SS levels but in the case of the marine filling, SS levels will be controlled by the filling rates and the leading edge of seawall, as demonstrated by the water quality modelling results. Although the works can cause acoustic disturbance, which is assessed separately below, marine filling and transport of marine fill materials is not considered to be a major source of threat to CWDs. The magnitude of such impacts to CWDs in Hong Kong from this project is considered to be small and the significance of impact to be low and no mitigation would be required.

Acoustic Disturbance from Daytime Construction Works

Bored Piling

13.9.2.76 Underwater noise caused by human marine activities has the potential to cause disturbance of the CWDs normal activities and can mask important communication and ranging sounds. While such noise can occasionally be intense and loud enough to injure or kill CWD (such as in the case of blasting or percussive piling operations), the impacts on dolphins are usually sub-lethal and affect behavioural patterns and activities. Anthropogenic noise is believed to be a source of stress for cetaceans (Wright et al. 2007).

13.9.2.77 Marine percussive piling operations have been avoided during the construction of the 3RS project as this method is considered to be potentially very harmful to CWDs (Jefferson et al. 2009). The avoidance of percussive piling will help to reduce potential noise impacts on the CWDs.

13.9.2.78 However, while not involved in other marine works such as land formation and seawall construction, bored piling is required for the construction of the new runway approach lights to the east and west of the new runway and marker beacons. Although there is information available on noise produced by percussive piling (Richardson et al. 1995; Würsig et al. 2000), very little has been published about noise and effects of bored or vibratory piling. However, this technique is undoubtedly much quieter than percussive piling and has much less potential to cause injury or serious disturbance to CWDs.

13.9.2.79 Noise created by bored piling methods tends to be a less intensive continuous noise, rather than the pulsed high power sounds emitted through percussive piling. Thus, bored piling usually creates a steady sound that is less disruptive to CWDs than the pulsed or burst sounds associated with activity such as percussive piling (Wursig et al., 2000). CWDs are known to habituate to low-level sounds such as those produced through bored piling (Greene and Moore,

1995). While the noise will not result in any injury to the CWDs, it is considered that there is the potential for CWDs to avoid the areas where the works are being undertaken.

13.9.2.80 While bored piling works generally takes a longer time period to drive the piles, the bored piling works required for the landing lights and marker beacons will be completed within a few weeks and as such, the duration of the impacts will be very short and localised. In addition, the bored piling has been scheduled to avoid peak CWD calving season during March to June.

13.9.2.81 Due to the small amount of bored piling work envisioned for this project, its short duration and the avoidance of the peak calving season, it is considered that this issue would be of low impact significance and no mitigation would be required. However, the use of a dolphin exclusion zone will be implemented as a precautionary measure.

Re-Alignment of Fuel Pipeline

13.9.2.82 The Horizontal Directional Drilling (HDD) method will be adopted for the diversion of the aviation fuel pipeline involving drilling through bedrock from a launching site located at the west of the airport island to the daylighting point adjacent to the offshore receiving platform at Sha Chau. Two holes will be drilled through the deep rock stratum at depths of 90-120 m below the seabed. Underwater noise generated by HDD and associated vibrations may potentially impact CWDs given that they are acoustically sensitive. However, noise from HDD tends to be a less intensive continuous noise, rather than the pulsed high power sounds emitted through percussive piling and it is anticipated that negligible noise will enter the water due to the depth of drilling below the seabed. The sound transmitted from the rock stratum to the marine environment is not expected to be significant as a large proportion of the sound energy is likely to be absorbed or reflected due to the thick layer of marine mud between the seabed and water interface.

Laying of Electrical Cables

13.9.2.83 Diversion of the submarine electric cable requires a combination of direct bury (water jetting) for most of the 6 km of cabling, the excavation of a section of open trench and minor excavation at a field joints outside of the SCLKCMP. These activities are not likely to generate significant noise and would be an insignificant impact, but attendant vessel(s) at the areas of excavation could cause disturbance. In addition, potential nuisance impacts could occur in relation to the short term deployment of temporary working platform for the submarine electric cable diversion which may cause disturbance to CWDs. Impacts from such general construction works are discussed and assessed below.

General Construction Works

13.9.2.84 Limited details are, known about the effects of dredging or reclamation work on cetaceans. The available literature relates to large whales and involves dredging. Richardson et al. (1990) conducted sound playback experiments with bowhead whales (*Balaena mysticetus*) in the Arctic, and used sounds recorded from active dredgers. The whales showed some behavioural responses, changing their vocalisation patterns, feeding and diving behaviour when the noise corresponded to that of dredgers at about 3-11 km distance.

13.9.2.85 However, reactions of CWDs may differ and, in general, the increased use of high frequency sound by CWDs would be expected to make them less vulnerable to the effects of equipment such as dredgers, which generally produce very low frequency sounds (less than a few kHz - see Greene 1987). Also, stationary dredgers appear to have less effect than more transitory sound sources (Richardson & Würsig 1997). The only small toothed whale for which there are some quantitative data on reaction to dredgers appears to be the beluga whale. In general, belugas did not react much to dredgers and whales were sighted well within the ensonified areas, suggesting that they did not find the noise to be highly disturbing (Richardson & Würsig 1997).

13.9.2.86 The most serious concern is that disturbing noise would cause CWDs to abandon critical habitat and thereby reduce their survival and reproductive prospects. Jefferson (pers. obs.) has observed CWDs in Hong Kong moving very close to grab dredging operations near the Sha Chau area and the CWDs appeared to be attracted to the disturbance of the sea bottom as the work could make the prey more accessible. This is probably indicative that the level of disturbance is not major. However, there is data to suggest that dredge/fill activities and coastal reclamation have a negative population-level impact on CWDs as shown by the dumping of contaminated marine mud at East Sha Chau (Hung 2008).

13.9.2.87 As discussed above, the use of dredging and excavation of the seabed for the 3RS project has been minimised as far as possible and the works that do require excavation would be of short duration. The potential noise from the DCM works for the land formation has also been assessed above (see **Sections 13.9.2.63 - 13.9.2.69**) and is not predicted to create underwater noise to a level that would cause any impacts to CWDs. Significant acoustic disturbance from backfilling is also not predicted with the impacts from the marine vessels assessed in **Section 13.9.2.93.**

13.9.2.88 While there is virtually no possibility of severe damage to the CWDs from this acoustic disturbance and the frequencies are probably of a level not heavily used by the CWDs so their communication will not be significantly impaired, the excavation and backfilling works may result in at least temporary abandonment of habitat both to the north and also potentially to the west of the airport (see Jefferson 2000), forcing animals to spend time in lower-quality habitats, which in turn, could lead to lowered fitness, reduced reproductive output, or reduced survival. A low-moderate impact is predicted and no specific mitigation measure is considered necessary, but precautionary measures such as acoustic decoupling will be implemented.

Acoustic Disturbance from Nighttime Construction Works

13.9.2.89 Construction activities including land formation utilising the DCM method for ground stabilisation, filling activity and general marine construction activities will be undertaken 24-hours a day in order to meet the constraints of the 3RS development programme. Thus, much of the construction work for this project will occur during periods of darkness. This is considered worthwhile from a dolphin impact point of view, in terms of reducing the overall time period of the construction works and such an approach has also been used in other recent projects in Hong Kong, including the original airport construction. Preliminary studies during the baseline monitoring surveys for the EIA report using passive acoustic monitoring (EARs) have indicated that CWDs do occur in the 3RS project works area north of the current airport during the

nighttime. There is even some indication of increased CWD vocalisation rates at night compared to the daytime which may indicate increased levels of CWD activity at night in this area, although this is at present somewhat uncertain, as CWDs may simply be vocalising more at night. While it is not absolutely known what differences in behaviours there might be by the CWDs at nighttime compared to during the day, it is possible that there may be more feeding than travelling in the area north of the airport at night than in daytime.

13.9.2.90 Although impacts to CWDs from construction works (such as potential noise disturbance, changes in distribution and abundance, habitat fragmentation, reduction in carrying capacity, etc.) are essentially the same at night as during the day, because details of behaviours and occurrence patterns are not confirmed for the nighttime, as noted above, it is necessary to adopt a precautionary approach to the assessment. It is reasonable that high speed ferry traffic is lower at night than during daytime and therefore the corridor available to the north of the construction works is likely to be more available for CWD at nighttime than during daytime. This potentially makes the area north of construction works more favourable for CWDs at night and it is concluded that because of this and based on a precautionary principle, nighttime construction impact significance should be assessed as moderate and therefore appropriate mitigation measures would be required.

Acoustic Disturbance from Marine Vessels and Ferries

13.9.2.91 Marine vessel traffic can result in acoustic disturbance to CWDs and the more vessels there are and the faster the speed of the vessels, the greater the noise disturbance that would be created. Small cetaceans are acoustically-sensitive, and noise from marine traffic could cause behavioural disturbance (Würsig and Richardson 2009). Since CWDs and porpoises rely on their echolocation to navigate their surroundings, detect and capture prey, avoid predators, and communicate with one another, sound is vital to their survival (especially for mother-calf pairs). Humpback dolphins mainly produce lower-frequency, broad-band clicks in the range of about 2 kHz to >22 kHz during foraging and other activities (Van Parijs and Corkeron 2001, Sims et al. 2011). In comparison, large vessel traffic generally produces low frequency sounds of less than 1 kHz (Richardson et al. 1995), although ambient sound pressure levels near noisy shipping lanes in Hong Kong waters, in large part created by high speed ferries, can surpass 100 dB re. 1 µPa even up to a frequency of about 10 kHz (Sims et al. 2012).

13.9.2.92 Recent dedicated studies have investigated this aspect on Hong Kong CWDs (Ng and Leung 2003; Hung 2012; Sims et al. 2012; Piwetz et al. 2012). Sims et al. (2012) reported that vessel noise at about 100 m away exceeded the levels of CWD sounds at closer distances, suggesting that vessel noise is causing masking effects on CWD vocalisations, based upon a recent audiogram of a CWD (Li et al. 2012). This could result in behavioural disturbance to the CWDs, including, for example, a decrease in efficiency of feeding. If severe enough, CWDs may be displaced from their preferred habitats.

13.9.2.93 During the construction stage, large numbers of construction barges and other vessels will be required during the formation of the new land for the 3RS project. The average barge movements during the construction works are shown in Figure 4, **Appendix 13.13** (P281 Design Report BMT, April 2013), with the average number of construction vessel movements to and from the west of the works area being 42, and to and from the east of the works area being

22. During peak construction periods, these numbers would increase to about 120 and 60 vessel movements, respectively (Figure 5, **Appendix 13.13**). In addition, there will be about a peak of 120 stationary vessels located within the works area which will house the land formation plant and equipment, with an average of about 100 vessels anticipated to be working within the works area during the peak periods from 2016 Q2 to 2017 Q4. As these vessels will not be moving overall, they would not generate any vessel noise. The noise from the use of the equipment on the vessels, however, is assessed in **Sections 13.9.2.84 to 13.9.2.90** above.

13.9.2.94 However, the construction vessels will be largely slow-moving barges and crew boats, and while the activities they will be undertaking, backfilling etc, can cause noise disturbance, the noise from the movement of the vessels themselves would not be expected to have a serious impact on CWD behaviour and would be considered to represent a low impact.

13.9.2.95 Notwithstanding the construction vessels, the area around HKIA is also well used by other marine traffic and indication of recent volumes of marine traffic is given in **Table 13-26** which presents a breakdown of vessel traffic based upon visual surveys of four major navigation "gates" in western waters. The visual surveys capture all vessel traffic and types passing through the four gates during daytime hours and gate locations are shown in Figure 1, **Appendix 13.13**.

Table 13-26: Average Daily Daylight Marine Traffic Volumes (07:00-19:00) Visual Survey (between 6 September and 16 October 2012)

Vessel Classes	Gate 1 Towards Y3 Anchorage to the Southwest	Gate 2 Towards Lantau Island No, 2 Anchorage	Gate 3 Channel between Sha Chau and HKIA at Chek Lap Kok	Gate 4 Urmston Road
Ocean-going	0	0	0	24
River-trade	29	39	31	155
Tug & Tow	1	1	1	10
Fast Ferry(1)	10	19	28	86
Fast Launch	7	8	7	12
Small Craft	62	56	39	46
Total	**109**	**123**	**106**	**333**

Note: Visual Survey undertaken between 6th September and 16th October 2012

(1) Includes High Speed Ferries from SkyPier

13.9.2.96 The results above show that all of these waterways are used by a variety of vessels on a daily basis, with Urmston Road being the most utilised. Of the vessel types, High Speed Ferries (HSFs) pose the most significant collision threat to CWDs and are also known to generate the loudest underwater noise. The visual survey data identifies that the majority of HSFs in western waters use the Urmston Road, with a smaller number transiting through the other gates, including the channel between HKIA and the Lung Kwu Chau and Sha Chau Marine Park boundary, this route being more direct for those ferries travelling to and from Hong Kong to Macao and Zhuhai via northern Lantau waters.

13.9.2.97 HSF movements between Hong Kong's downtown ferry terminals and Macao / Zhuhai transit south of Lantau Island making use of the Adamasta channel as this is the well established route

for these journeys, with a small percentage of these total transits occurring north of Lantau Island, usually to avoid inclement weather or high sea swells in waters south of Lantau. **Table 13-27** below shows a daily average of 108 HSFs transit using Gate 4 (at Urmston Road, Figure 1, **Appendix 13.13**), while the daily average of HSFs utilising the channel between HKIA and the existing marine park is 58 in Year 2011 (Table 2, **Appendix 13.13**). Based on review of the Marine Department Automatic Identification System (AIS) Data under the Marine Traffic Impact Assessment Final Report (BMT, Aug 2012), a notable proportion (59% between the airport and Sha Chau and 50% at Urmston Road) of the total number of HSFs using these navigation routes are from SkyPier, as shown in **Table 13-27**. The proportion of the yearly HSF volume transit these navigation routes would be subject to around +/- 10% variation.

13.9.2.98 While **Table 13-27** below shows a daily total of 108 ferry transits using Gate 4 (at Urmston Road, Figure 1, **Appendix 13.13**), this total differs slightly from the 86 fast ferries noted in **Table 13-26** above as the surveys were visual surveys during daytime (07:00-19:00), as opposed to being determined from the Marine Department Automatic Identification System which covers 24 hours, and were undertaken during a different time.

Table 13-27: Daily Average HSF Movements from Marine Department Automatic Identification System (AIS) Data between December 2010 and November 2011 (BMT, Aug 2012)

Origination / Destination	**Number of Fast Ferries**	
	Between the airport and Sha Chau	**Urmston Road**
SkyPier	34 (59%)	54 (50%)
Non-SkyPier (HK China Ferry Terminal or Macao Ferry Terminal	24 (41%)	54 (50%)
Total	**58 (100%)**	**108 (100%)**

13.9.2.99 As shown in Figure 1, **Appendix 13.13**, the existing marine vessels including HSFs from SkyPier, river trade vessels and small craft, transit through the area north of the existing airport platform. However, a 3RS land formation works area will be designated and demarcated by floating booms, as detailed in (Figure 3, **Appendix 13.13**), and based on this, and as the land for the 3RS new platform is formed, the navigation routes for these vessels will be constrained to within a narrower area just north of the new HKIAAA area (Figure 6, **Appendix 13.13**), although no change to the direction of traffic flows are expected, these continuing to comprise two-way transits east and west.

13.9.2.100 In addition, during the period of the 3RS construction, it is expected that vessel traffic, including HSF traffic, may grow. Based on the Marine Traffic Impact Assessment Final Report (BMT, Aug 2012), HSF traffic is expected to increase by an annual growth rate of approximately 2.9% over 2011 levels for SkyPier, resulting in an increase in the number of HSFs from SkyPier in the northern Lantau waters to approximately 45 per day between the airport and Sha Chau and approximately 70 per day in Urmston Road in 2021. The projected number of non-SkyPier HSFs is approximately 30 per day between the airport and Sha Chau and approximately 65 per day in Urmston Road. This would result in the volume of SkyPier HSFs as a percentage of the total HSFs using the waters north of the airport platform remaining at approximately 60% as per the current situation detailed in **Table 13-27** above and at approximately 50% for SkyPier HSFs in Urmston Road. It is worth noting that while forecasts show an increase in HSF movements over this period, the effect of the introduction of direct competition to ferries operating between SkyPier and Macao / Zhuhai is to some extent unknown once the HZMB / HKBCF becomes

operation during this period. As the HSFs using SkyPier are the only ferries associated with the airport operations and within the control of the AAHK, only the impacts from these ferries, and not the other ferries operating from the Hong Kong and China Ferry Terminals on Hong Kong Island and the Kowloon Peninsula, respectively, can be mitigated.

13.9.2.101 As discussed above, based on the progressive land formation works, the CWDs will also have to abandon its preferred travelling area to the north of the existing airport platform and would be predicted to be pushed further north and interfacing more with the re-routed Sky Pier HSFs and the marine traffic within the Urmston Road. While the potential for increased risks of collisions between the CWDs and the vessels are discussed below, as noted above, potentially closer distances of the CWDs to marine vessels, particularly HSFs, could result in underwater noise levels changing CWD behaviours and even potentially masking their vocalisations. This would not likely affect the nearshore area of the airport west survey area, except where high speed vessels would traverse the area further to the west. The nearshore area to the west might therefore become an area of more frequent use by CWDs.

13.9.2.102 Therefore, the cumulative characteristics of construction noises, noise impacts from the rerouted HKIA SkyPier HSFs and other marine traffic and the potentially shortened distance to other traffic within the Urmston Road are considered to be of moderate impact significance and mitigation measures in the form of speed restrictions for SkyPier HSFs, with lower travelling speeds resulting in lower noise impacts, will be needed to ameliorate the predicted impact. Underwater noise monitoring will also be included as part of the EM&A programme in order to monitor the effectiveness of the mitigation.

Injury/Mortality from Construction Marine Traffic and Other Marine Vessels

13.9.2.103 Collisions with marine vessels have recently been identified as a significant cause of injury and death for many species of small cetaceans worldwide (Van Waerebeek et al. 2007). The AFCD stranding programme has been running for well over 18 years and provides notable information on the cause of death for CWDs in Hong Kong. Of the 179 CWD strandings documented in Hong Kong, the cause of death (COD) could only be identified in 10% of cases due to decompostion. Where COD could be determined, 8 (4.5%) were from vessel collision, 7 (3.9%) were from fisheries activities, 2 (1.0%) were disease related and 1 (0.6%) was from another cause (net ingestion). These figures represent absolute minimum numbers and it is reasonable to assume that a notable proportion of the other 90% of strandings that did not have COD identified could have been as a result of vessel collision, as it is identified as the most frequent cause of death in the CWDs and from international evidence (Wells and Scott 1997; Honma et al. 2001; Van Waerebeek et al. 2007; Ritter 2010; Carillo and Ritter 2010). This indicates that vessel collision is the most common cause of death for CWDs based on the AFCD stranding database, and it indicates that vessel collisions would appear to be a factor in the cause of death for Hong Kong CWDs (see Jefferson et al. 2006, Van Waerebeek et al. 2007). Thus, this can be considered as a threat, with high-speed vessels (especially passenger ferries) being thought to be a key culprit.

13.9.2.104 In addition, to those CWDs that are killed outright by vessel collisions, some CWDs are hit and injured. Analysis of the AFCD photo-identification catalog indicates that between 1.2 and 1.8% of known individuals had obvious evidence of injuries from previous vessel collisions on their

bodies, noting that this is likely to be an underestimate of the true numbers (Jefferson et al. 2006). These animals had suffered serious injuries (see Jefferson et al. 2006), which would have compromised the CWDs' health and fitness.

13.9.2.105 As detailed above, up to 64 average daily construction vessel movements would be expected during the construction of the land platform for the 3RS, rising to 180 during peak times. This marine traffic would be in addition to the existing marine traffic movement (**Table 13-27** above), and could increase the risk of collisions between the CWDs and the vessels. This could be compounded by the fact that, as noted in **Table 13-26** and **Table 13-27** above, the navigation route for ferries from the SkyPier, and other fast ferries, will be shifted as the project commences to further north of the ultimately new land formation area (Figure 6, **Appendix 13.13**) into an area that the CWDs would also be forced to use as part of their preferred travel area is lost by the land formation. This will ultimately become a permanent arrangement once the land formation works are completed.

13.9.2.106 The vessels that will be involved in construction activities for this project are slow-moving and these vessels would not be expected to spend a great deal of time around dolphin groups. Therefore, the risk of collision with CWDs will be smaller than for fast-moving vessels. However, given the large number of vessels movements per day, in addition to the existing vessel movements in this area of marine waters, the risk of CWD collisions with the construction vessels is considered to represent a low impact.

13.9.2.107 High-speed vessels, generally those travelling over 20-25 knots, travelling through CWD habitat, however, are of notable concern because small cetaceans are not always able to get out of their path. High-speed vessels can strike and injure, or kill, small cetaceans as indicted by the international research and evidence of the effects of marine traffic on cetaceans (Wells and Scott 1997; Honma et al. 2001; Van Waerebeek et al. 2007; Ritter 2010; Carillo and Ritter 2010). The ferries utilising the SkyPier would move up to full speed of 30 - 40 knots within about 1-1.5 km of leaving or prior to arrival at the pier and would be moving at high speed while navigating through the waters north of the airport island. These same problems can affect CWDs if high speed vessels traverse west of the airport. However, because of the configuration of the new third runway, it is not expected that high-speed vessels would traverse through the area immediately west of the airport including the nearshore area close to the western seawall, but that CWDs may be affected further out to sea where the high speed vessels may travel. Thus, the near shore areas of the airport west might become more heavily utilised by CWDs due to its relatively protected nature from vessels.

13.9.2.108 Based upon the newly constrained stretch of marine waters that high speed ferries and CWDs would have to share, the Hong Kong and worldwide known risk of collision from particularly high speed vessels and the risk of serious injury and mortality that could occur (see references above), the issue is considered a high impact and effective mitigation measures will be needed.

Changes in Movement Patterns Resulting from Construction Marine Traffic and Other Marine Vessels

13.9.2.109 A land-based study on Hong Kong CWDs showed changes in their diving behaviour in response to heavy vessel traffic (Ng and Leung 2003), and a more recent study, also land-based, showed

a significant increase in speed of travel of CWDs when in the presence of trawlers (Piwetz et al. 2012). Hung (2012, 2013) has also found evidence of increased CWD swim speeds in the presence of trawlers and increased reorientation in the presence of small tour boats and these findings are corroborated by the results of the project specific field surveys (**Sections 13.4.6.82** and **13.4.6.93**). Overall, there was indication that high speed ferry traffic within 500 m of CWD caused higher reorientation rates and lowered linearity than no or distant traffic, but sample sizes were only 6 in each case, and statistical significance could therefore not be fairly determined.

13.9.2.110 As noted above, both construction marine traffic and fast vessel traffic from the SkyPier will be utilising the navigation waters between HKIA and the SCLKCMP as a result of the land formation works and this has the potential to impact the passage of CWDs (who will also be forced further north for travelling) between the core areas of habitat use in northern Lantau waters or may otherwise deter CWDs from using waters where vessel traffic is increased and narrowed. Interface with the faster moving vessels, such as the SkyPier HSFs, their fast changing noise characteristic and the need to try and out swim or avoid the vessels, can cause stress to marine mammals, and therefore also CWDs (Mizrock 1995, National Research Council 2003). The stress can reduce fitness and hamper critical activities such as rest, feeding, socializing and reproduction.

13.9.2.111 It has been shown in numerous studies of marine mammals that marine traffic can have adverse effects on behaviours (including abandonment of habitat), hearing, masking of communication, habituation or tolerance, sensitisation, physiological stress (summarised in National Research Council 2003, Würsig and Richardson 2009). The short term reactions described by CWDs from other and the present EIA related studies are indicative that some manner of long-term effects summarised above could be taking place as well.

13.9.2.112 Construction vessels are mostly slow moving and therefore any impacts on CWDs behaviour from such traffic is likely to be low, compared to fast-moving vessels, which can be capable of major disturbance. In addition, the construction traffic will be temporary and past studies suggest that such temporary disturbances result in some recovery of activities after they are removed (Jefferson 2000; Jefferson and Hung 2004).

13.9.2.113 However, the potential impacts from the reduced distance and increased interface with HKIA SkyPier HSFs and other ferries to the north of the land formation area are considered to be of moderate impact significance, and appropriate mitigation measures will be needed.

Disturbance to the Function and Quality of Marine Parks

<u>SCLKCMP</u>

13.9.2.114 The Sha Chau and Lung Kwu Chau (SCLKC) Marine Park (MP), an area of 1,200 ha, is within approximately 1 km of the proposed 3RS project. This marine park was established primarily as a CWD management scheme during the construction of the original airport at Chek Lap Kok in 1996. Overall, it has been found to have been successful as a CWD protection measure, with increased densities of CWD being found within the marine park boundaries (Hung 2008). This means that activities associated with the construction of the 3RS project including the new

apron and runway and associated facilities, may have in-direct impacts on the functionality and quality of the marine park.

13.9.2.115 These potential effects would all likely occur through corresponding effects from gradual habitat loss from land formation, marine traffic and vessel noise and CWD prey resources, all of which are discussed in the respective sections above.

13.9.2.116 The SCLKCMP mainly serves to aid CWD conservation by providing a “safe area” where the CWDs are not subjected to threats like high-speed vessel traffic, marine construction activities, and fishing activities are also controlled in SCLKCMP. The addition of the 3RS is not likely to change this, as all of these protections will still be present and essentially unaffected by the creation of the project.

13.9.2.117 The issue of impacts of high-speed ferries is particularly relevant, as historical routes for HSFs ran between Sha Chau and Lung Kwu Chau. The establishment of this marine park effectively moved these ferry routes out of this area of high-density area for CWDs, increasing the value of the marine park in Hong Kong for reducing impacts of human activities on CWDs. While as noted above (**Section 13.9.2.100**), the number of HSFs from SkyPier would increase by approximately 2.9% annually over 2011 level during the construction period adding about 11 ferries per day to this route by 2021. This increase would not be expected to cause significant impact on the quality or function of the SCLKCMP.

13.9.2.118 It is possible that the building of the 3RS project could possibly result in an increased use of the SCLKCMP. CWDs may be displaced from the area north of the airport and could use the Sha Chau and Lung Kwu Chau area more. Such displacement during the construction works is considered to be a main reason why CWD numbers at Sha Chau declined during the AFRF construction and then recovered after completion (See Jefferson and Hung 2004). If this were to happen, then it could result in a benefit to the overall population by having more CWDs present in an area of protection. However, the increased density in the area could also result in more competition for food resources.

13.9.2.119 The fuel pipeline to the AFRF, located on Sha Chau, would require to be diverted. As described above (**Section 13.9.2.26**), the pipeline would be constructed using HDD through the sub-marine bedrock and would not result in any habitat loss, seabed disturbance or underwater noise. However, a temporary floating working platform will be constructed between Sha Chau Island and the offshore receiving platform, where the water is in the order of 4 m deep. The platform will be constructed of a series of interlocking barges and therefore will not cause any disturbance to the seabed. It will also be temporarily in position for about one year while the diversion works are on-going and no impacts to the CWD would be expected from this structure.

13.9.2.120 The pipeline welding works on the platform could however cause some noise disturbance to the CWDs key habitat. The SCLKCMP is used by the CWDs for all key activities but noise from welding works would likely be low and not cause any significant disturbance to the CWDs.

13.9.2.121 SI for the diversion of the fuel pipeline will be undertaken within the SCLKCMP, but will be over a very short duration and as detailed in **Section 13.9.2.26** the impacts on the marine environment would be insignificant.

13.9.2.122 Several issues discussed in detail elsewhere in this chapter would also likely have indirect effects on the marine park and its usefulness as a CWD conservation measure. These include habitat quality issues, such as potential loss of prey resources and hydro-dynamic changes to the water regime. These have generally been ranked as low for this project and it not believed that the project would notably degrade the quality of the marine park as CWD habitat. However, as the 3RS project works are in relatively close proximity to the SCLKCMP boundary at 900 m away, there is a need to adopt a precautionary approach and therefore, this issue is considered to be of low-moderate impact significance. With the implementation of precautionary measures including construction vessels speed limits and skipper training, no specific mitigation measure is considered required.

Planned Brothers Marine Park

13.9.2.123 The location of the planned marine park at the Brothers (BMP), an area of 850 ha, is within approximately 2.7 km of the proposed 3RS construction works. This planned marine park is also being recommended primarily as a CWD protection measure, since past research has shown this area around the Brothers to be an important feeding area, as well as the furthest east of the critical habitats for CWDs in Hong Kong (Jefferson 2007; Hung 2008). This means that activities during construction of the 3RS project and associated facilities have the potential to have an impact on the functionality and health of the potential marine park.

13.9.2.124 The planned BMP will not be directly affected and potential indirect effects would all be a result of the increased gradual habitat loss that could affect marine traffic movements and vessel noise and impacts to CWD prey resources, all of which are discussed in the respective sections above. In addition, due to the land formation of the 3RS project the CWDs would shift their existing travel route to the north as construction progresses. However, as noted in **Section 13.9.2.15**, if the new travel area is not used as extensively as the existing travel area, then CWDs may travel less to the Brothers area, and this could result in a negative impact on CWD abundance in that specific area. The number of HSFs from SkyPier will increase by 2.9% annually over 2011 level during the 3RS construction period. The HSFs exiting SkyPier and using the route between HKIA and Sha Chau, travel immediately west and away from the planned BMP. The HSFs using Urmston Road are some 500 m from the planned BMP boundary and the SkyPier ferries associated with HKIA operations that join the Urmston Road, do so opposite the River Trade Terminal and are some distance from the planned BMP. In addition, the increase in SkyPier high speed ferry traffic is not expected to be significant in terms of the function and quality of the BMP.

13.9.2.125 However, the fisheries production in this area is moderate, when considering the fisheries production distribution in Hong Kong as a whole. It has been concluded (**Chapter 14**) that there would not be any significant impacts on the sustainability of the fish resources, and specificialy the CWD prey species, due to the high mobility of the fish and availablity of prey for the CWD in the northern Lantau waters. Several issues discussed in detail elsewhere in this chapter would likely have indirect effects on the marine park and its usefulness as a CWD conservation measure. These include habitat quality issues, such as potential loss of prey resources and hydro-dynamic changes to the water regime. Because the Brothers area receives much of its freshwater input from the west, through the area of the 3RS Pproject footprint, it is possible that the project may degrade the quality of the marine park CWD habitat. However, water quality

modelling results indicate that this will not be the case. In view of the uncertainty on the effects of the construction works on the CWD use of the BMP, including the potential for CWD to travel to this area as a result of disruption of their existing preferrerd travel area, based upon a precautionary approach, this issue is considered to be of moderate impact significance and appropriate mitigation measures will be needed.

Southwest Lantau Marine Park (SWLMP)

13.9.2.126 The location of the potential marine park is at the Southwest Lantau off Fan Lau. The area is approximately 657 ha and it is within approximately 10 km of the proposed 3RS construction works. This potential marine park is also being recommended for conserving the natural environment and protecting the CWDs and other marine fauna.

13.9.2.127 The potential SWLMP is far from the area of the 3RS construction works and the island of Lantau provides an effective buffer to significant impacts. It is not expected that any significant impacts on the quality or function of this potential marine park from the 3RS development would occur.

13.9.2.128 Therefore, any disturbance to the function or quality of the SWLMP is considered to be of low impact significance, not requiring mitigation.

13.9.3 Operational Phase – Direct Impacts

Permanent Habitat Loss

13.9.3.1 As discussed above for the construction stage direct habitat loss impacts, approximately 672 ha of seabed habitat and 650 ha of marine waters that are used as CWD habitat will be permanently lost once the 3RS project land formation has been completed. As this land will be gradually formed to its ultimate extent during the construction phase, the habitat loss impacts associated with the operation phase impacts are ultimately the same as the end of the construction period.

13.9.3.2 In addition about 110 m^2 of seabed of moderate-low ecological value would be lost as a result of the piles for the approach lights and marker beacons. However, this area would be negligible compared to the availability of habitat for the CWD and would be considered of low significance.

13.9.3.3 Although the densities of CWDs do not appear to be very high in the 3RS footprint area as compared to critical habitat areas such as west Lantau, the Sha Chau and Lung Kwu Chau area and the Brothers and Siu Ho Wan area, they have still been noted in moderate abundance. The area is not known to be prime nursery habitat, however, it has been shown to be important for CWD use during the nighttime.

13.9.3.4 The results of the focussed surveys concurred with the AFCD long-term monitoring programme data which shows that the area north of the existing airport island is a preferred travelling area from east to west connecting core habitat and feeding areas with over 20% of their time spent travelling. The permanent loss of part of the travel area is discussed in **Sections 13.9.3.16 – 13.9.3.20**. Given this and the ranges of the CWDs that utilise this specific area, the habitat loss

would not be considered to have as notable effect on individual CWDs as they are not continuously present in the area.

13.9.3.5 The cumulative loss of other areas of key CWD habitat in addition to the 3RS land formation needs to be considered in terms of the available habitat left. The ultimate land formation area for the 3RS represents a very small proportion (less than 1%) of the total CWD habitat, notwithstanding the fact that the CWDs may have preferred habitat areas and not use all the area equally, available in the Pearl River Estuary (PRE) and about 2.5% of the Hong Kong habitat area.

13.9.3.6 The new HKIAAA will be expanded from 611 ha to approximately 729 ha after the 3RS project is in place, and would therefore add about 118 ha of "restricted" habitat to the area. The extent of the new HKIAAA is indicative and subject to change upon further design development that the new HKIAAA will follow the boundary as stipulated in CAP 313A Shipping and Port Control Regulations. Nevertheless, this restricted area would effectively provide some protection to CWDs, in much the same way that a marine park or reserve does, by restricting fishing activities and vessel access. The travel/foraging area to the west would also not be negatively affected. However, it is possible that the CWDs would not use the alternate, northern travel area as much due to disturbance from vessel traffic there. Based upon a worst case situation and taking a precautionary approach, in light of the currently-identified declining trends of CWD numbers in Hong Kong and the size of the loss and the fact that it is permanent, the impact to the CWDs would be of high impact significance to the Hong Kong sub-population of CWDs and mitigation would be required.

Loss of Carrying Capacity

13.9.3.7 As with habitat loss, as the land formation for the 3RS project will be gradually completed, the operation phase impacts will be the same as the end of the construction period, discussed above.

13.9.3.8 The carrying capacity of the Hong Kong/Pearl River Estuary population of CWDs is determined by the size and quality of their habitat. While the estimated population in the whole PRE is approximately 2,500 individuals (Chen et al. 2010), the sub-population of the Hong Kong CWD has been reduced to 61 (Hung 2013), compared to 158 in 2003 (**Appendix 13.2**, Figure 4).

13.9.3.9 The land formation for the 3RS project will gradually result in the loss of 672 ha of seabed habitat and 650 ha of marine water habitat. This will be permanent in the operation phase, once the construction works have been completed. While this area is not significant for the PRE population as a whole, accounting for less than 1 %, the carrying capacity of the Hong Kong sub-population of CWDs could be affected. However, it should be noted that the area to be lost is of moderate quality forming a travel area and as alternate areas would still be available for CWDs to travel among their core feeding areas, it is not expected that this would result in a serious effect on the CWDs, either in Hong Kong or the wider PRE.

13.9.3.10 As noted in **Section 13.9.1.22** for the construction stage, the area occupied as habitat by CWDs in Hong Kong is currently about 26,500 ha and the total permanent loss of habitat due to the 3RS land formation and seawall construction would represent about 2.5% of this habitat area.

Although this is a small proportion, it would likely be significant in light of the demonstrated declining numbers of CWDs in Hong Kong over the last decade or so, with CWD considered to be shifting to parts of their ranges outside Hong Kong waters.

13.9.3.11 The loss of carrying capacity for the Hong Kong CWD habitat would have the potential to result either in a very small overall reduction in population size or a shift in range of individuals to lower-quality habitat. Since a major use of this habitat is for travelling and milling, the latter often associated with moving positions and therefore also interpretable as travel, alternative habitats would likely be easier to find than if it were used as feeding for prime breeding habitat, for instance. The area west of the airport seems also to be used for foraging, at least quite close to the airport platform, but this area will not be subject to major development. However, taking a precautionary approach, overall, the loss of carrying capacity in the operation phase would be considered to be of moderate impact significance and would require mitigation.

Permanent Habitat Fragmentation

13.9.3.12 There is the potential for CWD habitat fragmentation to occur as a result of the land formation for the 3RS project. As the land formation for the 3RS project will be gradually completed, the operation phase impacts will be the same as the end of the construction period, discussed in detail above.

13.9.3.13 Habitat fragmentation can disrupt natural social groupings, in turn limiting reproductive capacity. The CWDs actively utilise the areas to the east and west of the proposed new land platform for feeding and travel between the two areas, providing inter-mixing between the two distinct social clusters identified in Hong Kong (Figure 9 of **Appendix 13.2**). Construction of the 3RS land platform could result in the eastern members of the northern community becoming more isolated as a result of reduced travelling between this area and the rest of this northern community to the north and northwest of the airport near to Sha Cha, and also from the western community. If it occurred, overtime, genetic diversity would be affected. However, another possible scenario would be for CWDs to stop using this area in the eastern portion of their range, or use it at a much lower frequency.

13.9.3.14 The specific impacts of such fragmentation on population levels are not known at this time, but the overall population in the PRE is large. In addition, any fragmentation is not expected to occur during the operation phase as, while the reduction in the size of the travel area would be permanent, the reduced width of the passage between the newly formed 3RS and the Tuen Mun coast should still be sufficient to allow CWD movement (assuming that vessel traffic in the new travel area is not disturbing enough to cause the CWDs to avoid use of that area). The CWDs are known to use the area closer to the Tuen Mun coast for travelling, as well as other activities such as feeding, and so it is considered that they would potentially more actively use the remaining corridor once the construction works have been completed and during the operation phase. However, this travel area is presumably less preferred, as there is much more vessel traffic in this area, which may therefore cause some reduction in overall travel through this area once the land platform is complete. The airport west would not be directly affected by the 3RS project with only a slight extension to the west end land node of the current north runway being implemented as shown in **Drawing No. MCL/P132/EIA/8-003**.

13.9.3.15 Therefore, accepting that the most likely scenario is lowered, but continued use of the alternate area and following a precautionary approach, the impact from operation phase fragmentation is therefore considered to be of moderate impact significance and appropriate mitigation measures will be needed.

Permanent Loss of Travelling Areas and Connectivity between Core Habitat Areas

13.9.3.16 As discussed above and in the construction phase impacts, the area to the north of the existing airport island is considered to be a preferred travel area for the CWD in Hong Kong to connect between the core area near the Brothers to the east and west Lantau and Sha Chau and Lung Kwu Chau and this area will be lost as a result of the 3RS land formation. As the land formation for the 3RS project will be gradually completed, the operation phase impacts will be the same as the end of the construction period, discussed in detail above. The airport west is outside the work area for this project and will not be directly affected with only a slight extention to the west end land node of the current north runway being implemented as shown in **Drawing No. MCL/P132/EIA/8-003**

13.9.3.17 Other areas used by the CWD for travelling include the channel closer to the Urmston Road and Tuen Mun coastline and from the northwest to the west Lantau but these will not be directly affected. However, the loss of the areas north of the existing airport platform could force the CWDs to move into the area further north of the new platform, dominated by the Urmston Road shipping channel, potentially increasing opportunities for collisions with marine vessels.

13.9.3.18 Although it is judged that the CWDs would be able to use alternate routes for travelling east and west, these travel areas are less suitable, due to the existence of more vessel traffic and the resulting higher risk of vessel disturbance and vessel collision. Therefore, if CWDs do use this alternate route, some impacts will likely have occurred.

13.9.3.19 The predicted impacts would be lessened somewhat by the presence of the new HKIAAA along the northern part of the new land platform. This restricted access area will be free from fishing activities and from high-speed vessel traffic and provide a safe corridor for travel, much in the same way the existing HKIAAA does now.

13.9.3.20 Based upon the above, the impact to travelling activities by the CWDs would be considered to be a moderate impact and mitigation measures would be required.

13.9.4 Operational Phase – Indirect Impacts

Permanent Loss of Prey Resources

13.9.4.1 As the land formation for the 3RS project will be gradually completed, the operation phase impacts on prey resources as a result of habitat loss will be the same as the end of the construction period, discussed above.

13.9.4.2 CWDs in Hong Kong feed on a wide variety of prey items and are opportunistic in their feeding habits (Jefferson 2000; Barros et al. 2004). Stomach contents of stranded CWDs have shown at

least 24 species of fish (mostly associated with the murky water of estuaries) and one species of cephalopod are consumed by these animals (Barros et al. 2004).

13.9.4.3 As shown in **Drawing No. MCL/P132/EIA/13-026**, fish prey for CWDs in Hong Kong are distributed throughout the western waters. As detailed above, the land formation work for the 3RS project would result in the permanent loss of 672 ha of benthic habitat that could be used by CWD prey species. While CWD prey are found in the area to be lost, the fisheries assessment (**Chapter 14**), concluded that the loss of benthic habitat would have a moderate-low impact on fish resources in western waters. The latest fisheries survey findings for the third runway project reviewed that the sea area to be lost from the land formation of the project is not of high fisheries production. The fisheries production in these areas is moderate, when considering the fisheries production distribution in Hong Kong. It was concluded that there would not be significant impact on the sustainability of the fish resources due to the high mobility of the fish and availability of prey for the CWD in the northern Lantau waters.

13.9.4.4 In addition, the key feeding areas for the CWD are noted to be around the Brothers and Siu Ho Wan, Sha Chau and Lung Kwu Chau and in west Lantau, areas which would not be directly affected by the 3RS project. However, the effects of the new airport platform on hydrodynamics and water quality, which would subsequently affect the prey species, are discussed in **Section 13.9.4.12** below.

13.9.4.5 Based on the above, no significant loss of any prey resources for the CWD is expected from the 3RS land formation area and impacts associated with lower feeding success are not predicted. Stranding and observation data from the AFCD long-term monitoring do not provide indications that the CWDs are in a malnourished state. Therefore, this issue is considered to be of low impact significance and no mitigation measures will be needed.

Changes in Distribution, Abundance and Patterns of Habitat Use

Distribution

13.9.4.6 The addition of the 3RS land platform is expected to cause changes in CWD distribution as CWDs will lose 650 ha of marine water habitat once the new runway is complete. This will be a permanent loss of this area of habitat for CWDs affecting the distribution of the Hong Kong sub-population, and reducing their effective range. The amount of loss of habitat will likely be insignificant for the PRE overall population, but could be significant for the much smaller area (26,500 ha) occupied by the Hong Kong sub-population of CWDs. The travel/foraging area to the west of the airport will not be directly affected and after construction is complete it is expected that the CWDs would continue to use this area.

13.9.4.7 The loss of 650 ha or about 2.5% of this habitat area could have an affect on the distribution of the Hong Kong sub-population, as CWDs will have to move from this area to other waters (presumably still within Hong Kong's boundaries), but the area is mainly used for travelling and alternate travel area will be available.

Abundance

13.9.4.8 As the area to be lost upon completion of the 3RS project has been shown by the survey and literature review to be a preferred travel area (as assessed above), and the fact the CWDs would be expected to be able to shift their existing travel route further north after construction is completed, a significant reduction in CWD abundance is not expected. However, if the new travel area is not used as extensively as the existing travel area (for instance, as it is more disturbed and less attractive to the CWDs), then CWDs may travel less to the Brothers area, and this would potentially impact CWD abundance in this area.

Patterns of Habitat Use

13.9.4.9 Since the 3RS project would mainly be affecting a travel area, there would not be expected to be any long term significant direct effects on foraging of the CWDs or breeding/calving. The travel/foraging area to the west of the airport will not be directly affected. However, lessened contact between the two CWD communities (see above) could result in less breeding opportunities and therefore negatively affect calf production which is, however, expected to be low.

13.9.4.10 CWDs are present in and near the area of the 3RS project footprint at night and there is the possibility that night use is more consistent than that of daytime use, that is, that the CWDs stay longer in the area, perhaps to feed. This makes the area potentially even more meaningful than with an assumption of it largely being a daytime travel area.

13.9.4.11 The impacts associated with distribution, abundance and patterns of habitat use overall are therefore considered to be of moderate impact significance and appropriate mitigation measures will be needed.

Changes in the Hydrodynamic Regime and Water Quality

13.9.4.12 Changes in the hydrodynamic regime and water quality can have significant effects on water quality and in turn on the fish and other cetacean prey resources, and can therefore have indirect impacts on the CWDs themselves. It is possible that the land formation for the 3RS project would affect the water currents that bring freshwater discharge from the Pearl River to the area of the Brothers and Siu Ho Wan.

13.9.4.13 However, based on the hydrodynamic model results presented in **Section 8.7.2**, the changes in tidal discharges, including both increases and decreases, are relatively small after implementation of the 3RS project as compared to the base scenario without the project (refer to **Table 8.72** and the analysis presented in **Section 8.7.2**). The changes in hydrology will also not result in significant changes in the water quality of the study area from the base case. The depth-averaged monthly water quality results are presented in **Appendix 8.15 (Tables 1, 2, 3-a, 4, 5, 6, 7 and 8)**.

13.9.4.14 Taking WSR E4 and E12 as examples (E4 represents the planned marine park at the Brothers / Tai Mo To and E12 represents Sham Shui Kok area), the water quality results are summarised below:

- Temperature results **Appendix 8.15 (Table 1)** show no change from base case;

- Salinity results **Appendix 8.15 (Table 2)** show at most only a 2 % (0.3 psu) difference in salinity during summer months compared to base case, which is insignificant when compared to the annual range (13.0 – 30.1 psu in base case);
- Dissolved oxygen results **Appendix 8.15 (Table 3-a)** show at most only 0.1 mg/L difference compared to base case, which is insignificant when compared to the annual range of approx. 2 mg/L in base case;
- Biological oxygen demand results **Appendix 8.15 (Table 4)** show no change from base case;
- Suspended solid results **Appendix 8.15 (Table 5)** show at most 1 % (0.1 mg/L) difference compared to base case, which is insignificant when compared to the annual range (8.2 – 12.5 mg/L) in base case;
- Total inorganic nitrogen results **Appendix 8.15 (Table 6)** show at most 0.01 mg/L compared to base case, which is insignificant when compared to the annual range of approx. 0.4 mg/L in base case;
- Unionised ammonia results **Appendix 8.15 (Table 7)** show no change from base case; and
- *E.coli* results **Appendix 8.15 (Table 8)** show no change from base case.

13.9.4.15 This issue is therefore considered to be of low impact significance and no mitigation would be needed.

Oil or Chemical Spillage

13.9.4.16 Operational phase oil and chemical spills could occur from vessel collisions or airplane accidents. As assessed during the construction stage as a result of construction vessel collisions, the release of key pollutants such as hydrocarbons, PCBs and butyltins into the marine environment could interfere with the health and reproduction of the CWDs (Jefferson et al. 2006).

13.9.4.17 However, as described for the construction stage impacts (**Section 13.9.1**), CWDs are able to metabolise and excrete hydrocarbons. Bio-accumulation is unlikely to be a concern as CWD prey (estuarine fish and crustaceans) are also able to metabolise petroleum hydrocarbons (Capuzzo and Lancaster, 1981; Whipple et al., 1981; Brzorad and Burger, 1994). Also, CWDs would not be likely to ingest enough oil for acute effects because any spill would be lost through evaporation and other weathering processes in a very short time (that is, 2-3 days even for a large spill) and the amount remaining in the marine environment would be small. In terms of long term impacts from ingestion of small amounts of oil over time, again the spill would not persist in the environment long enough. In addition, there is evidence (**Section 13.9.2.51** above) to show that marine mammals can detect and avoid spills.

13.9.4.18 The operation phase issues relating to vessel movement and safety fall under the jurisdiction of the Marine Department. In northern Lantau waters traffic measures are in place including navigation buoys (buoys CP 1 through CP7) and lights to demarcate the main waterway, with

vessel movement monitored and coordinated by a marine vessel traffic control centre which maintains surveillance over Hong Kong navigable waters so as to monitor and regulate vessel movements, and gives information and offers advice to mariners on the prevailing navigational conditions through a VHF network.

13.9.4.19 The Marine Department also has a sophisticated Maritime Oil Spill Response Plan (MOSRP) in place that complies with the provisions of the International Convention on Oil Pollution Preparedness, Response and Co-operation 1990 (OPRC). The MOSRP aims to ensure a quick and effective response to any spill incidents in local Hong Kong waters.

13.9.4.20 These measures would mean that the risk of any marine accidents would be negligible.

13.9.4.21 In terms of aircraft accidents, no large-scale spills of oil or aviation fuel have been identified in Hong Kong during the first 15 years of operation of HKIA. The operation of the 3RS could result in a proportional increase in the chance of such a spill (based on a scale up of airport operations), due to the increased amounts of fuel / oil being used to meet the increased demand from additional air traffic movements.

13.9.4.22 However, despite the negligible risk of a spillage, should an incident occur, AAHK has Fuel Spill Response Plans to deal with the accidents and spillages to ensure it is rapidly contained and cleaned as far as possible to minimise the risk to the marine waters and marine life and any material that did enter the waters would disperse in region of 3-4 days without any long term effects on water quality (ERM 1995).

13.9.4.23 Therefore, based on the above, operation phase impacts on CWDs from oil or chemical spillages are considered low and no mitigation would be required. Nevertheless, an operation phase spill response plan would be implemented as a precautionary measure.

Acoustic Disturbance from Marine Traffic

13.9.4.24 As detailed in **Section 13.9.2.91** above, marine vessel traffic can result in acoustic disturbance to CWDs. While larger vessels produce noise at lower frequencies below those typically used by the CWDs for echolocation, the noise from shipping lanes containing high speed ferries, can surpass 100 dB re. 1 µPa even up to a frequency of about 10 kHz (Sims et al. 2012), with noise at this level being able to mask the communication sounds of the CWDs. As previously noted, this could result in behavioural disturbance to the CWDs, decrease in feeding and potentially displacement of the CWDs from their preferred habitats.

13.9.4.25 During the operation phase, based on the Marine Traffic Impact Assessment Final Report (BMT, Aug 2012), the daily average marine traffic volume will increase from approximately 230 to 330 between 2011 and 2030 at Gate 3, the channel between Sha Chau and HKIA, while at Gate 4 Urmston Road the daily average will increase from approx. 540 to 810 between 2011 and 2030. However, marine traffic associated with the airport operations and the 3RS project will be largely associated with HSFs from the SkyPier which would use a new navigation route close to the northern side of the new land formed for the 3RS project, travelling between HKIA and the SCLKCMP, as well as Urmston Road. Thus, in terms of HSFs, traffic will increase by 42% by 2030 over 2011 level as a worst case, resulting in an increase in the number of fast ferries from

SkyPier in the northern Lantau waters to approximately 50 per day between the airport and Sha Chau and approximately 80 per day in Urmston Road in 2030. The projected number of non-SkyPier HSFs is approximately 35 per day between the airport and Sha Chau and approximately 80 per day in Urmston Road. The percentage of HSFs associated with the SkyPier will remain at about 60% of the total HSFs utilising the waters between the airport island and Sha Chau and at about 50% in Urmston Road. Such a significant number of such vessels can disrupt CWDs travelling and diving. As the HSFs using SkyPier are the only ferries associated with the airport operations and within the control of the AAHK, only the impacts from these ferries, and not the other ferries operating from the Hong Kong and China Ferry Terminals on Hong Kong Island and the Kowloon Peninsula, respectively, can be mitigated.

13.9.4.26 As shown in Figure 6, **Appendix 13.13** and discussed in **Section 13.9.3** above, the land formation for the 3RS will mean that the paths of vessel movements from the east side of the airport platform to the waters west of Hong Kong will be restricted even more, as the land formation area will push vessels further to the north and closer to the southern boundary of the SCLKCMP and the Tuen Mun coastline.

13.9.4.27 Having an increasing number of high-speed vessels using a narrower corridor of movement results in closer spacing of the vessels would result in higher levels of anthropogenic noise, which is known to cause behavioural disturbance to CWDs. As noted above, there is a possibility that the use of high speed ferries in this reduced area could cause the CWDs to use this area less or to be affected in other ways. It has been shown in numerous studies of marine mammals that marine traffic can have adverse effects on behaviour, including abandonment of habitat, masking of communication, sensitisation and physiological stress (National Research Council 2003, Würsig and Richardson 2009). The short term reactions described for CWDs from other and the present EIA related studies are indicative that some manner of long-term effects are taking place as well. It is, however, also noted that CWD near Fan Lau, southwest Lantau, feed, socialise and travel very close to the busy high speed ferry route in that area (Hung 2012, 2013) and it is concluded that the same near-ferry lane activity is likely to continue north of Lantau Island.

13.9.4.28 Therefore, the noise impacts from HKIA SkyPier ferries that have been pushed further north and the potentially shortened distance to other traffic within the Urmston Road are considered to be of moderate-high impact significance, requiring mitigation. Underwater noise monitoring will also be considered as part of the EM&A programme to monitor the effectiveness of the mitigation.

Injury/Mortality from Marine Traffic

13.9.4.29 As noted above (**Section 13.9.2.104**) and in **Appendix 13.2**, there is notable evidence from previous studies from around the world (Wells and Scott 1997; Honma et al. 2001; Van Waerebeek et al. 2007; Ritter 2010; Carillo and Ritter 2010) that CWDs are being injured or killed as a result of collisions with marine vessels and high speed ferries are considered to be the major concern (Parsons and Jefferson 2000; Jefferson et al. 2006).

13.9.4.30 The AFCD long-term stranding database has been assessed to determine how many CWD may be killed or injured as a result of vessel collisions (HK photo-ID catalog of the AFCD long-term database). CWD strandings in Hong Kong have been examined from the start of detailed

records (1995) through to August 2013, a period of over 18 years. During this period, 179 CWD strandings were documented in Hong Kong. The cause of death (COD) could only be identified in 10% of the strandings found due to the onset of advanced decompostion. Where COD could be determined, 8 (4.5%) were from vessel collision, 7 (3.9%) were from fisheries activities, 2 (1.0%) were disease related and 1 (0.6%) was from another cause (net ingestion). These figures represent absolute minimum numbers and it is reasonable to assume that a notable proportion of the other 90% of strandings that did not have COD identified could have been as a result of vessel collision, as it is identified as the most frequent cause of death in the CWDs and from international evidence.

13.9.4.31 However, while it is understood that the decline in CWD numbers would be a result of a mix of causes including the fact that the CWDs are shifting to waters outside of Hong Kong, the analysis of the standing data indicates that death/injury from vessel collision may be a notable factor. Based upon this, vessel collision is considered a very serious threat to CWDs.

13.9.4.32 The areas of CWD habitat use would be reduced by development of the 3RS, resulting in vessels being channelled into the smaller navigation space north of the new land formation. This could be compounded by the fact that the CWDs would be expected to be forced into this area as the preferred travel area is lost to the land formation. In addition, the numbers of HSF movements are projected to increase by 2030 and having an increasing number of HSFs using a narrower corridor of movement results in closer spacing of the vessels and less area for CWDs that might be feeding in the area to surface without strong risk of being hit by a vessel.

13.9.4.33 Therefore, in light of the above, the impacts from injury or mortality from the rerouted HKIA SkyPier HSFs and the potentially shortened distance to other traffic within the Urmston Road are considered to be of high impact significance, and mitigation measures are needed.

Changes in Movement Patterns due to Marine Traffic

13.9.4.34 Marine traffic, particularly high speed vessels, can cause CWDs to change their behaviour and movement patterns, in terms of swim speeds, diving, course of travel, groupings used in travel, etc (**Section 13.4.6.90**).

13.9.4.35 Fast vessel traffic from the SkyPier and other berths will be utilising the navigation waters between HKIA and the SCLKCMP as a result of the land formation works, as well as Urmston Road, in addition to ferries from the China and Macao ferry piers. As noted above, the number of high speed ferry movements is increasing and this has the potential to impact or deter the CWDs (who will also be forced further north for travelling) ability to travel between the core areas of habitat use in northern Lantau waters. The resulting stress of sharing habitat with large numbers of high speed vessels can hamper the CWD activities such as resting, feeding, socialising and reproduction.

13.9.4.36 It has been shown in numerous studies of marine mammals that marine traffic can have adverse effects on behaviour, and the literature and focussed survey results are indicating, that such changes, as discussed above, are occurring.

13.9.4.37 Thus, the potential impacts from the reduced distance and increased interface with HKIA SkyPier ferries to the north of the land formation area are considered to be of moderate-high impact significance, requiring mitigation. The airport west area, however, would be outside the paths of the HSFs travelling between Hong Kong and the Chinese / Macao cities and therefore isnot be expected to be affected.

Function and Quality of the Marine Parks

SCLKCMP

13.9.4.38 Potential operation-phase impacts of this project on the current and proposed marine parks in the north Lantau area are mostly associated with disturbance from the noise of aircraft taking off and landing at the new expanded airport. The SCLKC is close to the approach and departure routes for aircraft at HKIA and therefore it can be expected that an increase in noise would result with the addition of new flights.

13.9.4.39 Although there have been no detailed studies examining this aspect for CWDs in Hong Kong, there is currently no evidence that CWDS are avoiding the area directly to the east or west of the existing HKIA, the major routes for departing and landing aircraft, due to the aircraft themselves. The area directly to the west of the airport platform traditionally has been considered a lower density CWD area. However, results of the CWD monitoring for this project suggest that CWD density is higher than previously known (see **Section 13.4.6.113** above), but it is unknown whether CWD occurrence patterns have changed there since the airport opened in 1998.

13.9.4.40 Much has been written about the effects of aircraft noise on marine mammals (reviews by Richardson et al. 1995, Würsig et al. 1998, Luksenburg and Parsons 2009), but there has been little detailed work on effects of airports near CWD habitats. In general, whales and dolphins tend to dive abruptly when airplanes fly directly overhead at less than about 250-460 m altitude, but reactions are extremely variable, depending on species, general behaviour, sex-age composition, and other factors (Würsig et al. 1998). Schools of spinner dolphins that rested during daytime close to the flightpath of jet airplanes at the Kailua Kona Airport, Big Island Hawaii, dived abruptly and for about twice their usual time each time a jet flew overhead (at about 250 m altitude), but the dolphins did not vacate this preferred resting area (Würsig and Evans 2001).

13.9.4.41 In reality, the strip of water in which significant noise from aircraft overhead enters the water is rather narrow, representing an approximate 26° cone around the location of the sound source at any one time, known as the ‘Snell’s Cone’ (as associated with Snell's Law of incidence of light or sound refraction). Outside of Snell’s Cone and in the absence of large surface waves, the majority of the sound energy is reflected off the water’s surface and little enters the water column. Therefore, due to this information and the continued presence of CWDs directly under the current airport approach and take-off areas, the issue of aircraft noise disturbance to CWDs is considered to be insignificant.

13.9.4.42 The SCLKCMP mainly serves to aid CWD conservation by being a “safe area” where CWDs are not subjected to threats like high-speed vessel traffic, marine construction activities, and fishing

activities are also controlled in SCLKCMP. The addition of the 3RS project to HKIA is not likely to change this, as all of these protections will still be present and essentially unaffected by the creation of a third runway.

13.9.4.43 As a result of the land formation, both CWDs and marine traffic, including high speed ferries (HSFs) would be chanelled in to a narrower area of open water north of the new land formation. The number of HSF movements is to increase by about 42% as a worst case in this area by 2030 (over 2011 movements). While this has potential implications for CWDs travelling between core habitat areas, as assessed in other sections, because the HSFs do not travel through the SCLKCMP, the function and quality is not expected to be compromised by the HSFs.

13.9.4.44 It is possible, however, that the construction of the 3RS could result in an increased use of the SCLKCMP. CWDs would be expected to be displaced from the area north of the airport and could shift to use the Sha Chau and Lung Kwu Chau area more. If this were to happen, then it could result in a benefit to the overall population by having more CWDs present in an area of protection. However, the increased density in the area could also result in more competition for food resources.

13.9.4.45 Several issues discussed in detail elsewhere in this chapter could also have indirect effects on the marine park and its usefulness as a CWD conservation measure. These include habitat quality issues, such as potential loss of prey resources and hydro-dynamic changes to the water regime. These have been ranked as low for this project and it not considered that the project would notably degrade the quality of the marine park as a CWD habitat as a result. However, as the 3RS project is in relatively close proximity to the SCLKCMP boundary at 900m away, there is a need to adopt a precautionary approach and therefore, this issue is considered to be of low-moderate impact significance.With the implementation of precautionary measures including spill response plan and other CWD mitigation measures, the impact significance will be further reduced and no specific mitigation measure would be needed.

Planned Brothers Marine Park (BMP)

13.9.4.46 As noted in **Section 13.4.3.17**, the designation of the marine park is tentatively to be around 2016 immediately follow the completion of the HZMB project.

13.9.4.47 In terms of HSFs from SkyPier, while SkyPier HSF movements are expected to increase in future, SkyPier HSFs transit westwards of the airport and do not pass the BMP. In addition, berthing operations would be screened from the BMP by the new HKBCF island. Thus, while the are potential implications for the CWD travelling between core habitat areas, as assessed in other sections, operations of the HSFs from SkyPier are not expected to effect the function and quality of the BMP.

13.9.4.48 There is potential for the BMP to be affected as a result of potential for changes in hydrodynamic flows affecting CWD prey resources there, although it is impossible to predict the actual level of the effects with any certainty. Due to the mixture of potential effects on the BMP, this issue is considered to be one of moderate impact significance.

13.9.4.49 Based on the hydrodynamic model results, generally minimal changes in flow velocities at most ecological sensitive recievers (<0.1 m/s) have been predicted, which suggests that the project would not induce significant changes to the hydrodynamic regime at most locations. Areas showing more significant changes in peak velocity (e.g. >0.2 m/s) are generally located within immediate surroundings to the project.

13.9.4.50 To the immediate north of the 3RS project, reduction in peak velocity is predicted with the implementation of land formation area. The effect is more pronounced during the wet season, when flow velocities in the North Lantau area are generally faster due to the additional freshwater flows from the Pearl River Delta estuaries. With the project in place, reductions in flow velocity to the north of the project would be expected, though these reductions are not anticipated to lead to water quality issues as the peak flow velocity remains relatively high despite the reductions associated with the project.

13.9.4.51 A number of known CWD prey resources, such as *Ilisha* sp., *Johnius* sp., *Mugil* sp., *Sardinella* sp., *Thryssa* spp. and *Trichiurus* sp. were recorded within the BMP according to results of fisheries surveys. Most of the species were found within BMP during both wet and dry season and in similar abundance, except for *Sardinella* sp. which had much greater abundance (more than 10 times) in BMP during wet season than dry season and *Thryssa* spp. which was only caught within BMP during wet season.

13.9.4.52 Several issues discussed in detail elsewhere in this chapter would also likely have indirect effects on the marine park and its usefulness as a CWD conservation measure. These include habitat quality issues, such as potential loss of prey resources and hydro-dynamic changes to the water regime. Because the Brothers area receives much of its freshwater input from the west, through the area of the project footprint, it is possible that the 3RS project may degrade the quality of the marine park as a CWD habitat. However, the water quality modelling results (**Chapter 8**) indicate that this will not be the case. While there are not predicted to be any significant impacts associated with the reduction of CWD prey resources as a result of changes in local hydrodynamics in the BMP, based on a worst case situation and adopting a precautionary approach, it is considered that the 3RS project could affect the CWD use of the BMP and, therefore, this issue is considered one of moderate impact significance and appropriate mitigation measures will be needed.

Potential Southwest Lantau Marine Park (SWLMP)

13.9.4.53 The potential SWLMP is very far removed from the area of the 3RS and the island of Lantau provides an effective buffer to significant impacts. Therefore, any disturbance to the function or quality of the SWLMP is considered to be of low impact significance, and no mitigation measures would be required.

13.10 Summary of Impacts Evaluation

13.10.1.1 The potential ecological impacts to marine habitats in the Study Area as a result of the construction and operation of the proposed 3RS project have been evaluated according to Table 1 Annex 8 of the EIAO-TM and are presented in **Table 13-28 to Table 13-29** below.

13.10.1.2 In summary, the following species of conservation importance identified in **Table 13-21** may receive potential impacts of moderate to high significance that requires mitigation or precautionary measures:

- Chinese White Dolphin
- Marine fishes (Longheaded eagle ray, Pale-edged stingray, Goatee croaker, Long-tooth grouper, Orange-spotted grouper, Tiger-toothed croaker)
- Ahermatypic cup coral (*Balanophyllia* sp.) at northeastern shore of airport island

13.10.1.3 Mitigation measures are required to address the significant impacts predicted above. All the potential ecological impacts to marine habitats and key sensitive receivers in the study area resulting from the project together with the suggested mitigation or/and enhancement measures are summarised in **Table 13-28** to **Table 13-29** below. Details of the recommended mitigation and enhancement measures are provided in **Section 13.11** and **Section 13.13** below.

Table 13-28: Overall Impact Evaluation and Mitigation / Enhancement for Marine Ecology (Excluding Marine Mammals)

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
Construction Phase – Direct Impacts										
Habitat loss	Land formation and seawall construction	Intertidal and sub-tidal hard bottom habitats	Low quality artificial seawall habitat constructed of rock boulders	Common intertidal species; Common gorgonians	Approx. 5.9 km; Intertidal species of moderate-low abundance; Subtidal gorgonian species in very low coverage (<1%)	Permanent upon completion of construction	Irreversible	Large but readily re-creatable	Low-moderate in construction phase	No but pre-construction dive survey is proposed as precautionary measure.
		Open marine waters	Moderate-high within HKIAAA; moderate outside HKIAAA but within footprint	5 fish species of conservation importance within HKIAAA; 4 fish species of conservation importance outside HKIAAA within footprint	A total of 650 ha	Permanent after completion	Irreversible	Large	Moderate	Yes
		Sub-tidal soft bottom habitats	Habitat of moderate-low ecological value, composed of silt and clay with some rock outcrops	Benthic fauna	A total of 672 ha	Permanent after completion	Irreversible	Large	Moderate upon completion of construction	Yes
	Diversion of submarine pipelines by horizontal directional drilling involving a landing point	Rocky shore at SCLKCMP	Common rocky shore habitat which is of moderate-low ecological value	Common intertidal species & sub-tidal coral species	Approx. 100 m^2	Permanent after completion	Irreversible	Small	Low	No but pre-construction dive survey is proposed as precautionary measure.

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
	Diversion of submarine 11 kV cables by water jetting and open trench excavation at the field joint area	Sub-tidal soft bottom habitats	Rock outcrops and soft bottom composed of silt and clay; habitat of low ecological value	Common ahermatypic cup coral and gorgonian species	0.65 ha	Temporary	Reversible	Small	Insignificant	No
	SI in SCLKCMP	Sub-tidal soft bottom habitats around Sha Chau	Subtidal soft bottom habitat with low quality	Benthic fauna and marine fishes	0.12 m^2/ High	Temporary	Reversible	Small	Insignificant	No
	Floating temporary platform for diversion of submarine aviation fuel pipelines	Open marine waters around Sha Chau	Open marine waters with high ecological value	Marine ish species	225 m^2 (0.0225 ha)/ High	Temporary	Reversible	Small	Insignificant	No
	Construction of approach lights and marker beacons	Two ends and northwestern waters of the 3rd Runway	Marine water with moderate quality	Marine fish species	Approx. 0.011 ha	Permanent	Irreversible	Small	Insignificant	No
			Subtidal soft bottom habitat with moderate-low quality	Benthic fauna and marine fishes	Approx. 0.011 ha	Permanent	Irreversible	Small	Insignificant	No
Loss of Carrying Capacity	Land formation	North western waters of Hong Kong	Marine water of moderate to moderate-high ecological value	Marine fish species	672 ha	Permanent after completion	Irreversible	Small	Low	No

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
Habitat Fragmentation	Land formation	North western waters of Hong Kong	Marine water of moderate to moderate-high ecological value	Marine fish species	672 ha	Permanent after completion	Irreversible	Small	Low	No
Construction Phase – Indirect Impacts										
Changes in Species Distribution, Abundance and Patterns of Habitat Use	Above ground pipeline section of length approximately 45 - 110 m	Intertidal habitat	Rocky shore with moderate-low ecological value	Intertidal species	approximately 45 - 110 m along the rocky shore	Temporary	Reversible	Small	Low	No
	Increased marine traffic	North western waters of Hong Kong	Open water of moderate to moderate-high ecological value	Marine fish species	Large	Temporary	Reversible	Small	Low	No
Release of suspended solids and associated changes in water quality (dissolved oxygen depletion)	Ground improvement and seawall construction, sand filling.	Intertidal and sub-tidal hard bottom habitats at northern Lantau coast, SCLKCMP, BMP, SWLMP, San Tau SSSI	A variety of habitats of low to high ecological values. Seagrass bed of high ecological value; mangrove/ mudflat; natural rocky shores; artificial reefs habitat	4 seagrass species; 2 horseshoe crab species; 5 estuarine fauna; common crustaceans and bivalves; corals	N/A	Temporary	Reversible	Small	Low – moderate for corals; Insignificant to Low for other habitats	No but pre-construction dive survey is proposed as precautionary measure.

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
		Marine waters at N. Lantau, BMP, SCLKCMP	Moderate to high	14 fish species, 1 seahorse species, 1 pipefish species, 2 horseshoe crab species and 1 seasnail of conservation importance; other common fish species	Very large	Temporary	Reversible	Small	Low	No
Release of contaminants from pore water	DCM process	Marine waters at N. Lantau; SCLKCMP;BMP	Moderate to high	14 fish species, 1 seahorse species, 1 pipefish species, 2 horseshoe crab species and 1 seasnail of conservation importance; other common fish species	Very large / moderate abundance	Temporary	Reversible	Small	Insignificant	No

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
Oil/ Chemical spillage	Construction vessels accidents or leakage of petroleum from construction plants	Marine waters at N. Lantau; SCLKCMP;BMP	Moderate to high	14 fish species, 1 seahorse species, 1 pipefish species, 2 horseshoe crab species and 1 seasnail of conservation importance; other common fish species	Very large / moderate abundance	Temporary	Reversible	Small	Insignificant	No
Importation and transportation of marine fill and filling activities	Potential of fill materials runoff to the marine waters during transportation	Marine waters at N. Lantau	Moderate to Moderate-high	Marine fish species	Very large	Temporary	Reversible	Small	Low	No
Piling activities and associated underwater noise	Construction of new runway approach lights and maker beacon	Sub-tidal soft bottom habitat; marine waters.	Sub-tidal habitat of moderate-low ecological value; marine water habitat of moderate to moderate-high quality	Benthic fauna and marine fishes	Approx. 108 m^2	Temporary and short	Irreversible	Small	Low	No
Operation Phase – Direct Impacts										
Permanent habitat loss	Land formation and seawall construction	Sub-tidal soft bottom habitats	Habitat of moderate-low ecological value, composed of silt and clay with some rock outcrops	Benthic fauna	672 ha	Permanent	Irreversible	Large	Moderate upon completion of construction	Yes

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
		Intertidal and sub-tidal hard bottom habitats	Low quality artificial seawall habitat constructed of rock boulders	Common intertidal species; Common ahermatypic cup corals *Balanophyllia* sp. and gorgonians.	Approx. 5.9 km; Intertidal species of moderate-low abundance; Sub-tidal coral species in very low coverage (<1%)	Permanent upon completion of construction	Irreversible	Medium and readily re-creatable	Low to moderate upon completion of construction	No. Pre-construction coral dive survey to review the feasibility for coral translocation as precautionary measure.
		Open marine waters of project footprint	Moderate to moderate-high	6 fish species of conservation importance	650 ha	Permanent	Irreversible	Large	Moderate	Yes
	Diversion of submarine pipelines by horizontal directional drilling involving a landing point	Rocky shore at Sha Chau Lung Kwu Chau Marine Park	Common rocky shore habitat with moderate ecological value	Common intertidal species	Approx. 100 m^2	Permanent	Irreversible	Small	Low	No
	Construction of approach lights and marker beacons	Two ends and northwestern waters of the 3rd Runway	Marine water with moderate quality	Marine fish species	Approx. 0.011 ha	Permanent	Irreversible	Small	Insignificant	No
			Subtidal soft bottom habitat with moderate-low quality	Benthic fauna and marine fishes	Approx. 0.011 ha	Permanent	Irreversible	Small	Insignificant	No
Loss of Carrying Capacity	Land formation	North western waters of Hong Kong	Marine water of moderate to moderate-high ecological value	Marine fish species	672 ha	Permanent	Irreversible	Small	Low	No

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
Habitat Fragmentation	Land formation	North western waters of Hong Kong	Marine water of moderate to moderate-high ecological value	Marine fish species	672 ha	Permanent	Irreversible	Small	Low	No
Operation Phase – Indirect Impacts										
Change in hydrodynamics	New land formation	Marine waters flow across Sha Chau	Moderate-high	Marine fish species	1,200 ha / moderate abundance for marine fishes	Permanent	Irreversible	Small	Insignificant	No
		Marine waters flow through the east of the airport channel	Moderate-high around the Brothers	Marine fish species	Moderate abundance for marine fishes	Permanent	Irreversible	Small	Low	No
		Marine waters immediately west of the existing airport island	Moderate	Marine fish species	Moderate abundance for marine fishes	Permanent	Irreversible	Small	Low	No
		Marine waters immediately north of the existing airport island	Moderate	Marine fish species	Moderate abundance for marine fishes	Permanent	Irreversible	Small	Low	No
Changes in water quality associated with change in hydrodynamics	New land formation	Marine waters at N. Lantau	Moderate	6 fish species of conservation importance and 1 horseshoe crab species	Moderate abundance for marine fishes but low abundance of horseshoe crab	Permanent	Irreversible	Small	Insignificant	No

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
		Intertidal and sub-tidal habitats within the Study Area	A variety of habitats of low to high ecological values.	4 seagrass species, 2 horseshoe crab species of conservation importance; *Balanophyllia* sp. & *Paracyathus rotundatus*, other common corals, intertidal and subtidal species	N/A	Permanent	Irreversible	Small	Insignificant	No
		San Tau Beach SSSI	High	3 seagrass species and 2 horseshoe crab species of conservation importance	2.7 ha / Moderate abundance	Permanent	Irreversible	Small	Insignificant	No
		SCLKCMP	High	11 marine fish species species, 1 pipefish species, 2 horseshoe crab species and 1 seasnail species of conservation importance; gorgonians; and other marine fishes	1,200 ha / Moderate for marine fishes; moderate low for corals	Permanent	Irreversible	Small	Insignificant	No

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
		Planned BMP	High	3 marine fish species and 1 seahorse of conservation importance; gorgonians; and other marine fishes	Approx. 850 ha/ Moderate for marine fishes; moderate low for corals	Permanent	Irreversible	Small	Insignificant	No
		Potential SWLMP	High	Marine fish species	Approx. 657 ha	Permanent	Irreversible	Small	Insignificant	No
Indirect disturbance of habitats due to deterioration of water quality	Storm water runoff, sewage effluent discharge, spent cooling discharge, fuel spillage and maintenance dredging	Northern Chek Lap Kok waters adjacent to the 3RS	Moderate	Marine fish species	Small	Temporary	reversible	Small	Insignificant	No
Impingement and entrainment due to seawater intakes	An increase in cooling demand from the existing seawater pumping house (SWPH-1 and new SWPH-7)	Fish post-larvae in vicinity	Moderate	Fish post-larvae	Small	Permanent	Irreversible	Small	Low	No
Indirect disturbance of marine fauna due to aircraft noise	Aircraft noise	Marine fishes	Moderate	Marine fish species	Large	Permanent	Irreversible	Small	Insignificant	No

Table 13-29: Overall Impact Evaluation and Mitigation/Enhancement for Marine Mammals

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
Construction Stage – Direct Impacts										
Temporary habitat loss	Land formation and seawall construction	Marine waters north of airport island	Moderate to Moderate-high*	CWD	650 ha/ Moderate	Permanent after completion	Irreversible	Large	Moderate-high	Yes
	Bored Piling for approach lights and marker beacons				110 m^2 (0.011 ha)/ Moderate			Small	Low	No
	SI in SCLKCMP	Marine waters around Sha Chau	Moderate-high		0.12 m^2/ High	Temporary	Reversible	Small	Insignificant	No
	Floating temporary platform for diversion of submarine aviation fuel pipelines				225 m^2 (0.0225 ha)/ High					
	Diversion of submarine 11 kV cables by water jetting and open trench excavation at the field joint area	Marine Waters between airport and Sha Chau			0.65 ha/ Moderate - High					
Loss of carrying capacity	Land formation and seawall construction	Marine waters/ CWD habitat	Moderate to Moderate-high*	CWD	650 ha/ Moderate	Permanent after completion	Irreversible	Medium	Moderate	Yes
Habitat fragment-ation	Land formation and seawall construction	Marine waters/ CWD habitat	Moderate to Moderate-high*	CWD	650 ha/ Moderate	Temporary	Reversible	Medium	Moderate	Yes
Loss of CWD travelling area and connectivity between core CWD habitat areas	Land formation and seawall construction	Travel Area north of existing airport island	Moderate to Moderate-high*	CWD	650 ha/ Moderate	Permanent after completion	Irreversible	Medium	Moderate	Yes
Construction Stage – Indirect Impacts										

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
Loss of prey resources for CWD as a result of loss of benthic habitat	Land formation and seawall construction	Marine waters and benthic habitat	Moderate to Moderate-high*	CWD fish prey species/ CWD	672 ha/ Moderate - High	Long Term	Irreversible	Small	Low	No
Disturbance to the CWD use of travelling area and connectivity between core CWD habitat areas	Land formation and seawall construction and disturbance	Travel Area north of existing airport island	Moderate to Moderate-high*	CWD	650 ha/ Moderate	Long Term	Irreversible	Medium	Moderate	Yes
Changes to species distribution, abundance and patterns of habitat use	Land formation and seawall construction and disturbance	Marine waters	Moderate to Moderate-high*	CWD	650 ha/ Moderate - High	Temporary	Reversible	Medium	Moderate	Yes
Elevation in suspended solids	Land formation and seawall construction	Marine Waters north of existing airport island	Moderate to Moderate-high*	CWD	650 ha/ Moderate	Temporary	Reversible	Small	Low	No but CWD exclusions zone, and WQ mitigation measures would be implemented
	Bored Piling for approach lights and marker beacons				110 m^2 (0.011 ha) / Moderate					
	SI in SCLKCMP	Marine waters around Sha Chau	High		0.12 m^2/ High					

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
Elevation in suspended solids	Diversion of submarine 11 kV cables by water jetting and open trench excavation at the field joint area	Marine Waters between airport and Sha Chai	Moderate - high	CWD	0.65 ha/ Moderate - High	Temporary	Reversible	Small	Low	No but WQ mitigation measures would be implemented; Dolphin exclusion zone would also be implemented during water jetting and open trench dredging works
Reduction in dissolved oxygen	Land formation, bored piling, minor excavation and SI for 11 kV cables.	Marine waters near airport and Sha Chau	Moderate - high	CWD	650 ha/ Moderate - High	Temporary	Reversible	Small	Insignificant	No but WQ mitigation measures would be implemented
Release of contamin-ation and bioaccum-ulation	Land formation, bored piling, minor excavation and SI for 11 kV cables.	Marine waters near airport and Sha Chau	Moderate - high	CWD	650 ha/ Moderate - High	Temporary	Reversible	Small	Insignificant	No but WQ mitigation measures would be implemented
Risk of oil or chemical spills	Construction works and marine vessel collision	Marine waters	Moderate to Moderate – high*	CWD	Extensive / Moderate - High	Temporary	Reversible	Small	Low	No but a spill response plan would be implemented as precautionary measure
Release of contaminants during Deep Cement Mixing (DCM)	Land formation	Marine Waters north of existing airport island	Moderate to Moderate – high*	CWD	Area of DCM works / Moderate	Temporary	Reversible	Small	Low	No

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
Impacts to marine life from the importation and transport-ation of marine fill and filling activities	Land formation	Marine waters	Moderate to Moderate – high*	CWD	650 ha/ Moderate - High	Temporary	Reversible	Small	Low	No
Increased acoustic disturbance from construction works	Bored piling for approach lights and marker beacons	Marine waters	Moderate to Moderate – high	CWD	Small / Moderate - High	Temporary	Reversible	Small	Low	No but dolphin exclusion zone should be adopted as a precautionary measure
	11 kv cable and fuel pipeline diversion								Insignificant	No
	General construction works								Low-moderate	No but precautionary measures will be adopted to further minimise the impact
Increased disturbance from nighttime construction works	Land formation	Marine waters	Moderate to Moderate – high*	CWD	Small / Moderate - High	Temporary	Reversible	Small	Moderate	Yes
Increased acoustic disturbance from changes to marine vessels and ferry traffic	Construction vessels	Marine waters	Moderate	CWD	Small / Moderate - High	Temporary	Reversible	Small	Low	No but skipper training and vessel controls will be implemented as a precautionary measure

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
	High speed ferries		Moderate - high		Extensive / Moderate - High	Long Term	Irreversible	Medium	Moderate	Yes
Increased risk of injury/ mortality to CWDs from marine traffic	Construction vessels	Marine waters	Moderate	CWD	Small / Moderate - High	Temporary	Reversible	Small	Low	No
	High speed ferries		Moderate - high		Extensive / Moderate - High	Long Term	Irreversible	Medium	High	Yes
Changes to CWD movement patterns as a result of marine traffic	Construction vessels	Marine waters	Moderate	CWD	Small / Moderate - High	Temporary	Reversible	Small	Low	No
	High speed ferries		Moderate - high		Extensive / Moderate - High	Long Term	Irreversible	Medium	Moderate	Yes
Disturbance to the function and quality of Marine Parks	Construction works	SCLKCMP	High	CWD	1200 ha/ High	Temporary	Reversible	Small	Low-moderate	Yes
		BMP	High		850 ha/ Moderate-High			Small	Moderate	Yes
		SW Lantau MP	High		657 ha/ Moderate			Small	Low	No
Operational Stage – Direct Impacts										
Permanent habitat loss	Land formation and seawall construction	Marine waters north of airport island	Moderate to Moderate – high*	CWD	650 ha/ Moderate	Permanent	Irreversible	Large	High	Yes
	Bored piling for approach lights and marker beacons				110 m^2 (0.011 ha)/ Moderate			Small	Low	No
Loss of carrying capacity	Land formation and seawall construction	Marine waters/ CWD habitat	Moderate to Moderate – high*	CWD	650 ha/ Moderate - High	Permanent	Irreversible	Medium	Moderate	Yes

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
Habitat fragment-ation	Land formation and seawall construction	Marine waters/ CWD habitat	Moderate to Moderate – high*	CWD	Extensive / Moderate - High	Permanent	Irreversible	Medium	Moderate	Yes
Permanent loss of CWD travelling area and connectivity between core CWD habitat areas	Land formation and seawall construction	Travel area north of existing airport island	Moderate to Moderate – high*	CWD	650 ha/ Moderate	Permanent	Irreversible	Medium	Moderate	Yes
Operational Stage – Indirect Impacts										
Permanent loss of prey resources for CWD as a result of loss of benthic habitat	Land formation and seawall construction	Marine waters and benthic habitat north of airport island	Moderate to Moderate – high*	CWD	672 ha/ Moderate	Permanent	Irreversible	Small	Low	No
Changes to species distribution, abundance and patterns of habitat use	Land formation and seawall construction	Marine waters north of airport island	Moderate to Moderate – high*	CWD	650 ha/ Moderate	Permanent	Irreversible	Medium	Moderate	Yes
Changes to the hydro-dynamic regime and water quality as a result of the new land formation	Land formation and seawall construction	Western waters	Moderate	CWD	Extensive / Moderate - High	Long Term	Irreversible	Small	Low	No

Potential Impact	Source	Receiver	Nature of Impact						Significance of Impact	Further Mitigation / Enhancement Required
			Habitat Quality	Species Affected	Size / Abundance	Duration	Reversibility	Magnitude		
Risk of oil or chemical spills	Marine vessels and aircraft accidents	Western waters	Moderate	CWD	Extensive / Moderate - High	Temporary	Reversible	Small	Low	No but a spill response plan would be implemented as precautionary measure
Increased acoustic disturbance from increased marine traffic	High speed ferries	Marine waters	Moderate – high	CWD	Extensive / Moderate - High	Long Term	Irreversible	Medium	Moderate-high	Yes
Increased risk of injury/ mortality	High speed ferries	Marine waters	Moderate – high	CWD	Extensive / Moderate - High	Long Term	Irreversible	Medium	High	Yes
Changes to CWD movement patterns from marine traffic	High speed ferries	Marine waters	Moderate – high	CWD	Extensive / Moderate - High	Long Term	Irreversible	Medium	Moderate-high	Yes
Impacts Disturbance to the function and quality of Marine Parks	Noise from aircraft and land formation footprint	SCLKCMP	High	CWD	1200 ha/ High	Long Term	Irreversible	Small	Low-moderate	No but precautionary measures e.g. spill response plan and other mitigation measures for CWDs will further reduce the impact
		BMP	High		850 ha/ Moderate - High			Small	Moderate	Yes
		SW Lantau MP	High		657 ha/ Moderate			Small	Low	No

*Note: The habitat quality refers to **Table 13-18**, which shown the overall habitat quality for marine waters within the project footprint and HKIAAA is considered as "moderate-high", with habitat use not just for CWD but also with marine fishes of conservation importance, with ecological linkage with intertidal and sub-tidal habitats and potential value of moderate to high.

13.11 Mitigation Measures and Precautionary Measures

13.11.1 Hierarchy of Impact Mitigation

Background

13.11.1.1 Annex 16 of the EIAO-TM states that the general policy for mitigating impacts on important habitats and wildlife, in order of priority, is:

(a) Avoidance: Potential impacts shall be avoided to the maximum extent practicable by adopting suitable alternatives;

(b) Minimisation: Unavoidable impacts shall be minimised by taking appropriate and practicable measures such as constraints on intensity of works operations or timing of works operations; and

(c) Compensation: The loss of important species and habitats may be provided for elsewhere as compensation. Enhancement and other conservation measures shall always be considered whenever possible.

13.11.1.2 The proposed 3RS project layout and construction methods have been chosen to avoid and minimise potential ecological impacts by design, as summarised below:

Minimisation of Land Formation Area

13.11.1.3 During the course of design consideration for the 3RS, through the strategic assessment of options, the required overall size of the land formation needed for the additional facilities has been minimised to reduce, as much as possible, the overall loss of habitat for marine resources, especially the CWD. The alignment of a runway is governed by the geographical location as well as the predominant wind direction for landings and take-offs. Considerations for runway alignment therefore form the first major foundation for any airport project, as runway alignment effectively governs available options for future layout and operation of airport facilities and can result in permanent operation constraints on an airport.

13.11.1.4 A total of 15 alignment were further developed to focussed on generic layouts to demonstrate the broadest range of possible runway alignments options and these were subject to assessment against a set of mandatory compliance criteria and a sixteenth option.

13.11.1.5 In addition, a total of 18 airport layout options were considered and evaluated against constructability and operation requirements and environmental considerations. Further details are provided in **Chapter 3**. Overall, previous land requirement estimates were in the region of 743 ha to 827 ha but have now been reduced to 650 ha of open waters and 672 ha of seabed area as a minimum requirement.

13.11.1.6 During the course of preliminary engineering design, key environmental differentiators for comparison of airport layout options have been considered in the development of preferred layout (**Section 3.4** in **Chapter 3**). CWD, fisheries and marine ecology are some of the key

environmental differentiators. The options comparison have considered the potential disturbance to CWD feeding grounds, disturbance to dolphin calves, permanent loss of feeding grounds, proximity of site boundary to SCLKCMP and associated risk of CWD injury due to collision with vessels, etc. based on the available information by the time of the study, in shortlisting the options where potential impacts were relatively lesser than other options. An example of avoidance of substantial expansion to the west of Chek Lap Kok (Option 4 – S(D+Z)) (**Table 3.9** in **Chapter 3**) due to the potential of affecting a larger area associated with CWD breeding grounds and calves, a larger area associated with CWDs engaged in feeding activities, a larger area of permanent habitat loss for CWDs and generating more impacts to CWDs during both construction and operation phase have been considered. This option is not further considered for the airport expansion layout.

Use of Construction Methods with Minimal Risk/Disturbance

13.11.1.7 Some marine construction methods are known to have a high risk of injury or disturbance to CWDs (see Jefferson et al. 2009), and thus every attempt has been made to avoid these types of methods during construction of the 3RS project. Percussive piling and underwater blasting are the two most significant examples and this project plans to avoid these two methods. While dredging is not considered as harmful as the above practices, it still has the potential to cause disturbance to CWDs and to cause negative impacts to the CWD's food source. Therefore, dredging operations will be avoided during the land formation and non-dredge techniques will be adopted for the main land formation and ancillary works including the diversion of the aviation fuel pipeline to the AFRF. The use of the Deep Cement Mixing (DCM) method instead of conventional seabed dredging for creation of the 3RS land platform will significantly reduce the risk of negative impacts through the elevation of suspended solids and contaminants on CWDs, fisheries and the marine environment. Land filling activities will be undertaken only behind a 200 m leading seawall. In addition, only short term bored piling will be used to form the new approach lights and marker beacons for the new runway and the CWD peak calving season of March to June will be avoided for these activities. Also, the horizontal directional drilling (HDD) method and water jetting methods will be used for placement of undersea cables and pipelines and these will minimise the disturbance to the CWDs and other marine ecological resources.

Consideration of Alternative Alignment for Pipeline Diversion with Minimal Risk/Disturbance

13.11.1.8 Alternative alignment for the submarine pipelines diversion has been considered to reduce the length within the bed rock levels of SCLKC Marine Park (**Appendix 13.14**). By adopting a similar alignment as Option 2 as far as possible, the HDD horizontal alignment close to Sha Chau would be as shown in yellow (**Appendix 13.14**) (the preferred alignment is shown in red).

13.11.1.9 This alignment involves both additional drilling distance and the introduction of a compound radius curve (combined horizontal and vertical curve) with a compound radius in the order of 700m. Both of these changes from the preferred alignment will substantially increase the construction risk associated with the HDD works and in particular the ability to day light at the selected location on the island close to the Aviation Fuel Receiving Facility. The layout of the compound curve means that any misalignment would be virtually impossible to adjust given the

very hard rock conditions and the day lighting has the potential to occur in the water to the north of the island. It is therefore concluded that this alignment is not a viable alignment.

13.11.1.10 By adopting the HDD method, disturbance to the marine environment would be negligible as the drilling will be carried out through the bedrock well below the seabed and both the bedrock and the sediment layers of the seabed would dampen any indirect and minor noise impact that may be expected during HDD drilling activities. It is again noted that the HDD drilling would take place at a depth of several tens of metres below the seabed. Although the section passing through rock underneath the existing SCLKC Marine Park would be slightly shorter, adopting the alternative and longer alignment would increase the risk of failing to accurately reach the selected day lighting location as discussed above and would also result in a larger amount of excavated materials and longer work duration for the pipeline installation. It should also be noted that the alternative alignment would ultimately be located completely underneath the seabed of the proposed extended marine park which in future will link the existing SCLKC Marine Park with the planned Brothers Marine Park as well as with the future 3RS HKIAAA.

Consideration of Alternative Treatment to Existing Pipelines after Diversion

13.11.1.11 It is considered to cap the two ends of the existing submarine pipelines after diversion, but alternative treatment has been reviewed to minimize the risk of leaving the pipelines in existing locations. If the whole length of the two pipelines is to be filled, grout would have to be introduced into them from both ends i.e. from the end at the airport island and the end at Sha Chau Island. This would require significant additional works within the SCLKC Marine Park and involve the handling of additional cement grout at the works area within the marine park. Due to the long length of the pipelines and the curved alignment, the complete filling of the pipelines could not be fully guaranteed. For these reasons and taking into account the significant depth of the pipelines below the seabed and the rock armour protection above them, it has been reasonably concluded that filling the whole length of the pipelines with cement grouting is not necessary and is unlikely to result in any environmental benefit. It should be noted that the existing pipelines will be completely flushed in order to remove any aviation fuel inside the pipelines prior to any grouting activity, with flushing residues treated / disposed of in accordance with all relevant Hong Kong requirements. Also, pipeline pigging would be deployed to remove any remaining fuel residues that may have adhered to the inner walls of the pipelines prior to capping at the two ends. Therefore, the decommissioned pipelines would not cause any adverse environmental impact even if they are only capped and grouted along a relatively short section at each end.

Strict Enforcement of No-Dumping Policy

13.11.1.12 Often, construction work involves extended work by personnel from coastal sites, reclaimed lands, anchored barges, skiffs, or other types of vessels. A No-Dumping Policy is simply a policy prohibiting dumping of wastes, chemicals, oil, trash, plastic, or any other substance that would potentially be harmful to dolphins and/or their habitat in the work area. It is mandatory that an educational program of the no-dumping policy be made available to all construction-site personnel for all project-related works. Obviously, to be effective, such a policy needs to be strictly enforced and there need to be stiff fines for infractions. Unscheduled, on-site audits will also generally be required.

Good Construction Site Practices

13.11.1.13 Good construction site practices will be observed, which is standard in most marine construction projects in Hong Kong these days. Among other things, this should include the regular inspection of the integrity and effectiveness of all silt curtains, and monitoring of effluents to ensure that any discharge meets effluent discharge guidelines. To minimise the potential temporary disturbance due to the delivery barges and stationary construction vessels north of the airport platform during construction, construction traffic (land and sea) including construction plants, construction vessels and barges should be kept to a practical minimum. Any idle vessels should be avoided in the construction area. The overall objective is to keep the number of working or stationary vessels present on-site to the minimum anytime. Unscheduled, on-site audits for all good site practice restrictions should be conducted, and fines or penalties sufficient to be an effective deterrent need to be levied against violators.

13.11.2 Water Quality Mitigation Measures

13.11.2.1 Implementation of the recommended water quality mitigation measures will also minimise the impacts on marine ecological resources. Details of the relevant water quality mitigation measures are described in **Section 8.8**, and are also summarised below.

13.11.2.2 The water quality mitigation measures during construction phases include consideration of alternative construction methods, deployment of silt curtain and good site practices. As recommended by the Water Quality Impact Assessment (**Chapter 8**), silt curtains will be deployed during the bored piling works for new runway approach lights and marker beacons as a precautionary measure to minimise the dispersion of suspended solids and contaminants.

13.11.2.3 Alternative construction methods including use of non-dredge methods for ground improvement (e.g. Deep Cement Mixing (DCM), prefabricated vertical drains (PVD), sand compaction piles, steel cells, stone columns and vertical sand drains) have been proposed to minimise the need for marine sediment removal, which will limit the release of sediment plumes during the construction phase (details see **Section 3.6.2**). This will greatly reduce the potential for adverse construction-related water quality impacts and associated impacts on marine ecology.

13.11.2.4 For the construction of other marine infrastructure facilities, no percussive piling will be used, but instead bore piling is selected as the preferred foundation system to support the approach lights, lighted marks and beacons for less disturbance to the surrounding environment (details see **Section 3.7.2**).

13.11.2.5 For the diversion of submarine aviation fuel pipelines, horizontal directional drilling (HDD) through the sub-sea bedrock level is proposed instead of traditional open trench method to avoid the impact on seabed (details see **Section 3.7.3**). This will greatly reduce direct impact on marine benthos habitats between the airport island and Sha Chau.

13.11.2.6 For the diversion of submarine 11 kV cables, water jetting method will be used for direct bury of cable from airport to outside of the SCLKCMP boundary (details see **Section 3.7.4**). No trench excavation is required and the seabed will be reinstated to original level upon construction completion. This will reduce the sediment release to the marine environment. For the field joint

location, excavation will be carried out to expose a section of the existing cable for connecting to the new cable. The excavated trench will then be reinstated and backfilled with sediment on top to the original seabed level. This will allow recolonisation of marine fauna upon completion of works.

13.11.2.7 Other specific measures for water quality impacts are presented in **Section 8.8.1**. In summary, these recommended measures include selection of marine fill materials with optimal fines content, provision of advance seawall of at least 200 m prior to commencement of marine filling activities, deployment of double layer silt curtains around active eastern works areas prior to commencement of sand blanket laying activities, deployment of double layer silt curtains around the partially completed seawalls prior to commencement of marine filling activities, use of closed grabs for field joint excavation works for the submarine cable diversion, and deployment of silt curtains to surround the closed grab dredger as a precautionary measure. Other measures to minimise contaminants in storm water discharges during operation phase are also specified in **Section 8.8.2**.

13.11.3 Establishment of a New Marine Park

13.11.3.1 In order to compensate for the 672 ha of seabed habitat and 650 ha of open waters habitat loss associated with the land formation for the 3RS project, the establishment of a new marine park matrix is proposed which would comprise an area of approximately 2,400 ha and also provide critical linkages between the current SCLKCMP (an area of 1,200 ha) and the planned BMP (an area of 850 ha). Together, all three marine parks would make up about 4,450 ha.

13.11.3.2 Marine Protected Areas (MPAs) which excludes fishing at core area and other anthropogenic disturbances may benefit the adjacent marine ecosystems outside the MPAs in two ways: (1) through the net emigration of juvenile and adult fish (termed “spillover effect”), and/or (2) export of pelagic eggs and larvae from the restored spawning stocks (Harmelin-Vivien et al., 2008). Based on the study of the effect of the spillover of fishes from the Mombasa Marine Park in Kenya, it was revealed that the establishment of Mombasa Marine Park, within which all forms of fishing are prohibited, significantly increased fish stocks adjacent to the park (McClanahan and Mangi, 2000).

13.11.3.3 Within Hong Kong, only one study had investigated the changes of demersal fish community after reclamation for HKIA, followed by the establishment of MPAs including SCLKCMP and the Pearl River Chinese White Dolphin Nature Reserve (PRCWDNR). The PRCWDNR has a core area of 140 km^2, where vessels are not allowed to enter without approval by the management department for the nature reserve. During reclamation, the fish community was dominated by young or small-sized species and fast-growing species. After the establishment of the MPAs, the fish density outside the MPAs was found to increase significantly, and the spillover effect lasted more than 15 km away from the boundary of the MPAs (Tam et al., 2013). Within the marine park, management of fishing activities may be carried out through permit system and the establishment of Marine Park Management Plan that may include core area as fisheries no-take zone. Furthermore, complementary fisheries management measures have been in place in Hong Kong waters following the implementation of the amended Fisheries Protection Ordinance which came into effect in 15 June 2012. These include setting up a registration system for local fishing vessels, limiting new entrants and maintaining an appropriate level of fishing effort, and

restrict fishing activities of non-fishing vessels. All these measures can help to strengthen the spillover effect for the proposed marine park, the connection between SCLKCMP, the planned BMP, the PRCWDNR and the future extended HKIAAA.

13.11.3.4 It is anticipated that the connection of all these marine protected areas with the extended HKIAAA as fisheries no-take zone will provide synergistic effects for the conservation of marine ecology and fisheries resources. In addition, a suite of controls and restrictions according to the Marine Parks Ordinance (Cap.476) and the Marine Parks and Marine Reserves Regulation (Cap. 476A), including the control of fishing activities, speed restriction to 10 knots or below and other anthropogenic disturbance, would further promote the recovery of marine ecology in the northern Lantau waters and adjacent area. The fisheries survey findings in the current study support that marine park can increase the marine fauna densities through protection of marine habitat. High yield was recorded in SCLKCMP, while other survey areas outside SCLKCMP (except the planned BMP) recorded low to moderate yield only (**Section 14.4.3**). A higher ichthyoplankton mean density was also recorded in SCLKCMP (**Appendix 14.3**). Therefore, it indicated that there is a certain protection effect on marine ecology within these protected areas.

13.11.4 Pre-construction Phase Coral Dive Survey

13.11.4.1 There will be direct loss of 5.9 km artificial seawall with coral species of conservation importance scattered along the sub-tidal habitat. The ahermatypic cup coral recorded along the northeastern seawall is *Balanophyllia* sp., which was recorded in low coverage. The impact significance for the loss of this sub-tidal habitat and species is considered as low-moderate upon completion of construction. The daylighting locations and pipeline connection to the existing offshore receiving platform at Sha Chau will cause direct loss of approximate 100 m^2 rocky shore habitat. The sub-tidal habitat over there has record of *Balanophyllia* sp. also at low coverage (< 5%). It is proposed to conduct pre-construction dive survey at the artificial seawalls at northern and northeastern airport island and at the daylighting location at Sha Chau to check the status of the ahermatypic cup coral and other coral species that will subject to direct impact and review the feasibility of translocation. A pre-construction coral dive survey plan and report will be prepared for agreement with the Authority prior to the commencement of marine works.

13.11.4.2 Considering the common distribution of this species in the western Hong Kong waters and with the re-provision of 13 km artificial seawall of similar design and substrates, the coral species is anticipated to recolonise the sub-tidal zone along with time. With the extension of HKIAAA as a marine exclusive zone, the re-established habitat will be protected from anthrogenic disturbance. The impact of loss of sub-tidal habitat is considered to be low during the operation phase, and no further mitigation measure is considered required.

13.11.5 Marine Mammals

13.11.5.1 Based upon the predicted impacts to the CWDs from the construction and operation of the 3RS project, a range of mitigation measures, as well as ecological monitoring, have been recommended, as summarised below in **Table 13-30** and **Table 13-31** for the construction and operation phases, respectively. Details on measures that have been implemented to avoid impacts are presented in **Sections 13.11.2.3** to **13.11.2.6** above.

Table 13-30: Summary of Construction Phase Mitigation and Monitoring for Chinese White Dolphins

Impact	Significance	Mitigation	Mitigation Type/ Precautionary Measure	Monitoring[2]
Loss of dolphin habitat				
Land formation	Moderate - High	New Marine Park[3]	Compensation	Surveys
Bored piling	Low	n/a	n/a	n/a
Ancillary works excavation	Insignificant	n/a	n/a	n/a
Loss of carrying capacity	Moderate	New Marine Park[3]	Compensation	Surveys
Habitat fragmentation	Moderate	New Marine Park[3]	Compensation	Surveys
Loss and disturbance to travel area	Moderate	New Marine Park[3]	Compensation	Surveys
Loss of prey resources	Low	n/a	n/a	n/a
Changes to abundance and habitat Use	Moderate	New Marine Park[3]	Compensation	Surveys
Elevation in suspended solids	Low	n/a	n/a	n/a
Reduction in dissolved oxygen	Insignificant	n/a	n/a	n/a
Release of contamination	Insignificant	n/a	n/a	n/a
Oil/chemical spills	Low	Spill Response Plan[1]	Precautionary	n/a
Deep cement mixing	Low	n/a	n/a	n/a
Transportation of marine fill	Low	n/a	n/a	n/a
Acoustic disturbance from construction works	Low- Moderate	Dolphin Exclusion Zone Acoustic Decoupling	Precautionary	n/a
Disturbance from nighttime construction works	Moderate	Dolphin Exclusion Zone Acoustic Decoupling	Minimisation	n/a
Acoustic disturbance from marine vessels				
Construction vessels	Low	Speed Limits[1] Skipper Training[1]	Precautionary	n/a
High speed ferries	Moderate	Speed Restrictions and Route Diversion	Minimisation	Surveys
Injury/mortality from marine vessels				
Construction vessels	Low	Speed Limits[1] Skipper Training[1]	Precautionary	n/a
High speed ferries	High	Speed Restrictions and Route Diversion	Minimisation	Surveys
Changes to CWD movements patterns from marine vessels				
Construction vessels	Low	Speed Limits[1] Skipper Training[1]	Precautionary	n/a
High speed ferries	Moderate	Speed Restrictions and Route Diversion	Minimisation	Surveys
Disturbance to function and quality of marine parks				
SCLKCMP	Low- Moderate	Speed Limits[1]	Precautionary	Surveys

Impact	Significance	Mitigation	Mitigation Type/ Precautionary Measure	Monitoring[2]
		Skipper Training[1]		
BMP	Moderate	New Marine Park [3]	Compensation	Surveys
SW Lantau	Low	n/a	n/a	n/a

Note (1): Spill response plan and construction vessel speed limits and skipper training are precautionary measures only
(2): Surveys refer to coordinated sets of vessel-based monitoring and land-based and acoustic (using PAM or equivalent) surveys that will feed into the EM&A monitoring plan.
(3): To be implemented tentatively around 2023 to tie in with the full operation of the 3RS, to practically compensate the permanent habitat loss arising from the 3RS project.
(4) The implementation of the Dolphin Exclusion Zone during bored piling is recommended as a precautionary measure only.

Table 13-31: Summary of Operational Phase Mitigation and Monitoring for Chinese White Dolphins

Impact	Significance	Mitigation	Mitigation Type/ Precautionary Measure	Monitoring[2]
Loss of dolphin habitat				
Land formation	High	New Marine Park	Compensation	Surveys
Bored piling	Low	n/a	n/a	n/a
Loss of carrying capacity	Moderate	New Marine Park	Compensation	Surveys
Habitat fragmentation	Moderate	New Marine Park	Compensation	Surveys
Loss of travel area	Moderate	New Marine Park	Compensation	Surveys
Loss of prey resources	Low	n/a	n/a	n/a
Changes to abundance and habitat Use	Moderate	New Marine Park	Compensation	Surveys
Hydro-dynamic changes	Low	n/a	n/a	n/a
Oil/chemical spills	Low	Spill Response Plan[1]	Precautionary	n/a
Acoustic disturbance from HSF vessels	Moderate- High	SkyPier Speed Restrictions and Route Diversion	Minimisation	Surveys
Injury/mortality from HSF vessels	High	SkyPier Speed Restrictions and Route Diversion	Minimisation	Surveys
Changes to CWD movements patterns from HSF vessels	Moderate- High	SkyPier Speed Restrictions and Route Diversion	Minimisation	Surveys
Disturbance to function and quality of marine parks				
SCLKCMP	Low-Moderate	SkyPier Speed Restrictions and Route Diversion Spill Response Plan[1]	Precautionary	Surveys
BMP	Moderate	New Marine Park	Compensation	Surveys
SW Lantau	Low	n/a	n/a	n/a

Note (1): Spill Response Plan is a precautionary measure only
(2): Surveys refer to coordinated sets of vessel-based monitoring and land-based and acoustic (using PAM or equivalent) surveys that will feed into the EM&A monitoring plan.

13.11.5.2 Further details in the mitigation measures identified in **Table 13-30** and **Table 13-31** above are provided in the sections below, while details of the ecological monitoring and audit are provided in the standalone Environmental Monitoring and Audit Manual**.**

Construction Phase Mitigation and Precautionary Measures

Establishment of New Marine Protected Areas / Linking of Existing Marine Parks

13.11.5.3 The loss of 650 ha of marine waters habitat utilised by the CWD is considered a moderate-high impact for the construction phase. With the following mitigation measures recommended, short-term residual impacts are considered acceptable (Section **13.14**). The habitat loss due to construction would become permanent habitat loss in the operation phase. This permanent habitat loss arising from the 3RS project can practicably be compensated by the provision of the proposed Marine Park to be implemented tentatively around 2023 to tie in with the full operation of the 3RS.

SkyPier High Speed Ferries' Speed Restrictions and Route Diversions

13.11.5.4 Based on the prediction of moderate-high impacts to CWDs resulting from high speed ferries, mitigation measures in relation to marine traffic control need to be specified to reduce acoustic disturbance, risk of injury or mortality and changes to abundance and patterns of habitat use. Once the 3RS project construction is underway, the paths of vessel movements from the east side of the airport platform to the waters west of Hong Kong will be restricted even more, pushing SkyPier and other vessels further to the north and closer to the southern boundary of the SCLKCMP. Having an increasing number of high-speed vessels, using a narrower corridor of movement, results in closer spacing of the vessels and less area for CWDs to surface without strong risk of being hit by a vessel. It would also result in higher levels of anthropogenic noise, which is known to cause behavioural disturbance to dolphins.

13.11.5.5 In order to specify suitable mitigation, it is necessary to know what a 'safe' speed for vessels moving around the CWDs is, so that appropriate speed limits can be established. In fact, there appear to be no scientific studies that empirically evaluate the differing effects of specific vessel speeds on dolphins of any species, but nonetheless, there is some information from the literature that provides guidance, as indicted by the international research and evidence of the effects of marine traffic on cetaceans (Wells and Scott 1997; Honma et al. 2001; Van Waerebeek et al. 2007; Ritter 2010; Carillo and Ritter 2010).

13.11.5.6 For manatees (another type of marine mammal, not closely related to dolphins), which suffer serious problems from vessel collision and have been better studied, speed limits in protected areas were found to be effective mainly by:

(1) Increasing reaction times for boat captains;

(2) Increasing reaction times for the animals; and

(3) Reducing the severity of injuries if a collision does occur.

13.11.5.7 Overall, the information suggests that speed limits are an "appropriate, reasonable, and defensible" protection measure for marine mammals in general (Calleson and Frohlich 2007).

13.11.5.8 For cetaceans (mostly large whales), there has also been some work done to define safe speeds for the animals. Laist et al. (2001) found that most severe or lethal injuries involved vessels travelling at speeds of 14 knots or greater. In the most detailed study ever conducted on the effects of vessels travelling at different speeds on cetaceans, it was found that the largest increase in risk of death to the marine mammals occurred at vessel speeds of 9-15 knots and at speeds greater than 15 knots, the chances of the manatees being killed rapidly approach 100% (Vanderlaan and Taggart 2007; Fig. 4).

13.11.5.9 Previous studies have noted that heavy vessel traffic can result in some changes to the diving and swim speed behaviour of CWDs (Ng and Leung 2003; Piwetz et al. 2012; Hung 2012 and, 2013). However, studies have shown that it is the fast moving vessels (generally > 10-15 knots) that result in obvious behavioural disturbance (Mizrock 1995, National Research Council 2003).

13.11.5.10 High speed ferries (HSF) generally travel at speeds of 30-40 knots in open waters, and it has been found that such high speeds can be especially dangerous for cetaceans (Ritter 2010) and at the very least cause continuing intermittent behavioural changes in CWDs as they attempt to avoid rapid and noisy ferry approaches (Sims et al. 2012), especially while foraging or transiting across ferry lanes. Data from the AFCD long-term studies (Hung 2012, 2013) and the present intensive one-year study show clearly that such behavioural changes take place. However, the risks to CWDs decrease as vessel speeds reduce and therefore, any reduction in speed from the 40 knots of the HSFs will provide benefit and additional protection to the CWDs.

13.11.5.11 Thus, for the construction stage, some restrictions on SkyPier High Speed Ferry (HSF) routings and speed of travel are proposed in order to reduce the potential for adverse impacts from such vessel movements on CWDs, in particular in areas of higher CWD density during 3RS project construction. From the start of construction, it is proposed that SkyPier HSFs operating to / from Zhuhai and Macau would divert north of SCLKCMP with a 15 knot speed limit to apply for the part-journeys that cross high CWD abundance grid squares, for example as indicatively shown in **Drawing No. MCL/P132/EIA/13-024**. Both the alignment of the northerly route and the portion of routings to be subject to the speed limit of 15 knots shall be finalised prior to commencement of construction based on the future review of up-to-date CWD abundance and EM&A data and taking reference to changes in total SkyPier HSF numbers. Should the SkyPier HSFs that use the Urmston Road to travel north into the PRE also interface with the speed restriction area for the SkyPier HSFs operating to / from Zhuhai and Macau, then they would also be required to adhere to the 15 knot speed restriction. This significant reduction in HSF speed would be considered to have beneficial effects on risks and disturbance to CWDs and the mitigation would be considered effective as it will be adopted by all SkyPier HSFs operating to / from Zhuhai and Macau. This proposed mitigation would avoid the current situation of the SkyPier HSFs travelling to Zhuhai and Macau passing south of the SCLKCMP at high speeds substantially reducing the impacts of these vessels (which constitue to 60% of the HSFs) in this area. The AAHK is fully committed to the implementation of these mitigation measures and has the ability to enforce the requirements on the SkyPier HSF operators, all of which are under its jurisdiction. A maximum of 10 knots will be enforced through the designated SCLKCMP area at all times.

13.11.5.12 The EIA Study Brief suggested that a possible mitigation measure that may serve to minimise HSF impacts on CWDs in South west Lantau would be a relocation of the busy ferry routes passing south of Lantau even further south (that is, further away from the areas of higher CWD abundance near Fan Lau). Such a mitigation measure would not be applicable to HSFs using SkyPier, which are the only ferries associated with airport operations and that are within the control of AAHK. All HSFs operating from SkyPier sail west from the airport and do not use ferry routes south of Lantau. The SkyPier HSFs travel to Macao in a westerly direction from the east of the airport and the south of Lantau is not relevant. If the SkyPier HSFs travelled east and then through the Ma Wan channel and to the south of Lantau, they would still travel close to the CWD habitat at the Brothers would add significantly to their journey. Relocating the ferry routes south of Lantau further south is therefore only relevant to other ferries operating from the Hong Kong and China Ferry Terminals on Hong Kong Island and the Kowloon Peninsula, respectively. AAHK has no jurisdiction over these HSF operations, their speeds or navigation routes and is not able to control them as part of mitigation for the 3RS project.

13.11.5.13 A qualitative marine traffic impact assessment was nevertheless completed that considered three alternative routes further south of Lantau. The assessment identified that the current ferry routing through the Adamasta Channel is already narrow and heavily used and that further constraints would not be safe or considered acceptable to marine users, with changes to route alignments likely to complicate already high HSF traffic flows using traffic separation schemes in both Hong Kong and Mainland waters as well as associated marine traffic junction arrangements. Potential route alternatives going south of the Soko Islands were found to be less sheltered, potentially exposing HSFs to greater wave heights than currently experienced. One route option considered more closely followed the existing Adamasta Channel route with a less pronounced diversion in the vicinity of Fan Lau, but this was also found to result in multiple potential marine traffic conflicts and was therefore also not considered safe. Thus, options for relocating busy ferry routes south of Lantau further to the south as well as not being applicable to HKIA ferry operations were also found to be not feasible. It is felt that the proposed speed restrictions and route limitations will help to alleviate impacts on CWDs from HSFs in terms of both collisions and noise disturbance. Postponing the decision on northerly route diversion alignment and the section of the diverted route to be subject to the 15 knots speed limit until further review of updated CWD abundance data will ensure the measures are as effective as possible.

Dolphin Exclusion Zones

13.11.5.14 The construction scheduling has avoided undertaking bored pilling during the peak calving season. However, when intermittent construction activities have the potential to cause behavioural disturbance or even physical harm to cetaceans, monitored exclusion zones can help to reduce the chances of impacts (see Jefferson 2000; Caltrans 2006). As only CWDs within close range of the activity of interest are at risk, the risk can be minimised and avoided by not undertaking such activities when CWDs are nearby. Dolphin Exclusion Zones (DEZ) are often used as mitigation measures in military and oil industry seismic surveys, but the diameter of the zone is highly variable, and there is generally little empirical confirmation of the effectiveness of these measures (see Weir and Dolman 2007). Exclusion zones ranging from 250 m to 500 m in radius have been used in Hong Kong in the past, depending on the activity. “Lower impact” activities such as dredging and cable–laying operations have used a 250 m

radius, while those activities that are perceived to be more harmful (e.g., underwater blasting or percussive piling) often apply up to a 500 m radius. Based upon the above, as no percussive piling or underwater blasting will be undertaken, an exclusion zone of 250 m radius would be considered appropriate for this project for land formation and other construction works. It should be noted, however, that there may be percussive piling undertaken on land once the platform has been created but this will not affect the CWD. In summary, a DEZ would be implemented during ground improvement works (e.g. DCM), water jetting works for submarine cables diversion, open trench dredging at the field joint locations and seawall construction. A DEZ would also be implemented during bored piling work but as a precautionary measure only.

13.11.5.15 The principles of the exclusion zone are that, during daylight hours, the area will be visually inspected for CWDs prior to commencement of the land formation works. However, it is proposed that the 3RS construction works will be undertaken 24 hours per day and the activities that will be undertaken during the nighttime are detailed in **Section 13.9.2.89**. As visual exclusion zone monitoring relies on the visual detection of CWDs, it would therefore not be suitable during the nighttime periods. Based upon this, an alternative method would be required for any land formation works outside daylight hours. This might include Passive Acoustic Monitoring (PAM) and/or the use of night-vision scopes / goggles. The latter are now much more efficient than several years ago (see Maldini et al. 2012). PAM involves the use of hydrophones or automated cetacean detectors and specifications to be developed during detailed design will specify further exploration of the use of PAM with real-time data capability. The effectiveness of the night-vision equipment needs to be tested in conditions to those similar to the actual work site to ensure that CWD detections out to the edge of the exclusion zone are effective. The best manner in which to carry this out is by tracking CWD groups by binoculars in the evening, as light decreases and then segueing to night vision devices to continue to track the animals in semi-darkness. In this manner, distances of efficient nigh-time tracking can be ascertained and protocols of nighttime tracking can be established. Such visual surveys are enhanced by having real-time acoustic feedback of CWD groups. As noted in the EM&A Manual, a specification for the DEZ, both during daytime and nighttitme, will be prepared at the pre-construction stage for evaluation by the relevant authorities and the exact method of use will be defined fully at that stage.

13.11.5.16 The DEZ should be monitored by independent CWD observers with an unobstructed, elevated view of the area. Land formation and bored piling works would not be allowed to begin until the observer certifies that the area is continuously clear of CWDs for a period of 30 minutes (see Weir and Dolman 2007) and thereby adequately spanning the approximate maximum dive time of the CWDs of up to 4 minutes (Jefferson 2000). Works should cease if CWDs move into the exclusion zone / area during these activities and works should not start again until the observer has confirmed that the area is continuously clear of dolphins for a period of 30 minutes.

13.11.5.17 Any DEZ should be specific to the intensive and noisy construction activities that would be of potential disturbance to the CWDs and should not apply to the entire 3RS designated area until such land formation and bored piling activities take place. Each area will need to be evaluated and determined as a potential DEZ on a case by case basis and further details will be provided at the detailed design stage when the construction sequencing is progressed.

13.11.5.18 The observers must be adequately trained and qualified, (with a degree in biological sciences, experience in observing dolphins, and basic knowledge of literature on CWDs in Hong Kong) and should be independent of the construction contractor and should form part of the independent Environmental Team (ET) to be employed by the Contractor. An Independent Environmental Checker (IEC) would be required to audit the work of the ET. An important aspect of applying this mitigation technique effectively is that the observer should have the power to call-off construction activities in the exclusion zone if the ET detects CWDs.

Acoustic Decoupling of Construction Equipment

13.11.5.19 Construction equipment can be noisy and, when such pieces of equipment are used on the water or in coastal areas, some of the sound may be transmitted into the water and affect small cetaceans as noise pollution. It is therefore desirable to reduce construction noise as much as possible. Construction machinery, such as compressors and generators, that are placed onto the steel hulls of barges are particular culprits. Air compressors and other noisy equipment that must be mounted on steel barges should be acoustically-decoupled to the greatest extent feasible, for instance by using rubber or air-filled tyres. Specific acoustic decoupling measures shall be specified during the detailed design of the project for use during the land formation works. This technique has been used extensively in Hong Kong since the original airport construction project (see Jefferson 2000). Sound isolating and absorbing techniques have been recommended by many acousticians and formalised for applications in the USA by Southall (2005).

Spill Response Plan

13.11.5.20 Only potentially low impacts to CWDs are predicted as a result of an oil or chemical spillage and therefore, no mitigation measures are required. However, an oil and hazardous chemical spill response plan is proposed to be established during the construction phase as a precautionary measure so that appropriate actions to prevent or reduce risks to CWDs can be undertaken in the event of an accidental spillage. Among the provisions should be measures to contain spills and prevent them from spreading, including booms and possibly silt curtains. Chemical dispersants can be toxic to some animals and thus are not recommenced to be used in the event of a spill. The spill response plan as part of water quality mitigation measures will be developed at a later stage as a precautionary measure.

Construction Vessel Speed Limits and Skipper Training

13.11.5.21 As fast-moving vessels are more of a threat to CWDs than slower-moving ones, a speed limit of 10 knots should be strictly observed for construction vessels within the areas where CWDs are likely to occur, namely through areas with the highest CWD densities (as currently indicated by the 1 x 1 km grid squares in Figure 6 of **Appendix 13.2**). This speed limit of 10 knots within the boundaries of the SCLKCMP appears to be effective in protecting CWDs from vessel collisions and acoustic disturbance. The Contractor, in conjunction with the Environmental Team (ET), should undertake workshop(s) for all vessel captains working in the area, prior to construction, to educate them about local cetaceans, as well as guidelines for safe vessel operations in the presence of CWDs. Also, vessels traversing through the work areas should be required to use predefined and regular routes (which would presumably become known to resident dolphins) to

reduce disturbance to cetaceans due to vessel movements. Specific marine routes shall be specified by the Contractor prior to construction commencing.

13.11.5.22 The mitigation of vessel speed limits is only proposed for construction vessels during the construction. The predefined routing for construction vessels shall cover waters both inside and outside the works area, but within Hong Kong waters, in order to minimise the disturbance to the CWDs and shall also avoid dolphin hotspots. A "Regular Marine Travel Routes Plan" to define the routings for construction vessels will be prepared and submitted to the relevant Authority for approval within 2 months of the commencement of construction.

13.11.5.23 Implementation would be enforced by the Contractor and applied to all vessels engaging in construction works under the contractual agreement. A specification for defining the Vessel Speed Limits and Restrictions will be prepared and agreed upon during the detailed design stage for inclusion in the Contract Documents.

Operational Phase Mitigation and Precautionary Measures

Establishment of New Marine Protected Areas / Linking of Existing Marine Parks

13.11.5.24 As discussed above, the 650 ha of CWD habitat loss would be a high impact to the Hong Kong sub-ppopulation of the CWD and an additional marine park is proposed to mitigate these impacts. As avoidance and minimisation measures are exhausted, compensatory measure is therefore required.

13.11.5.25 Worldwide, Marine Protected Areas (MPAs), have become an effective way to help maintain or restore marine habitats, by curtailing fishing (such as set-netting or trawling), industrial activities including shipping and oil and gas development, and giving speed restrictions to watercraft. A review of marine protections areas around the world (see **Appendix 13.15),** indicates that several small MPAs, comparable to the smaller sizes available in Hong Kong and being proposed for the new 3RS Marine Park, are providing positive indications that they provide protection and add to the conservation of cetaceans.

13.11.5.26 Specifically for Hong Kong, the value of the SCLKCMP as a CWD conservation measure has been demonstrated through long-term monitoring efforts (see Hung 2008). Hung (2008) has shown that CWDs use the area of the marine park preferentially for feeding and resting behaviour, and mothers with young calves use it to nurse and care for their offspring. Based upon the grid analyses conducted by Hung (2008, 2012, 2013), it is clear that the areas around Lung Kwu Chau and especially to the north and east of Lung Kwu Chau, which lie within the boundaries of the SCLKCMP or just adjacent to it, have some of the highest densities of CWDs among all areas of Hong Kong. Further, these areas have been used as prime habitat by CWDs for the duration of the AFCD long-term study, presently a consistent pattern of use that remains to the present time (see Hung 2013). This provides solid evidence that the SCLKCMP has been effective in providing protection to the Hong Kong sub-population of CWDs. In light of this, marine parks at Fan Lau in Southwest Lantau and the Brothers have also been proposed. The designation of the Brothers Marine Park (BMP), which is an area in close proximity to the airport and proposed 3RS project, has commenced a detailed study in August 2013 for the design and implementation of the marine park designation.

13.11.5.27 In order to compensate for the 672 ha of seabed habitat and 650 ha of open waters habitat loss associated with the land formation for the 3RS project, the establishment of a new marine park matrix is proposed which would comprise an area of approximately 2,400 ha and also provide critical linkages between the current SCLKCMP (an area of 1,200 ha) and the planned BMP (an area of 850 ha). Together, all three marine parks would make up about 4,450 ha of CWD marine park area, as shown in **Appendix 13.16.** It should be noted that the extent of the proposed new Marine Park will need to be designated under the Marine Parks Ordinance and the current estimate of its area is indicative and subject to change after discussion and agreement with the Hong Kong Government and other stakeholders.

13.11.5.28 The addition of this new marine park area and even more importantly, the linking of three marine park areas into a large marine park of about 4,450 ha, is expected to significantly improve the conservation prospects for the Hong Kong sub-population of CWDs by mitigating the impacts of habitat loss, fragmentation, changes in patterns of habitat use, as well as minimising the noise and disturbance from marine traffic, specifically HSFs, as detailed below. The management of fishing activities in marine parks by AFCD will also provide important protection for the CWDs, as stranding data indicate that net entanglement is the second leading cause of death for CWDs in Hong Kong, after vessel collision. The documented declining trends in the sub-population must be reversed or halted for the continued existence of CWDs in Hong Kong and the single most promising measure for increasing the chances of CWD survival would be to increase the protected area of habitat by the magnitude proposed.

13.11.5.29 There is a declining trend of the CWDs in northern Lantau waters (both northeast and northwest), west Lantau and Southwest Lantau (the three main areas in which CWDs consistently occur in Hong Kong) as noted from the long term AFCD monitoring programme (Hung 2008, 2012, 2013 and new analysis by Jefferson for this EIA study as noted in Section 13.3.4 in **Appendix 13.2**). While the causes are likely to be a combination of factors, one factor is that the CWDs are shifting their movements to the portions of their individual ranges outside of Hong Kong waters, in addition to mortality as supported by stranding data (AFCD unpublished) and previous studies (Jefferson 2000; Jefferson and Hung 2004). Thus, while the decline is occurring, the Hong Kong sub-population may be able to be supplemented from CWDs in PRE waters if sufficient protection is provided to the habitat in Hong Kong, providing a better chance of reversing the decline than if the Hong Kong CWDs were an isolated population and mortality were the sole cause of the decline. The provision of the marine protection area would also provide suitable marine habitat that could be used by the CWD as potential alternate travel areas to the north of the 3RS.

13.11.5.30 While the new protected area cannot be considered to be ‘pristine’, it will provide a very large area in which CWDs will enjoy significant protection from high-speed vessel traffic, excess fishing activities and other human based threats. Under the current practice, fishing permit would be issued to *bona fide* fishermen to engage in permitted forms of fishing in marine parks. The Marine Park can only be fully effective for CWDs if vessels, particularly high speed vessels, are limited to slow speeds and commercial fisheries are strongly curtailed, with these two issues representing the major identified anthropogenic causes of death to CWDs in Hong Kong (see Jeffeson 2000; Parsons and Jefferson 2000; Jeffeson et al. 2006).

13.11.5.31 The Marine Parks Ordinance provides the following key protection to designated marine parks:

- Vessel speed restrictions to 10 knots;
- No new development is allowed within a marine park without prior approval in writing of the Marine Parks Authority;
- No person is allowed to moor or anchor a vessel in a marine park except under and in accordance with a permit or at mooring buoys or mooring sites provided by the Marine Parks Authority;
- The Marine Parks Authority may, if he considers it necessary in the interests of good management, prohibit or restrict the entry into, or movement within a marine park or part thereof of any person, vehicle or vessel;
- Prohibition of fishing, hunting and collecting animals and plants in marine park, unless with a permit granted;
- No person shall within a marine park deface, injure, soil or defile any notice, marker, buoy, facility or installation erected, used or maintained by the Marine Parks Authority; obstruct or pollute in any way any pool or body of water; or deposit any litter; and
- Damaging any shoreline features on a beach, mudflat, cliff or seabed is not allowed.

13.11.5.32 Wardens patrol the Marine Parks on a daily basis by both land and sea, day and night, and at irregular hours to take enforcement action against anyone who infringes the Marine Parks Ordinance or relevant regulations. Any contravention may lead to a fine of HKD 25,000 and one year imprisonment.

13.11.5.33 The regulation of fishing activities in the marine protected area will promote the recruitment of juvenile fish and prey resources for CWDs and the ban on fishing with trawl nets since 31 December 2012 will provide further potential for fisheries resources recovery. This, together with the increased HKIAAA adding further protected habitat (see below), is seen as a potentially effective method of assisting the Hong Kong sub-population's survival prospects.

13.11.5.34 A marine park that expands the area of the present SCLKCMP to the west, east, and south of the present park and provides links with the planned Brothers Marine Park is considered especially beneficial in protecting major travelling (and also used for other behaviours) areas of CWD between the "hotspot" of the SCLKCMP, the relative "hotspot" around the Brothers and south and southwest of the existing and expanded airport. The area immediately west of the airport appears to be a feeding ground for CWDs and since this would also be a part of the new expanded marine park, would provide valuable further protection. It has been shown that linkages between marine protected areas, often referred to as "corridors", are especially effective in allowing movement of individuals from one protected area to another (Hoyt 2011). In addition, it is generally recognised that marine parks are most effective when they are large in relation to the ranges of the protected animals and also that they work best when they can providing linkages between areas of core habitat for important life functions (see Hoyt 2009).

13.11.5.35 It should also be noted the the new marine park will be contiguous with the PRE CWD national nature reserve established by the Mainland side, thereby providing a 'corridor' of

protected habitat between Hong Kong and the mainland. The new marine park will also provide vital connections with the two other marine parks in North Lantau and, together with the contiguous HKIA exclusion zones and connection to the large PRC nature reserve, would substantially increase the area of CWD habitat within which potentially harmful activities, such as coastal development and fast moving vessels, would be restricted.

13.11.5.36 This entire proposed expansion of protected areas would be considered to help offset the loss of the travelling area as a result of the 3RS project, ameliorate impacts associated with habitat fragmentation and carrying capacity and habitat loss and provide needed protection from the threat of net entanglement (which has been identified as the second leading cause of death from stranded CWDs). Thus, this matrix of protected areas is expected to provide a positive step for maintaining CWDs in North and North-East Lantau.While the areas of highest CWD density in Hong Kong are east of Lung Kwu Chau and off the west Lantau coastline, there has been major opposition and obstacles to getting these areas designated as protected habitat for CWDs. Although it is recognised that the long-term importance of such designations to the continued presence of CWDs in Hong Kong, the proposed 3RS marine park is considered feasible and also manageable, due to its location directly adjacent to the airport.

13.11.5.37 Given the significance of Marine Park establishment as a key mitigation measure, the successful establishment of the proposed Marine Park is of key importance. It is not practicable to seek to designate the proposed new areas of Marine Park while construction activities for the 3RS project are ongoing. The Administration has made a firm commitment to seek to designate the proposed marine park of approximately 2,400 ha in the waters north of the 3RS project in accordance with the statutory process stipulated in the Marine Parks Ordinance, as a mitigation measure for the permanent habitat loss arising from the 3RS project. AAHK will seek to assist in completing the designation tentatively around 2023 to tie in with the full operation of the 3RS.

13.11.5.38 The AAHK proposes to commence preparatory work and the process of Marine Park establishment as early as possible, with the target to complete the designation of the proposed Marine Park tentatively around 2023 to tie in with the full operation of the 3RS. As part of this preparatory work effort, a thorough consultation of all directly and indirectly affected stakeholders shall be undertaken.

13.11.5.39 A detailed study initiated and led by AAHK will be carried out during the construction phase to review relevant previous studies and collate available information on the ecological characters of the proposed area for marine park designation and review available survey data marine traffic and planned development projects in the vicinity. Based on the findings, ecological profiles of the proposed area for marine park designation would be established and the extent and location of the proposed marine park be determined. The proposed enhancement measures detailed in **Section 13.13** will also be reviewed in light of the marine park designation and the AAHK will consider the potential measures that may serve to enhance the effectiveness of the new Marine Park area with the intention of adding to existing management measures as defined in the Marine Parks Ordinance where feasible and practicable.

13.11.5.40 In addition, a management plan for the proposed marine park will be proposed, in consultation with AFCD, covering information on the responsible departments for operation and management (O&M) of the marine park, as well as the O&M duties of each of the departments

involved. The management plan will be submitted to Director of Environmental Protection (DEP) for approval before the commissioning of the 3RS project.

13.11.5.41 A further advantage of providing expansion of the existing park and a linkage to the new proposed park to the east is that much of this area is connected to existing and new (due to the new runway) Airport Exclusion Zones, which already provides protection to CWDs by restricting all vessel traffic. In addition to the marine parks area, the restricted access HKIAAA zone would be expanded to a total of 729 ha, an addition of 118 ha after the 3RS project is in place, as discussed in **Section 13.9.3.6** above. It should be noted that while the marine park areas would allow marine vessels but at reduced speeds of 10 knots, HKIAAA would have extra value as CWD habitat as all unauthorised marine traffic is prohibited. As such the additional 118 ha to 729 ha in total of HKIAAA would respresent a valuable resource to the overall marine protection areas. Based on this, a total area of about 5,179 ha would be formed (in the region of 3,129 ha of which would be from the 3RS project) in which the CWDs would be protected from excess fishing activities and high-speed vessel threats. Under the current practice, fishing permit would be issued to bona fide fishermen to engage in permitted forms of fishing in marine parks. While the extent of the proposed Marine Park and the new HKIAAA are indicative and subject to change during detailed design as well as the designation process under the relevant ordinances, the combined area representing the overall marine protection areas would not be expected to change significantly. This would dramatically increase the amount of protected area for CWDs in North Lantau (which is currently only 1,811 ha comprising the SCLKCMP and existing HKIAAA), and would make virtually the entire zone of North Lantau an area with moderate to strong CWD protection measures, with the exception of the Urmston Road shipping channel, the region just north of the SCLKCMP, the area east of the Brothers and directly east of the airport and the airport channel (the latter of which are all low-density areas for CWDs). The linking of the existing / planned / potential marine parks and the inter-connection of several moderate and high value habitats for CWDs through this plan would help to ensure the protection of the CWD travelling area and the linkages between the two main social clusters of CWDs north and west of Lantau Island, which are considered important for suitable gene flow within the Hong Kong CWD sub-population.

13.11.5.42 Potential habitat loss, habitat fragmentation, carrying capacity, loss of travel areas and changes to abundance and patterns of use (including impacts to BMP) can be compensated and also, noise and disturbance from marine vessels can be mitigated to some extent by the combined positive effects of adding a large amount of new, effective protected area of CWD habitat in Hong Kong for the Hong Kong CWDs sub-population's range which has been shown to be declining in all three of its major habitat areas over the last decade or so. It is noted that the declines are considered to be a combined result of mortality, with high speed vessels considered to be a major factor, and CWDs shifting their movements to the portions of their individual ranges outside of Hong Kong waters. Thus, there is a better chance of reversing the decline than if the Hong Kong CWDs were an isolated population and the vessel controls in the new marine park along with other vessel route and speed restrictions would help minimise disturbance, injury and mortality to the CWDs. This would come about through the addition of the new marine park in northwest Lantau (**Appendix 13.16**), plus the additional 118 ha of restricted zone in the new HKIAAA. As noted above, the firm commitment to seek to designate the marine park, in which activities that would pose a risk to the CWDs, including high speed ferries and some fishing activities, would be regulated and subject to proper management in

accordance with the Marine Parks Ordinance, are considered to be adequate to effectively mitigate the predicted impacts on the CWDs arising from the project to an acceptable level.

13.11.5.43 In summary, the proposed Marine Park is assessed to be a practicable and feasible measure. As shown by literature review and field surveys, it is an effective measure in mitigating the loss of habitats for marine fauna and CWD (**Sections 13.11.3.2** to **13.11.3.4**; and **Sections 13.11.5.34** to **13.11.5.36**; **Appendix 13.15**). The designation, control and management of the Marine Parks are governed by the Marine Parks Ordinance (Cap. 476), which stipulates the Director of Agriculture, Fisheries and Conservation as the Marine Parks Authority and sets out the necessary procedures for marine park designation. THB/AAHK, as supporting policy bureau and project proponent respectively, would take the lead in implementation, including the provision of resources for designation of the marine park, with support and advice from Environment Bureau and AFCD, with a view to completing the designation tentatively around 2023 to tie in with the full operation of the 3RS (**Sections 13.11.5.37** to **13.11.5.38**). Monitoring surveys have also been proposed during operational stage to monitor the effectiveness of the mitigation measures (**Section 13.16.1.5**).

SkyPier High Speed Ferries' Speed Restrictions and Route Diversions

13.11.5.44 Once the 3RS project land platform has been completed, HSF vessel movements from the SkyPier, together with river trade and other vessels, to the waters west of Hong Kong will be restricted into a narrower corridor north of the new 3RS land platform. The increased number of HSFs in a narrower corridor of movement would result in increased conflicts with the CWD, which will also have to move north as a result of the loss of its preferred travel area. Close contact with high speed vessels increases disturbance and also the risk of collisions.

13.11.5.45 As noted above, based on studies of cetaceans, speeds in excess of 10-15 knots have been known to cause increase risks of injury and mortality and reduced vessel speeds can increase reaction times for the animals and reduce the severity of injuries if a collision does occur. Reduction in vessel speed is considered to be an "appropriate, reasonable, and defensible" protection measure for marine mammals in general (Calleson and Frohlich 2007).

13.11.5.46 Thus, it is recommended that SkyPier HSFs operating to and from Zhuhai and Macau continue to divert north of SCLKCMP transiting through those areas with the relatively-high CWD densities, for example as indicatively shown by the 1x1 km grid squares in Figure 6 of **Appendix 13.2**, at a maximum speed of 15 knots. As in the construction phase, this proposed mitigation would avoid the current situation of the SkyPier HSFs travelling to Zhuhai and Macau passing south of the SCLKCMP at high speeds substantially reducing the impacts of these vessels (which constitute 60% of the HSFs) in this area. It is stressed that the section of the route subject to the 15 knot limit and the area of application are only indicative at this stage. Any decision on the section of the diverted route subject to the speed limit and its application to SkyPier ferries will be taken after consideration of updated CWD abundance data from both the AFCD database and from additional 3RS EM&A data obtained during the pre-construction and construction monitoring periods. Of particular importance to this decision will be the updated information available at that time on CWD abundance in Hong Kong. The EM&A commits to undertaking underwater acoustic monitoring and land based theodolite surveys, specifically designed in part to identify future changes in underwater noise that may be attributable to HSF

traffic and associated patterns of CWD movements in relation to HSF activities. It is proposed that these elements of the proposed EM&A effort are further developed and elaborated during the detailed design stage prior to commencement of construction. Due consideration will therefore be given to the effectiveness of the SkyPier HSF diversions and speed limit mitigations as can be determined at this future time period from the underwater noise and other monitoring data, as well as taking account of the actual details of future SkyPier HSF operations after the opening of the Hong Kong Zhuhai Macau Bridge. It is noted that all vessels travelling through designated Marine Park areas shall anyway be restricted to a maximum of 10 knots. The general principle is that the slower the vessel speeds in important habitat areas, the better the protection for the CWDs.

13.11.5.47 With the 10 knot speed limit in the marine park established together with the speed limit within high CWD density grid squares used by the SkyPier HSFs diverting north of Lung Kwu Chau, it is anticipated that adverse impacts on CWDs will be effectively mitigated, given that SkyPier HSFs comprise approximately 60% of the total volumes of HSFs navigating the waters between the airport island and the SCLKCMP. The AA is fully committed to the implementation of these mitigation measures and has the ability to enforce the requirements on the SkyPier HSF operators, all of which are under its juristriction.

13.11.5.48 SkyPier has become an important component of HKIA's multi-modal transport capability, serving eight destinations in the Pearl River Estuary including Zhuhai and Macao. As detailed in **section 13.9.2.100**, future ferry operations may grow in the period up to 2030/31, although there is considerable uncertainty on the effect that the HZMB may have on HSF demand / numbers to and from Macao / Zhuhai / other ports in the Western PRE once the bridge and the HKBCF becomes operational.

13.11.5.49 **Section 4.5.1.41** describes the planned future development of SkyPier as part of an Intermodal Transfer Terminus (ITT) and this expanded facility also including a bonded bus station and a bonded road connecting HKIA to the HZMB Boundary Crossing Facility. As well as providing continuing ferry operations, the ITT will also provide efficient bus access to and from Zhuhai and Macao as well as other locations in the Western PRE. As stated, there is considerable uncertainty on the effect that the introduction of bonded bus journeys and other means of transport between the ITT and Macao / Zhuhai / other ports in the Western PRE may have on ferry demand / numbers once HKBCF becomes operational and projections of in **Section 13.9.2.100** can be viewed as a high-estimate.

13.11.5.50 Although HSF traffic from SkyPier / the ITT is projected to grow in future years, the EM&A will monitor the actual numbers of HSFs utilizing the SkyPier, by obtaining vessel movement numbers directly from the SkyPier operators, as the HZMB and HKBCF commence operations. The proposed HSF speed limit controls as detailed are expected to be effective in reducing HSF impacts on CWDs given that the future proportion of SkyPier HSFs would remain at about 60% of the total in the channel between HKIA and Sha Chau, thereby reducing both the physical threat from fast moving HSFs and the high noise levels known to be generated by HSFs travelling at speeds of over 30 knots. It should be noted that the speed of marine vessels, compared to the volume of traffic, is a fundamental factor in the risk of injury/mortality and noise disturbance for CWDs. It is again stressed, however, that decisions on the section of the diverted routes subject to the speed limit and its application to all SkyPier HSFs will be taken

after consideration of the updated CWD abundance data from both the AFCD database and from additional 3RS EM&A (the future underwater noise monitoring and other data) as well as considering the effectiveness of the construction phase SkyPier HSF diversions and speed limits and taking account of actual future SkyPier HSF operations after the opening of the Hong Kong Zhuhai Macau Bridge.

Operational Spill Response Plan

13.11.5.51 Only potentially low impacts to CWDs are predicted as a result of an operation phase oil or chemical spillage and therefore, no mitigation measures are required. However, an Emergency Spill Response Plan is proposed to be established during the operation phase as a precautionary measure.

13.11.5.52 Precautionary measures for fuel management and spill response should include the following:

- Fuel pipelines and hydrant systems should be designed with adequate protection and pressure / leakage detection systems;
- A 'spill trap containment system' should be designed and provided at aircraft apron and stand areas;
- An emergency spill response plan should be in place to provide timely and effective response and remediation of spillage events;
- Spill response equipment should be available on site and regularly checked and maintained;
- Operation of the fuel supply and refuelling systems should be restricted to qualified and trained personnel with adequate knowledge of the spill response procedures in place;
- A robust monitoring system should be set up to discourage poor practices associated with maintenance of aircraft, vehicle and refueling systems by airport tenants and franchisees; and
- Detailed records of all spillage events should be kept and maintained.

13.12 Secondary Impacts

13.12.1.1 The allocation of the new marine park and HKIAAA will add a total of 2,518 ha of protected waters to Hong Kong's northwestern waters (approximately 2,400 ha of marine park and 118 ha of additional HKIAAA, making 729 ha in total) and together with the planned BMP and the existing SCLKCMP would provide a total of about 5,179 ha of habitat in which the CWDs would be protected. The establishment of this new area as marine park would effectively mean that high speed vessels would be restricted to a maximum of 10 knots and commercial fisheries activities would be under control or managed in accordance with the Marine Parks Ordinance. The Marine Park management would be proposed in the detailed design stage, which may cover 'no-take zone' in core area where fisheries resources are more abundant and at area where CWDs show relatively more feeding activities. The control of fisheries activities would have positive secondary impacts on fish resources, as indicated from the fisheries survey

findings that a higher biomass of fisheries resources were recorded within Sha Chau and Lung Kwu Chau Marine Park than the adjacent northern Lantau waters, which in turn would have advantages for CWD prey.

13.12.1.2 The future extension by approximately 118 ha of HKIAAA for the third runway to the existing HKIAAA will create a fisheries resources "no-take-zone" totally 729 ha as all vessels are restricted to enter without a permit for security purpose. Fisheries resources are thus expected to increase with the extended fisheries "no-take" zone, as indicated from the fisheries survey findings that a higher biomass of fisheries resources were recorded within HKIAAA and in adjacent waters to the west of Chek Lap Kok, and is comparable to Sha Chau and Lung Kwu Chau Marine Park.

13.13 Enhancement Measures

13.13.1 Background

13.13.1.1 Mitigation measures to ameliorate against specific impacts to the marine ecological environment have been detailed above. However, notwithstanding these, further measures to enhance the marine environment are also recommended.

13.13.1.2 While moderate, moderate-high or high impacts are predicted and mitigation in the form of a new marine park is recommended for the direct loss of CWD habitat resulting from the 3RS land formation, further enhancement of marine habitat is recommended.

13.13.1.3 As well as a direct loss of CWD habitat due to land formation will also be a loss of marine ecological resources in general due to the 3RS land formation. It is proposed to formulate and implement a Marine Ecology and Fisheries Enhancement Strategy (MEFES), with the aim of contributing to enhancing marine ecology (including for the CWD) and fisheries resources in northern Lantau waters.

13.13.1.4 It is proposed that the MEFES should be framed under the following key aspects areas:

- Enhancement of habitats for marine ecology and fishery resources;
- Promotion of a sustainable fisheries industry;
- Encouragement of scientific research and studies; and
- Promotion of environmental education and eco-tourism.

13.13.1.5 The potential enhancement measures covered by each of the above key aspects are described below. All enhancement measures recommended would be funded by AAHK with additional support to be sought from other relevant parties as needed not limited to the management of enhancement measures and additional funding where appropriate.

13.13.2 Enhancement of Habitats for Marine Ecology and Fisheries Resources

13.13.2.1 As presented in **Section 14.11**, the following enhancement measures, with details to be established at the detailed design stage, would be beneficial for strengthening marine ecology and fisheries resources:

- Eco-enhancement designs of seawall – Incorporating the eco-enhancement design features into suitable sections of the future extended artificial seawall would help re-colonisation of intertidal and sub-tidal fauna as well as recruitment of juvenile fishes (as evidenced in the baseline ecological field survey findings that intertidal and sub-tidal fauna were recorded along the artificial seawall and juvenile fishes are recorded in vicinity to the existing northern and western airport seawalls).

- Potential fisheries "no-take-zone" / enhancement areas - in the future extended HKIAAA with restricted vessel entry, which would help in the betterment of marine fauna and fisheries resources.

- Deployment of artificial reefs – this would help provide hard substrates for recolonisation of marine fauna that will be beneficial to fisheries resources.

13.13.3 Encouragement of Scientific Researches and Studies

Setting up of Marine Research Programme

13.13.3.1 In order to further the understanding of CWDs and the marine environment in general, it is proposed to establish a Marine Research Programme in the northwestern part of Lantau. This Programme could serve to qualify green NGO initiatives that serve to enhance the knowledge of Hong Kong's local marine fauna and flora, with special emphasis on CWDs and finless porpoises, Hong Kong's resident cetacean species. In addition, the Programme could also support and/or collaborate with academic institutes to conduct scientific researches and studies that aim to:

- Provide long-term monitoring and/or in-depth understanding of the marine resources; and

- Facilitate the development of practices, measures and/or programmes for enhancement of marine ecology resources.

13.13.3.2 Examples of such researches and studies could include monitoring of CWDs in northwest Hong Kong waters / adjacent waters in PRE; modelling studies of CWD activities / fisheries resources to predict impacts of proposed marine infrastructure projects; monitoring of coral and benthic fauna at the future HKIAAAs and marine parks; study of the intertidal and estuarine habitats at North Lantau coast in which there are records of seagrass beds, horseshoe crabs, pipefishes, and/or other species of ecological importance; investigation of the effectiveness of eco-enhancement seawall designs and/or artificial reefs; and ecological and fisheries resources study before and after the designation of marine park.

Adaptive Management

13.13.3.3 The CWD population status in Hong Kong and the wider PRE is always changing as new threats appear and CWDs adapt to their ever-changing environment. Therefore, it is

recommended that periodic reassessment of the effectiveness of mitigation measures for CWDs should be undertaken and revision of mitigation measures in light of new information should be considered.

13.13.3.4 One aspect of this should be the use of CWD monitoring data, including baseline, construction and operation phase monitoring, to evaluate if an unacceptable decline in CWD numbers or behaviour is occurring during construction (or operation). Specific survey methods will follow those of the AFCD long term monitoring programme and this will allow for direct comparison of results among different phases. If a threshold of CWD decline in northwest Lantau compared to the current level of decline is reached, then this would trigger a re-evaluation of dolphin protection/mitigation measures, and potential changes, or even a suspension in the construction programme until the causes can be determined and rectified.

13.13.3.5 The strategies described above will help ensure that the mitigation and enhancement practices are adaptive in nature and always well suited to current conditions, even when such conditions change from time to time.

13.13.4 Promotion of Environmental Education and Eco-tourism

13.13.4.1 It is proposed that the MEFES would support initiatives that promote environmental education and eco-tourism initiatives relating to marine ecology and fisheries along the North Lantau coast and in northwest Lantau waters. Examples of such initiatives could include:

- Establishment of eco-trails with displays introducing the conservation of terrestrial / marine ecology and fisheries resources of North Lantau and surrounding waters
- Promotion of eco-tourism in the marine parks with environmentally friendly code of practice
- Development of eco-tourism for the public to raise their awareness on sustainable fishing operations (e.g. arrangement of guided tour for experiencing of fishing operation)
- Organisation of campaigns for cleaning of sandy shores at the SCLKCMP, San Tau Beach SSSI, etc.
- Horseshoe crabs breeding and release programme at North Lantau soft shores.
- Education programme will be established for providing a platform for local school groups and general public, to learn more about the local marine ecology as well as CWD ecology.

13.13.4.2 The proposed Marine Research Programme could play a role in part of the above educational initiatives.

13.13.5 Environmental Enhancement Fund

13.13.5.1 The four key MEFES aspect areas will require significant and ongoing funding over a number of years in order for the key aims to be realised. AAHK acknowledges responsibility for such funding, however at this early stage in the development of the EEF and its potential initiatives, it

is premature to discuss the exact funding amount and mechanisms for allocation of funds to proposed initiatives.

13.13.5.2 It is proposed that the MEFES, associated management arrangements, funding amounts and fund allocation mechanisms shall be established prior to commencement of the construction phase of the project. AAHK will continue to engage with a range of fisheries and other stakeholder groups so that their concerns and suggestions on fisheries and other potential marine ecological enhancement measures can be taken into consideration where appropriate during the formulation of the MEFES and then during MEFES implementation.

13.14 Residual Impacts

13.14.1.1 The residual impacts refer to the net impacts after mitigation, taking into account the background environmental conditions and the impacts from existing, committed and planned projects. Residual impacts associated with the construction and operation phases have been assessed.

13.14.1.2 The permanent loss of up to 650 ha of marine water habitat for the CWDs, and the associated effects on travel areas, abundance and movement patterns and behaviour of the CWDs would cause moderate to high impact significance to the CWDs. While the footprint area of the 3RS is a very small proportion of the overall PRE population's habitat area and only 2.5% of the Hong Kong habitat area, it represents part of the home range for the Hong Kong sub-population. Also, it is probable that some HSFs will still need to move through regions of moderate or even high CWD density.

13.14.1.3 Mitigation will be required to address the potential project impacts and a series of avoidance and minimisation measures, as detailed in S.13.11, are recommended. However, even with all these measures in place, it is evaluated that the impacts to CWDs could not be mitigated to an acceptable level. As avoidance and minimisation measures are exhausted, compensatory measure is confirmed to be necessary. As detailed above, a large, new marine park in the North Lantau area has been proposed to further mitigate the impacts on CWDs.

13.14.1.4 The total area of the new marine park to be established for this project is approximately 2,400 ha, which is much greater than the lost of marine water habitat of 650 ha. With the full implementation of all of the proposed mitigation, and compensation/enhancement measures in place, it would be expected that there would be no significant residual impacts on the CWD sub-population in Hong Kong. The significance of the residual impacts of CWD habitat loss has been assessed in accordance with Section 4.4.3 of the EIAO-TM in **Table 13-32** below.

13.14.1.5 It is considered not necessary to implement other / additional specific mitigation measures for other marine ecological resources, as the proposed establishment of Marine Park and the operation of future HKIAAA will also benefit the conservation of marine ecology. There will be no significant residual impacts associated with the other marine ecology, including soft-bottom benthic habitat and coral communities along the northeastern shore of the existing airport island.

Table 13-32: Assessment of Residual Impacts from CWD Habitat Loss

Criteria	Assessment

Criteria	Assessment
Effects on public health and health of biota or risk to life. If the impacts may cause adverse public health effects and/or adverse impacts to the health of rare or endangered species or pose an unacceptable risk to life and /or survival of wildlife species, they are considered as a concerm.	The 3RS will be situated at the centre of northern Lantau waters, one of the key habitats to the CWDs (Jefferson and Hung 2004; Hung 2008, 2012). There is some concern that construction and operation impacts could result in lowered fitness, reduced reproductive output or reduced survival, thereby affecting the overall health of the dolphin population in Hong Kong, especially the ones that spend a majority of their time in northern Lantau waters and roam frequently between core areas around the Brothers and the Sha Chau and Lung Kwu Chau Marine Park. However, for this project, the construction impacts will be temporary, reversible and mitigation measures have been recommended to reduce the magnitude of impacts that could affect dolphin feeding, behaviour and health to a minimum and are not expected to be significant. Notwithstanding there will be some permanent loss of marine water habitat that will reduce the overall CWD habitat by 650 ha. However, the land formation is located in areas with moderate densities of CWDs and the loss of habitat is small in comparison to their total range and would not be predicted to significantly affect the health or carrying capacity of the overall population, but would likely cause impacts to the Hong Kong sub-population. While the Hong Kong population is declining, it is considered this is as a result of a shift of the CWDs to parts of their ranges out of Hong Kong in addition to mortality and thus, it is possible that Hong Kong sub-population could be supplemented from the PRE. Vessels, especially HSFs, cause threats to CWDs due to behavioural disturbance and the risk of vessel collisions. The proposed restrictions of the speeds and routes of SkyPier HSFs, and the additive effects of the addition of a large new marine park linking core feeding habitat in a broad zone of protected area with a 10-knot speed limit, is considered a valuable measure to assist in reducing the overall effects of HSFs on CWDs in Hong Kong.
Magnitude of the adverse environmental impacts. Magnitude refers to the scale of the adverse environmental impacts. If the impacts are major, they are considered as concerns. The extent to which the project would trigger or contribute to any cumulative impacts when considered in conjunctions with the existing and potential impacts from other projects shall also be considered.	The adverse impacts from 3RS construction in isolation are expected to be high for Kong Kong CWDs, since the habitat loss through land formation for the new runway will be relatively small in comparison to the population's range, but significant in relation to the Hong Kong sub-population range. Other construction phase impacts would be temporary and reversible. Implementing the appropriate recommended mitigation measures is expected to reduce these to acceptable levels. The 3RS project would be one of the projects contributing to cumulative impacts, as there are other projects proposed to be undertaken in the study area that would also contribute significantly to the cumulative impacts in the area. Given the

Criteria	Assessment
	magnitude of the various projects proposed, a significant proportion of the cumulative impacts would be expected to come from the 3RS land formation because of its large size and permanent duration. Thus, the contribution from the 3RS would be significant and cumulative impacts (before mitigation) would be expected from all concurrent projects taken into account. However, with appropriate mitigation measures for each project, including the new marine parks for the 3RS and HKZMB BCF, these are expected to be brought into the acceptable range.
Geographic extent of the adverse environmental impacts. Widespread environmental impacts are a greater concern than localised adverse environmental impacts. The extent to which adverse environmental imapcts may occur in areas away from the site for the designated project, including long range transportation of pollutants shall be considered.	The geographic extent of the adverse impacts on CWDs from 3RS construction will not be very large in comparison to the population's range and will be limited to nearby the works area in the northern Lantau waters. This includes the dispersion of suspended solids during filling works for the 3RS project, which will be controlled to be within a short distance of the works area with the adoption of non-dredge construction techniques and implementation of water quality mitigation. Individuals affected are those using Hong Kong waters as part of their range and their numbers were declining over the last decade (only some 60 individuals in 2012). Compared with the estimated size of some 2,500 dolphins of the PRE population, the Hong Kong sub-population constitutes a small proportion. Notwithstanding, the importance of northern Lantau waters is magnified when it is noted that it is one of two primary areas in Hong Kong where CWDs occur in high densities year-round (Jefferson 2007; Hung 2013) but the mitigation measures proposed, including the new 2,400 ha marine park, will help to confine most of the influence of the 3RS construction to an area which has lower CWD densities than the overall values of those areas (from AFCD data), and is used primarily as a travel area, with less feeding and socializing than the identified core areas. The travel/foraging area to the west of the airport will not be directly or permanently affected.
Duration and frequency of the adverse environmental impacts. Normally more weight shall be given to long tem, persistent and /or frequent environmental imapcts in determining the project's environmental acceptability. Future adverse environmental impacts as well as their likelihood should also be considered.	The construction phase impacts of the 3RS project will be of temporary duration and, therefore, reversible. However, the loss of habitat through land formation in the marine habitat will be permanent upon completion. The areas involved are not very large in relation to the overall population's range, but are considered significant for the Hong Kong sub-population. In addition, measures such as adopting the use of DCM for the land formation construction of the new runway will reduce noise and disturbance to the surrounding area, and minimise the amount of dredged material to be removed. However, the permanent area to be lost would be a significant impact (before mitigation), which is

Criteria	Assessment
	intended to be compensated for by the creation of a large new marine park linking important core areas of habitat.
Likely size of the community or the environment that may be affected by the adverse impacts. Those adverse impacts affecting larger numbers of people or greater areas of ecosystem shall be considered of greater importance.	The overall geographic extent affected by the 3RS project will be confined to a relatively small area in relation to the population range. The permanent loss of CWD habitat was already rated as high impact to the Hong Kong dolphins before mitigation.
Degree to which the adverse environmental impacts are reversible or irreversible. Irreversible adverse environmental impacts shall be considered as key concerns. The planned decommissioning or rehabilitation activities that may influence the degree to which the adverse environmental impacts are reversible or irreversible may be considered.	Construction phase impacts should be reversible, but operation-phase impacts associated with habitat loss from new land formation will be permanent and irreversible. However, a new 2,400 ha marine park is proposed as mitigation for this habitat loss.
Ecological context. More weight shall be given to those adverse impacts that occur in areas or regions that are ecological fragile and /or rare or undisturbed or which have little resilience to imposed stresses.	The north Lantau area has been subject to significant disturbance and development over the years, including from projects such as the construction of the original airport (and the associated Aviation Fuel Receiving Facility), North Lantau Transport Corridor, River Trade Terminal, Tuen Mun Areas 38 reclamation, the operation of the mud pits at East of Sha Chau and the Brothers, and the building of the HZMB, and associated HKLR, HKBCF and TM-CLKL. The area is also subject to increasing levels of marine traffic along the Urmston Road and fishing vessels throughout the area. Some impacts from these works have been noted on the marine ecosystems in the study, but there is also evidence to suggest that the ecosystems have to a certain extent, been tolerant to changes and recovered partially after the projects have been completed. The North-western waters are also influenced by some large seasonal variations in water quality (salinity and suspended solids) and naturally occurring marine sediment contamination to which the species present have habituated. Notwithstanding these impacts and a documented overall decline in CWD numbers over the last 10 years or so, it is still used by CWD as a major habitat in Hong Kong (Jefferson 2000; Jefferson and Hung 2004; Hung 2008, 2013).

Criteria	Assessment
	CWDs, as large-brained, social and adaptable mammals, are not considered to be especially ecologically fragile. Although they are not nearly as abundant as many oceanic dolphins, they are also not considered to be particularly rare in the region.
Degree of disruption to sites of cultural heritage. Which means what distruptions would be caused to the site which would affect its archaeological,historical and /or palaeontological significance.	Not applicable
International and regional importance. Those adverse impacts which affect and issue of interantions and regional concern shall be regarded as important.	According to the IUCN Red List of Threatened Species, the CWD is currently listed with the status “Near Threatened” (Reeves et al. 2008), which is close to qualifying for or is likely to qualify for a threatened category in the near future (IUCN 2008 (www.iucnredlist.org)). This is a protected species in the PRC. The Hong Kong/PRE CWD population is the best-studed, most well-known, and the largest known in the world (Jefferson 2007; Reeves et al. 2008), but it has not been assigned a status listing using the IUCN Red List categorisation. Imminent changes in taxonomy of humpback dolphins puts more emphasis on conservation of SE Asian populations. While the number of CWDs in the Hong Kong sub-population is relatively small in relation to the entire species, the HK/PRE population is much larger, and is considered important to conserve for the overall survival of species.
Likelihood and degree of uncertainty of adverse environmental impacts. If the adverse environmental impacts are uncertain, they shall be treated more cautiously then impacts for which the effects are certain and the precautionary principle shall apply.	There is some degree of uncertainty as to the exact impacts of some aspects from this project. There have been no specific studies of the impacts of bored piling on CWDs, nor how much the construction of the project will affect CWD movement corridors between the North-west and North-east Lantau. Notwithstanding, a precautionary approach has been applied to defining mitigation measures for the protection of the CWD from the project implementation. Also, an extensive set of baseline surveys have been conducted and pre-construction and construction-phase surveys will be undertaken to provide a thorough assessment of any impacts. These measureswill help to reduce uncertainty. The current marine park proposal as mitigation has taken uncertainty into account and attempts to apply the precautionary principle by providing a much larger area than that which is being lost, and adding other benefits through linkages of critical habitat areas. The marine park proposal would be expected to include additional benefits to other marine flora and fauna other than just dolphins.

13.14.1.6 While it is clear that the CWD population is of local, regional and international importance, the study area in North Lantau is one of two primary areas in Hong Kong where dolphins occur in high densities year-round (Jefferson 2007) and there is some degree of uncertainty of the impacts, the following factors should be considered in determining the residual impacts associated with the CWD habitat loss for the 3RS project:

- The magnitude of impacts relating to suspended solids dispersion, construction noise and disturbance and construction vessel movement that could affect CWD feeding, behaviour and overall health are not expected to be major;
- The majority of the predicted construction impacts are considered temporary and reversible;
- The mitigation measures proposed are expected to confine the influence of the 3RS construction to a relatively small area; and to minimise its impacts;
- Full implementation of mitigation measures including the addition of about 2,518 ha of new CWD protected area (about 2,400 ha of new marine park and 118 ha of expanded restricted access HKIAAA zone, making a total of 3,129 ha of protected marine habitat as a result of HKIA) would be expected to compensate for the impacts of the project; and
- The study area has not shown itself to be fragile or undisturbed.

Based upon the above, the residual impacts associated with the CWD habitat loss for the 3RS project would be considered to be acceptable and have met the requirements of Section 4.4.3 of the TM-EIAO.

13.15 Identification and Evaluation of Cumulative Impacts

13.15.1 Background

13.15.1.1 Marine systems are exposed to a wide range of impacts although, to date, few studies in Hong Kong have addressed cumulative ecological impacts associated with construction projects. Cumulative ecological impact assessments need to consider all activities in the study area in addition to the impacts predicted directly from the 3RS project. The cumulative impacts are, therefore, likely to be wider in scope than the potential impacts attributable only to the 3RS project.

13.15.1.2 The predicted impacts from this study are associated with the construction phase and of temporary duration, with marine works anticipated to take about 7 years. However, some permanent loss of habitat will occur. There are many projects being proposed to be implemented in the same study area and those that are concurrent to the 3RS project construction phase may cause cumulative impacts to the marine ecology of the study area, potentially resulting in the following:

- A prolonged period of impact;

- An increased intensity of the impact; and
- Induced synergistic impacts (i.e., effects that are greater in combination than singularly).

13.15.1.3 In addition to the construction phase impacts, land formation projects also result in the permanent loss of marine habitats. A review of the concurrent projects in the study area is provided in **Chapter 4** this report. In summary, the following projects detailed in **Table 13-33** below are relevant to the marine environment during the construction and operation phases.

Table 13-33: Summary of Potential Concurrent Projects which could result in Cumulative Impacts during Construction and Operation

Proposed Development/ On-going Projects	Nature of the projects	Major Potential Marine Ecological Impacts	Latest Programme	Status
Hong Kong – Zhuhai – Macao Bridge: Hong Kong Link Road (HKLR)	Dual 3-lane carriageway connecting HKBCF	Temporary loss of seabed and marine waters during construction: 243 ha* Permanent loss of seabed for marine piers and reclamation: 30 ha* Potential water quality impact during construction phase	Commenced in May 2012, for completion by end 2016	Under construction
Hong Kong – Zhuhai – Macao Bridge: Hong Kong Boundary Crossing Facilities (HKBCF)	Boundary crossing facilities and serves as transfer point for road traffic between HKLR and TM-CLKL	Temporary loss of seabed and marine waters during construction: 226 ha* Permanent loss of seabed for reclamation: 138 ha* Potential water quality impact during construction phase	Commenced in November 2011, for completion by end 2016	Under construction
Tuen Mun – Chek Lap Kok Link (TM-CLKL)	Dual 2-lane carriageway between northwest New Territories and HKBCF	Temporary loss of seabed and marine waters during construction: 141 ha* Permanent loss of seabed for marine piers and reclamation: 48 ha*	Commenced in November 2011, for completion by end 2016	Under construction
Tung Chung New Town Extension (TCNTE)	New town development extension for accommodate 220,000 population to meet housing and other development needs	Permanent loss of seabed and marine waters of around 134 ha for reclamation	Proposed commencement of construction in 2018 for first population intake in 2021 / 22	Under engineering and environmental assessment
Lantau Logistics Park (LLP)	Reclamation site at Siu Ho Wan for establishment of logistics facilities	Permanent loss of seabed and marine waters: 112 ha Potential water quality impact during construction phase	Development programme yet to be confirmed	Project status not confirm

Proposed Development/ On-going Projects	Nature of the projects	Major Potential Marine Ecological Impacts	Latest Programme	Status
New Contaminated Mud Marine Disposal Facility at Hong Kong International Airport (HKIA) East / East of Sha Chau	Contaminated mud disposal facilities	Temporary loss of seabed at HKIA East: about 164 ha* Temporary loss of seabed for South Brothers and East Sha Chau Mud Pits: about 106 ha* Potential water quality impact during construction phase	CMP to the south of the Brothers operate between 2013 and 2016; CMP at the East of Sha Chau operate starting from 2016	Currently in operation
Development of the Integrated Waste Management Facilities Phase 1 (IWMF)	Waste incineration plant, mechanical treatment plant and ancillary facilities at Tsang Tsui Ash Lagoon in Nim Wan (TTAL), Tuen Mun and an artificial island near Shek Kwu Chau (SKC)	#TTAL: confined to terrestrial area, loss of marine habitats and resources not expected. #SKC (south of Lantau Island outside the study area)	Latest programme yet to be confirmed	EIA approved
Providing Sufficient Water Depth at Kwai Tsing Container Basin and its Approach Channel	Dredging activities to provide sufficient seabed depth at Kwai Tsing Container Basin, portions of the Northern Fairway and Western Fairway	Temporary loss of marine habitats: 446 ha@ (about 220 ha are within the Principal Fairways where fishing is restricted)	Planned for commencement by end 2013 for completion by 2016	Detailed design and construction stage
Container Terminal 10 Development at Southwest Tsing Yi (CT10)	Development of a container terminal and associated facilities at the southwest of Tsing Yi island	Permanent loss of approx. 180 ha of seabed and marine waters with dredging, construction of seawalls and reclamation	No programme yet	Preliminary feasibility study
Harbour Area Treatment Scheme – Stage 2A	Strategic sewage disposal scheme to provide treatment for the sewage collected from urban areas in Kowloon and Hong Kong Island	Indirect disturbance in operation phase due to changes to water quality induced by the sewage discharge	Construction commenced in 2009 and scheduled for completion in 2014	Under construction
Leisure and Entertainment Node at Sunny Bay	Leisure and entertainment node at Sunny Bay to provide a cluster of entertainment, leisure and tourist facilities	Potential permanent loss of seabed and marine waters of 70 ha^	No programme yet	Feasibility study
Outlying Islands Sewerage Stage 2 – Upgrading of Cheung Chau and Tai O Sewage Collection, Treatment and Disposal Facilities (Upgrading of Tai O Sewage Collection, Treatment and Disposal	Upgrading of sewage collection, treatment and disposal facilities in Tai O	Potential water quality impacts during construction phase Permanent marine habitat loss of approx. 0.23 ha	Scheduled to commence construction in mid 2015 for completion in 2019	Project profile submitted in 2012

Proposed Development/ On-going Projects	Nature of the projects	Major Potential Marine Ecological Impacts	Latest Programme	Status
Facilities)				
Sludge Treatment Facilities	Proposed facility for treatment of dewatered sludge generated from the sewage treatment process.	Potential water quality impact during operation phase	Planned for commissioning in late 2013	Under construction

Source: *Hong Kong - Zhuhai - Macao Bridge – Hong Kong Link Road EIA Report (Arup, 2009b)
#Engineering Investigation and Environmental Studies for Integrated Waste Management Facilities Phase 1 – Feasibility Study, Environmental Impact Assessment Report (AECOM, 2011)
@Providing Sufficient Water Depth for Kwai Tsing Container Basin and its Approach Channel – Environmental Impact Assessment Report (Mott MacDonald, 2010)
^Hong Kong 2030: Planning Vision and Strategy Stragic Environmental Assessment – Revised Concept Plan for Lantau (LCP) Broad Brush Environmental Appraisal of the LCP (Hyder Consulting and Mott Connell, 2007)

13.15.1.4 Projects for which there are few definite details have not been included and the cumulative effects will be assessed by these projects themselves should they proceed.

13.15.2 Marine Ecology (excluding Marine Mammals)

13.15.2.1 The potential cumulative marine ecological impacts due to the loss of marine habitats and potential deterioration of water quality within the study area have been reviewed based on the marine ecological impact assessments of relevant approved EIA studies where available, or based on the latest baseline information in respective area. Those projects with status not confirmed or design information not available would only be considered for their potential permanent loss of marine habitats as worst case scenarios.

13.15.2.2 As detailed in **Table 13-34**, there would be cumulative total permanent loss of approximately 1,384 ha of marine habitats if all the identified concurrent projects are implemented as planned. For estimation of the cumulative loss of marine ecological habitats, it is conservatively assumed for the concurrent projects that the marine ecological habitat losses would be the same as the seabed losses. With regard to the cumulative loss of marine ecological habitats, the significance of impact is considered to be moderate, as a considerable portion (49%) of the total area to be lost would be contributed by the third runway project. It is considered the establishment of marine park of approximate 2,400 ha connecting with the existing SCLKCMP, the planned BMP, the PRE CWD national nature reserve and the future extension of HKIAAA will also compensate for the cumulative loss of marine habitats that contributed by the project. Therefore, there will be no adverse residual impact for the cumulative loss of marine habitats.

Table 13-34: Summary of Permanent Marine Ecological Habitat Losses of this Project and the Concurrent Projects

Projects	Permanent Loss of Marine Ecological Habitats
Expansion of Hong Kong International Airport into a Three-Runway System (this project)	Marine ecological habitat loss: 672 ha (Land formation works carried out in phases from late 2015/ early 2016 to late 2021, with majority of marine filling works competed by late 2018)
Hong Kong – Zhuhai – Macao Bridge: Hong Kong Link Road (HKLR)	About 30 ha of seabed and marine waters for marine piers and reclamation (Completion by end 2016)
Hong Kong – Zhuhai – Macao Bridge: Hong Kong Boundary Crossing Facilities (HKBCF)	138 ha seabed and marine waters for reclamation (Completion by end 2016)

Projects	Permanent Loss of Marine Ecological Habitats
Tuen Mun – Chek Lap Kok Link (TM-CLKL)	About 48 ha of seabed and marine waters for marine piers and reclamation (Completion by end 2016)
Tung Chung New Town Extension	Around 134 ha of seabed and marine waters on south and southeast of Chek Lap Kok waters (Project programme and design information not confirmed but considered as worst case scenario)
Lantau Logistics Park (LLP)	Around 112 ha of seabed and marine waters on northeast of Tai Ho Wan (Project programme and design information not confirmed but considered as worst case scenario)
New Contaminated Mud Marine Disposal Facility at Hong Kong International Airport (HKIA) East / East of Sha Chau	No permanent loss
Providing Sufficient Water Depth at Kwai Tsing Container Basin and its Approach Channel	No permanent loss
Container Terminal 10 Development at Southwest Tsing Yi (CT10)	About 180 ha of seabed and marine waters (Project programme not confirmed but considered as worst case scenario)
Harbour Area Treatment Scheme – Stage 2A	No loss of marine habitat
Leisure and Entertainment Node at Sunny Bay	About 70 ha of seabed and marine waters (Project programme and design information not confirmed but considered as worst case scenario)
Outlying Islands Sewerage Stage 2 – Upgrading of Cheung Chau and Tai O Sewage Collection, Treatment and Disposal Facilities (Upgrading of Tai O Sewage Collection, Treatment and Disposal Facilities)	Permanent marine habitat loss of about 0.23 ha in the western Lantau waters
Sludge Treatment Facilities	No loss of marine habitat
Total	Marine ecological habitat loss: 1,384 ha

13.15.2.3 As detailed in **Section 8.5.3**, the cumulative water quality impact assessment has already taken into account all the relevant concurrent projects where information is available. The cumulative impact assessment findings as detailed in **Section 8.7.1** indicated that there would be exceedances of the SS criterion under the WQO (i.e. < 30% of ambient baseline conditions) at the Brothers under the mitigated worst case scenarios. Elevated SS cause adverse impacts on the waterbody, such as reduced penetration of light, temperature changes, release of contaminants and nutrients, deplete dissolved oxygen levels, and all these changes can have negative impact on the marine biota (Bilotta and Brazier, 2008). The contributions to the SS exceedances by the third runway project are predicted to be up to 12%. The frequency of depth-average SS exceedances would be up to around 0.1% of the time in a year. The result is due to the very conservative modelling assumptions adopted for the disposal / capping operations at the CMPs at East Sha Chau and South of the Brothers. These disposal / capping activities were assumed based on the maximum allowable production rate as specified in the Environmental Permit for that concurrent project. Based on recent information provided by that project proponent in October and December 2013, it is understood that daily peak disposal and capping operations would be much lower than the allowable production rate in the past five years of operation (between 2009 and 2013). It is predicted that with a more realistic prediction of production rates using historic rates for disposal and capping, the SS elevations at the Brothers

would be significantly reduced and no cumulative exceedance of the principal criteria would arise. Thus cumulative impacts due to this concurrent project are considered to be low.

13.15.2.4 The cumulative effect of concurrent projects has already been taken into account in the hydrodynamic model for operation phase scenario. Based on the hydrodynamic model findings, the changes in tidal discharges, including both increases and decreases, are relatively small after implementation of the project as compared to the base scenario. More significant hydrodynamic changes are identified for the flow through the east of airport channel. The areas immediately surrounding the project are also predicted to have more significant changes in peak velocity. However, the predicted changes in water quality due to the changes in hydrodynamics at ecological sites of conservation importance show that the implementation of the project will not results in significant changes to the water quality of the study area, and thus significant water quality impacts as a result implementation of the project are not predicted (see **Section 13.8.4.1** to **13.8.4.10**).

13.15.3 Marine Mammals

13.15.3.1 There could be potential for cumulative impacts to the CWD in the study area due to increased habitat loss, increased noise from construction activities, coupled with the aggregated pressures from shipping, mud disposal at the CMP's and pollution arising from numerous sources both in Hong Kong and Southern China. As noted in **Table 13-32** above, residual impacts associated with permanent and irreversible habitat loss have been assessed in accordance with Section 4.4.3 of the EIAO-TM which includes the contribution to cumulative impacts. Further details of the extent that the 3RS project would trigger or contribute to potential cumulative impacts are provided below.

13.15.3.2 Cumulative impacts of various development projects, can often work synergistically to compromise the environment (Jefferson et al. 2009). The overall impacts of multiple projects can often be more than just the sum of their individual parts. This point has been increasingly recognised in recent years. As described above, there is potential for the 3RS project to cause impacts on CWDs in Hong Kong and the further impacts may occur as a result of the other projects being implemented concurrently in the general area of North Lantau Island.

13.15.3.3 Details of the concurrent projects that could cause cumulative impacts during the construction and operation phases are detailed below.

Concurrent Projects

<u>Container Terminal 10 Development at Southwest Tsing Yi</u>

13.15.3.4 The Container Terminal 10 (CT 10) development does not have a fixed implementation programme but will comprises additional land reclamation of about 180 ha. However, CWDs do not use this area as a significant part of their Hong Kong range and thus no significant cumulative impact contribution would be expected from the CT 10 project.

<u>HKBCF, HKLR and TM-CLKL</u>

13.15.3.5 HKLR viaduct connects to the HZMB at the Hong Kong marine boundary just west of the airport island, with the road then running along the southern edge of the airport island in viaduct and then tunnel and viaduct sections built on reclaimed land on the east of HKIA before connecting to HKBCF, which is formed on a new area of reclaimed land directly to the east of the northeast corner of the existing airport platform and to which the TM-CLKL is directly connected.

13.15.3.6 The 'footprint' of HKLR and TM-CLKL viaducts themselves are not very large (with about a total of 3.2 ha being predicted to be lost from HKLR viaduct piers) and, therefore, these are not expected to result in significant impacts to the CWDs once these sections are complete. The construction of the viaducts will also be undertaken within the pier casings to minimise release of suspended solids and will also avoid peak CWD calving seasons (May to June).

13.15.3.7 As such, the key issues relate to habitat loss as a result of the reclamations needed for HKBCF and TM-CLKL, which are large (about 184.4 ha in total) and partly located in areas of ecological importance to CWDs.

13.15.3.8 During the construction phase, it is anticipated that the reclamation works for the TM-CLKL would be completed before the start of the 3RS project and while tunnel works will be on-going until the end of 2016, as the tunnel will be formed by Tunnel Boring Machine (TBM), no impacts are predicted. As such, the key impact will be the construction of HKBCF which will have a moderate to major contribution to the overall cumulative impacts on CWD.

13.15.3.9 In respect of acoustic disturbance, the addition of over 180 delivery barges and about 120 stationary construction vessels north of the airport platform at the peak construction period for the 3RS project, could increase the impacts to the CWDs. Notwithstanding, mitigation in the form of acoustic decoupling for the dredging and reclamation works of HKBCF, HKLR and TM-CLKL projects will be applied and these measures are also recommended for the 3RS project. To minimise the potential temporary disturbance due to the delivery barges and stationary construction vessels north of the airport platform during construction, construction traffic (land and sea) including construction plants, construction vessels and barges should be kept to a practical minimum. Any idle vessels should be avoided in the construction area. The overall objective is to keep the number of working or stationary vessels present on-site to the minimum anytime. In addition, all three HZMB projects will control marine traffic in the construction area with vessel speed restrictions and designated routes allocated.

13.15.3.10 The cumulative scope and extent of the construction works could also have the potential to further disturb or block key CWD travel areas. The known travel area between the Brothers to the east and Sha Chau to the west, potentially being affected by HKBCF and TM-CLKL southern reclamation works.

<u>Lantau Logistics Park</u>

13.15.3.11 The proposed Lantau Logistics Park (LLP) will comprise reclamation of about 112 ha land along the northern coastline of Lantau Island which would result in permanent seabed loss once completed. The LLP project, however, is not located in an area of high CWD abundance (Figure 6, **Appendix 13.2**). Although it is only a few kilometres away from the Brothers, which are an important feeding and socialising habitat area for CWDs (Jefferson 2000; Hung 2008, 2013) and

also near to Sham Shui Kok, which is also recognised as an historically important area (Hung 2008, 2013), it is located in a relatively low-density area for CWDs. However, information at present on this is preliminary, and will be subject to re-evaluation once more information is available.

13.15.3.12 In terms of construction, it is understood that there is no implementation programme available for this study at this stage. For worst case assumption that the Stage I construction (including dredging and construction of the new seawall and removal of rock armour at the existing seawall) coincides with the 3RS land formation works in Year 2016 and Year 2017. It will also overlap with HKBCF project for these two years for worst case scenario. However, it is understood that the seawall for the LLP will be constructed first and silt curtains applied in order to minimise loss of sediment during construction. Also, the construction equipment and vessels will be confined largely to the coastal area which is a relatively low-density area for the CWD and would not block any CWD travel areas.

13.15.3.13 However, taking into consideration that the reclamation size is quite large and the site is close to important area of CWDs including Sham Shui Kok and the BMP, as a worst case, a moderate contribution to the overall cumulative impacts to CWD is anticipated.

Leisure and Entertainment Node at Sunny Bay

13.15.3.14 The future Leisure and Entertainment Node at Sunny Bay development does not have a fixed implementation programme but will comprise about 70 ha of new land formation in Sunny Bay. However, the CWDs do not use this area as an important part of their Hong Kong range and thus no significant cumulative impact contribution would be expected from the Sunny Bay development.

New Contaminated Mud Disposal Facility at HKIA East/East Sha Chau

13.15.3.15 Contaminated mud pits have been used in the North Lantau are for well over a decade to dispose of mud contaminated with high levels of heavy metals, organochlorines, and other toxic chemicals. There has been no evidence of contaminants causing significant impacts on water quality nor the surrounding marine ecology, nor evidence of any significant impact on CWDs, either during the placement of the mud or after capping. However, there is evidence that the CWD use of the area around the mud pits has decreased from 1996 to 2005, probably as a result of disturbance from the extensive dredging and dumping activities involved and reduced prey availability (Hung 2008, 2013). As noted in **Chapter 4** (**Section 4.5.1.34**), disposal of contaminated mud is expected to commence at the CMPs south of the Brothers between 2013 and 2016 which will overlap with the 3RS and HKBCF projects. While the impact is temporary, it is considered that the operation of the mud pits could likely have a minor contribution to the cumulative impacts on CWDs.

Kwai Tsing Container Basin Dredging

13.15.3.16 Approximately 5.5 Million metres cubed (Mm^3) of marine sediment will be dredged for the provision of sufficient water depth for the Kwai Tsing Container Basin. The construction works

are expended to be undertaken between 2013 and early 2016 and will therefore coincide with the construction period for the 3RS project.

13.15.3.17 However, the two projects are more than 17 km part and the approved EIA for the Kwai Tsing Container Basin recommended mitigation measures including reduced dredging rates and silt curtains. With the implementation of these mitigation measures, no significant impacts to water quality or marine ecology were predicted and all unmitigated impacts were predicted be localised. In addition, the CWDs do not use this area as an important part of their Hong Kong range.

13.15.3.18 Given the distance, the temporary impacts and the fact the Kwai Tsing Container Basin is not located in CWD habitat, there would not be expected to be any cumulative impacts on CWDs.

Tung Chung New Town Extension

13.15.3.19 The future Tung Chung New Town Extension development does not have a fixed implementation programme but will comprise additional land reclamation at the east and west of Tung Chung of about 134 ha. The development area is directly to the southeast of the airport island which is known as low-density area for CWDs. However, the regions within a few kilometres to the north and northeast of this area, close to the Brothers, are important habitat for the CWDs, and are used for a variety of activities including feeding (Hung 2008, 2013). Based on its location, this project is considered to have an overall minor contribution to the overall cumulative impacts on CWDs.

Assessment of Overall Cumulative Impacts to CWDs

13.15.3.20 As noted above, there are a large number of projects either being implemented or in the planning which, in their own right, could have some level of impact on the Hong Kong population of the CWD. Based upon the water quality modelling (**Chapter 8**), it has been concluded that assuming concurrent construction of some of these projects, sufficient mitigation from the individual projects and the 3RS project, which is using non-dredge techniques, will be implemented to minimise the cumulative water quality impacts. The land formations are, also, not predicted to result in significant effects on flows or water quality.

13.15.3.21 However, there is the possibility of cumulative impacts associated with habitat loss, acoustic disturbance from construction works, injury / mortality or disturbance from the increase construction vessel traffic and blockage of CWD transport corridors and their connectivity between core habitat areas. The potential cumulative impacts are discussed in the sections below.

Habitat Loss

13.15.3.22 If it is assumed that all of these projects with land formations and seabed disturbance occurring in North Lantau, namely the 3RS project, HKBCF, HKLR, TM–CLKL, Lantau Logistics Park, Tung Chung New Town Extension and the New Contaminated Mud Disposal Facility at HKIA East / East Sha Chau (although temporary only) will proceed to construction, then the overall

cumulative impacts for the CWD population in Hong Kong would be severe for the Hong Kong sub-population, if not for the overall PRE population of CWDs.

13.15.3.23 This is especially the case when possible impacts of past development are taken into consideration, such as the reduction in CWD densities in northern Lantau waters ((Jefferson (2000, 2007), Hung (2013)) coinciding with peak construction activities for the original new airport, and reduced use of areas around the mud pits and Tuen Mun Area 38 (Hung 2008).

13.15.3.24 The cumulative loss of habitat from all these projects is large (1,384 ha not including the temporary impacts associated with the contaminated mud pits at East Sha Chau and south of the Brothers) (as shown in **Drawing No. MCL/P132/EIA/13-025**) (figure showing all major land formations etc and also the area of the 3 marine parks), and the total loss from the 3RS project comprises about 49% of this total. This potential total loss from all projects represents about 5% of the total CWD habitat in Hong Kong of 26,500 ha. As noted above, the majority of these projects are not in key CWD habitat (for example, HKLR, part of the TM-CLKL and Tung Chung New Town Extension) and as such, each of these are likely to cause only minor contributions to the total cumulative impacts. As such, the majority of the cumulative impacts would come from HKBCF land formation and the 3RS project because of their large size, locations in areas with moderate CWD densities, and permanent and irreversible habitat loss impacts.

13.15.3.25 Notwithstanding, the amount of physical habitat lost from all projects will result in a loss of overall habitat for the CWDs in Hong Kong (see Hung 2008, 2013) and could affect the CWD's behaviour and activities, such as, feeding, resting, socializing, nursing, etc. However, while the study area has not shown itself to be fragile or undisturbed, the overall loss would represent a loss of overall CWD habitat in Hong Kong and specifically in the northern Lantau waters. As such, and keeping in mind the current declining trends in Hong Kong, cumulative impacts would be predicted to occur without mitigation.

13.15.3.26 In order to address the cumulative impacts the three HZMB project, HKLR, HKBCF and TM-CLKL, in addition to the other proposed projects above, but excluding the 3RS project, HKBCF EIA committed to designate the Brothers as an 850 ha marine park (BMP) for enhancing the CWD habitat. Based upon this, the net effect of the cumulative loss of CWD habitat from these projects was predicted to be significantly reduced, so that the residual impacts due to the marine habitat loss would be acceptable and further specific mitigation measures would not be needed for the cumulative CWD habitat loss.

13.15.3.27 However, the 3RS project contributes a significant amount to the overall habitat loss and, as detailed in **Section 13.10**, the impact from the 3RS project alone in terms of permanent habitat loss would be high. However, the 3RS project has recommended setting up approximately 2,400 ha of marine park area, as shown in **Appendix 13.16**, in addition to expanding the restricted access HKIAAA zone by 118 ha to 729 ha. In addition to providing extra CWD protection area, this proposal will also provide critical linkages between the SCLKCMP and the planned BMP. Based on this, a total area of 5,179 ha (about 3,129 ha of which would be from the 3RS project) would be formed (**Drawing No. MCL/P132/EIA/13-025**) in which CWDs would receive protection from fisheries operation and high-speed vessel threats, which are considered to be the two major anthropogenic threats to CWDs in Hong Kong. As stated in **Section 13.11**, while the extent of the proposed Marine Park and the new HKIAAA are indicative and subject to

change during detailed design as well as the designation process under the relevant ordinances, the combined area representing the overall marine protection areas would not be expected to change significantly.

13.15.3.28 The establishment of both of these marine park areas would significantly help conserve the remaining CWD habitat in Hong Kong waters and hence serve as an effective mitigation measure for the loss of CWD habitat arising from these projects. With these committed measures, the residual cumulative impacts to the CWD in terms of permanent habitat loss would be acceptable.

Acoustic Disturbance from Construction Works

13.15.3.29 Construction vessels tend to be slow-moving and without high energy or high frequencies of noises. Nevertheless, when intensive water-construction activities occur, the sheer number and extent of vessel activity tends to inhibit use of the immediate areas by dolphins, probably due to decreased efficiency of feeding and communication by noises, and vessel physical presence and movements (for example, Würsig et al. 2000, Würsig and Greene 2002). Such construction-related activity tends to disturb CWDs only for the extent of the activity, and they return to unaltered habitats once adjacent anthropogenic activity ceases. Nevertheless, the cumulative impacts of activities in northern Lantau waters could be of significance to efficient habitat use of the area for CWD for extended periods, especially if activities are staggered, such as construction of HKLR and HKBCF now, the third runway overlapping with this, and several potential reclamation projects overlapping with the latter. Such diminution / altering of habitat for more than one or two years can potentially affect calf production and survival, and thus an entire generation of CWD.

13.15.3.30 There is limited possibility of severe damage to CWD from the acoustic disturbance associated with the dredging, land formation and piling for the concurrent projects, however, the works could potentially result in at least temporary abandonment of the habitat in the area (see Jefferson 2000, Jefferson and Hung 2004) and based upon this and the peak number of about 120 stationary vessels for marine plant, the 3RS project has proposed to adopt mitigation in the form of acoustic decoupling of noisy equipment from the vessels to prevent transfer of noise into the marine environment, together with use of a dolphin exclusion zone during the marine works. The works for HKLR and TM-CLKL are relatively small compared to HKBCF which is expected to require in the region of 240 dredgers and barges over the 3 year construction period, compared to about 25 for the TM-CLKL.

13.15.3.31 Given that the number of vessels will increase significantly with these project being constructed concurrently, cumulative impacts could occur but with the main component being from the 3RS and HKBCF Projects. In order to address the cumulative impacts of noise from the construction works, each project needs to apply the same level of mitigation. It is noted that each of the three HZMB projects are using dolphin exclusion zones and acoustic decoupling, as per the 3RS project and these combined measures would be expected to reduce the magnitude of cumulative impacts of construction vessels to minor levels and further mitigation measures would not be required.

13.15.3.32 In terms of piling, all recent projects in Hong Kong have avoided the use of percussive piling which is known to potentially cause high impacts to the CWDs (see Würsig et al. 2000). In addition, bored piling for the 3RS project is limited to the piers for the new runway approach lights and the marker beacons, will last only a few weeks and will be conducted outside the peak calving season of March to June. Nonetheless, a DEZ will be implemented for this activity as a precautionary measure. Compared to the piling works required for HKBCF, HKLR and TM-CLKL, with the latter two projects comprising approximately 185 piers in total, the contribution to cumulative noise disturbance from the 3RS project would be low.

Injury / Mortality from Construction Vessels

13.15.3.33 The risk of collisions between construction vessels with the CWDs is an issue and potentially CWD would alter their diving and surfacing patterns to avoid collisions with marine vessels. This would result in some short-term behavioural disturbance to the CWD or displacement from their preferred habitats in severe circumstances.

13.15.3.34 Faster-moving vessels are more of a threat to CWDs than the slower construction vessels. As stated above, most construction vessels are slow moving, allowing the CWDs to avoid them and the chances of a CWD being struck by these slow vessels is considered relatively low.

13.15.3.35 However, the number of construction vessels utilising the northern Lantau waters will increase notably as a result of the concurrent projects, specifically for HKBCF and 3RS project which will be constructed adjacent to each other and the cumulative risk of injury or mortality from collisions with vessels will increase. Both of these key projects, together with HKLR and TM-CLKL, have proposed to adopt strict controls for their construction marine traffic, including speed limits of 10 knots to be strictly observed within the works area, define vessel routes and skipper training. The impacts would also be temporary and would last only during the cumulative period of construction works. Based upon this and the universal implementation of a similar level of mitigation, cumulative impacts can be reduced to acceptable levels.

Travel Areas and Connectivity between Core Habitat Areas

13.15.3.36 It is clear from past (Hung 2012, 2013) and present data that the area north of the existing airport is used for a variety of CWD behavioural functions, including travel between northwest and northeast Lantau. The longer that cumulative construction activities exist in and near this general area, the greater will be the effect on efficient habitat use of CWD, with both the 3RS project and HKBCF/TM-CLKL forcing the CWDs to move further north towards Tuen Mun. However, the corridor between the new 3RS project and waters to the north should still be available and valuable for CWD to transit between western and eastern waters north of the airport. As these implications could increase with all the projects being constructed and implemented concurrently, a long term monitoring programme, consistent with that being undertaken by AFCD, would be recommended as discussed in **Section 13.16** below.

13.16 Ecological Monitoring and Audit Requirements

13.16.1.1 The EIA has predicted the project would lead to some ecological impacts and has recommended a series of measures to avoid, minimise, and mitigate the impacts to an

acceptable level. An ecological monitoring and audit programme would be needed to ensure the recommended measures are properly implemented. In addition, the EM&A programme also serves other purposes, including but not limited to verify the accuracy of the ecological assessment study and recommending action plans in response to unpredicted impacts or ineffective mitigation.

13.16.1.2 The monitoring and audit requirements specific for marine ecology are presented in the Environmental Monitoring and Audit Manual. It is proposed to conduct ecological monitoring during the baseline, construction, post-construction and operation phases of the third runway project, with the aims to monitor the effects on the CWDs over the construction period, including the potential shift in the CWD travelling areas and habitat use, to determine the effectiveness of the reduction in HSF speeds on the acoustic impacts and disturbance to the CWDs and also determine the effectiveness of the mitigation (i.e. after the proposed Marine Park comes into operation) on CWD numbers. The CWD monitoring will be conducted by the ET, led by a CWD monitoring team leader with five years post-graduate experience in CWD monitoring.

13.16.1.3 An overarching goal of these surveys is to provide a dataset that can be compatible with the AFCD long term monitoring, be stratified in such a way as to allow the calculation of density and abundance for the various different phases listed above and to facilitate the calculation of trends from these estimates, providing some assessment of how the project may be impacting the CWDs. Further details on the survey methodologies are provided in the standalone EM&A Manual.

13.16.1.4 Three major types of field work have been proposed as follows:

a) Focussed vessel line transect surveys and also to collect individual CWD identification photos for examination of ranging patterns. As part of this vessel-based work, focal follows of individual CWD groups provide information on movements and travel patterns;

b) Land-based theodolite tracking of movements provides information on swimming and movement patterns of dolphin groups, and responses to vessels and other potential stressors; and

c) Autonomous passive acoustic monitoring (PAM or equivalent) of the dolphins and their environment (especially vessel and marine-construction noise), providing information on CWD presence and vocal activity, as well as noise levels in CWD habitat.

13.16.1.5 The vessel based monitoring surveys and CWD focal follows have been proposed over a period of at least 6 months for the baseline phase, on-going for the duration of the construction works, 12 month post construction monitoring and at least 12 months during operational stage to test the effectiveness of the mitigation measures, so that all four seasons are represented and seasonal differences can be examined.

13.16.1.6 In addition to the proposed vessel transect monitoring, some additional monitoring in the form of underwater acoustic monitoring and land-based theodolite tracking for CWD monitoring will be undertaken during the baseline and construction works. In all cases, the scope, locations and frequency of the monitoring will be further defined at the detailed design phase in agreement

with AFCD and EPD. The main aim for these two monitoring types is to supplement the vessel transect survey findings detailed above and to help verifying the predictions in the EIA. The need for further land-based theodolite and underwater acoustic surveys will be subject to a review of the above findings.

13.16.1.7 In conjunction with the monitoring efforts, given the uncertainty on the growth of HSF traffic from SkyPier / the ITT in future years, the EM&A will monitor actual numbers of HSFs operating from SkyPier after the HZMB and HKBCF commence operations by obtaining HSF movement data from the SkyPier operators.

13.16.1.8 A pre-construction coral dive survey is also proposed at the artificial seawall at northern and northeastern airport island, and the daylighting locations at Shau Chau to check the status of *Balanophyllia* sp. and other coral species and review the feasibility of translocation. A pre-construction coral dive survey plan and report will be prepared for agreement with the Authority.

13.17 Conclusions

13.17.1.1 A comprehensive baseline ecological review has been conducted for the identification of information gaps. Marine ecological surveys specific to the proposed project footprint, especially within the existing HKIAAA have been conducted, covering the intertidal, sub-tidal soft bottom and hard bottom habitats and marine waters. Updated verification surveys along the northern Lantau coast, SCLKCMP and the Brothers have also been taken, where appropriate, reference sites with similar ecological attributes to the habitats within the project footprint have also been carried out to facilitate the ecological valuation. The habitats within the project footprint are generally of low or moderate-low ecological value except for the marine waters. The marine waters within the existing HKIAAA are of moderate-high value due to the less disturbed environment and the usage by marine fishes and Chinese White Dolphins. The marine waters outside the existing HKIAAA are of moderate value due to the usage by marine fishes and Chinese White Dolphins. The Construction and operation phase impacts associated with land formation and other marine works will cause permanent loss of 672 ha seabed and the marine environment for marine fishes, CWDs, associated marine benthos and 5.9 km of artificial seawall with low coverage of gorgonians. The potential impacts on the marine fauna other than CWDs are considered to be low to moderate. Apart from the implementation of water quality mitigation measures and implementation of good site practices, other ecological enhancement measures (including eco-enhancement designs of seawall that would help re-colonisation of intertidal and sub-tidal fauna as well as recruitment of juvenile fishes, as well as extension of HKIAAA with restricted vessel entry which would help to protect the marine fauna) would enable the affected species to recover in long-term and reduce the residual impact in operation phase to insignificant level. The cumulative loss of approximate 1,384 ha of marine habitats is considered as a significant impact. With the compensation of the marine park and implementation of ecological enhancement measures including vessel speed limitation mitigation, no residual impacts are anticipated.

13.17.1.2 This chapter presents a detailed assessment of the expected marine ecological impacts of the development of the expanded Hong Kong International Airport into a Three Runway System (3RS). The primary species of ecological interest in this respect is the CWD, which is resident in Hong Kong's western waters and has been shown to be declining in abundance in Hong Kong

in recent years. Based upon the literature review, data gaps were identified and focussed marine ecological surveys undertaken over a 14-month period. In terms of the CWD, construction and operation phase impacts associated with land formation and associated marine works on habitat loss, travel areas and disturbance to CWDs behaviour have been assessed. It has been concluded that the 3RS development will likely have a number of significant impacts on the CWD population that occurs in Hong Kong's waters, largely related to the large amount of CWD habitat that will become unavailable, the effects on CWD travel areas and the impacts of high speed vessels. In addition to avoidance and minimisation measures, a range of mitigation measures have been proposed, including the establishment of a large new marine park which will provide approximately 2,400 ha of new protected waters and critical linkages with the planned Brothers Marine Park and the existing Sha Chau and Lung Kwu Chau Marine Park as well as with the significant area of HKIAAA marine exclusion zone. SkyPier ferry speed and route restrictions are expected to minimise impacts of vessel traffic on the animals, in addition to the benefits provided by the 10-knots speed limit once the marine park is established. As such, predicted impacts would be expected to be reduced to acceptable levels and the residual impacts are expected to comply with the TM-EIAO.

13.18 References

ACRP (2008). Effects of Aircraft Noise: Research Update on Selected Topics. Transportation Research Board, Washington, DC.

AECOM (2009a). Hong Kong Section of Guangzhou-Shenzhen-Hong Kong Express Rail Link: EIA Report. Prepared for MTR Corporation Limited.

AECOM (2009b). Agreement No. CE 52/2007 (HY) Tuen Mun-Chek Lap Kok Link – Investigation: EIA report. For Highways Department of the HKSAR Government

AECOM (2011). Agreement No. CE 29/2008 (EP) Engineering Investigation and Environmental Studies for Integrated Waste Management Facilities Phase 1 - Feasibility Study EIA Report. For Environmental Protection Department, HKSAR Government.

AFCD (2001). Pilotage Advisory Committee Paper No. 3/2001 – Proposed Marine Parks at Southwest Lantau and Soko Islands. Country and Marine Parks Authority.

AFCD (2013a). Freshwater Fish of Hong Kong. Retrieved on July 2, 2013 from http://www.afcd.gov.hk/english/conservation/hkbiodiversity/speciesgroup/speciesgroup_freshwaterfish.html

AFCD (2013b). Marine Parks. Retrieved on November 27, 2013 from http://www.afcd.gov.hk/english/country/cou_vis/cou_vis_mar/cou_vis_mar.html

AFCD (2013d). Horseshoe crab. Retrieved on April 15, 2013 from http://www.afcd.gov.hk/english/conservation/con_mar/con_mar_hor/con_mar_hor.html

AFCD (2013e). Hong Kong Biodiversity Database. Retrieved from http://www.afcd.gov.hk/english/conservation/hkbiodiversity/database/search.asp

AFCD (2013f). Unpublished data from AFCD long-term monitoring of small cetaceans in Hong Kong, 1995-2013. Dataset provided by HKCRP/AFCD to Jefferson.

AFCD (n.d.). Hong Kong Live Eco-map: Species Distribution – Mangroves and Associated Fauna. Retrieved on April 15, 2013 from http://www.hkecomap.net/distribution_detail_species.asp?AnimalID=7&SiteID=53&lang=eng

Aguilar, A. (2000). *Population biology, conservation threats and status of Mediterranean striped dolphins (Stenella coeruleoalba).* Journal of Cetacean Research and Management, 2, 17-26.

Anasco, N. C., Koyama J, Imai S, Nakamura K. (2008) *Toxicity of residual chlorines from hypochliorite-treated seawater to marine amphipod Hyale barbicornis and estuarine fish Oryzias javanicus.* Water, Air, and Soil Pollution 195: 125 – 136.

Anon (2008). Horseshoe crab (鲎). Retrieved on October 9, 2013 from http://www.gzagri.gov.cn/ztzl/ssysbh/ssysdwbh/wmsbcjdssysbhdwynx/hyg/200801/t20080130_16543.htm

Arup (2009a). Agreement No. CE14/2008 (HY) Hong Kong - Zhuhai - Macao Bridge Hong Kong Boundary Crossing Facilities – Investigation: EIA report. Prepared for Highways Department of the HKSAR Government.

Arup (2009b). Agreement No. CE26/2003 (HY) Hong Kong Section of Hong Kong - Zhuhai - Macao Bridge and Connection – HZMB Hong Kong Link Road – Investigation: EIA report. Prepared for Highways Department of the HKSAR Government.

Ashley-Ross, M. A. (2002). *Mechanical properties of the dorsal fin muscle of seahorse (Hippocampus) and pipefish (Syngnathus).* Journal of Experimental Zoology, 293, 561-577. Retrieved from http://onlinelibrary.wiley.com/doi/10.1002/jez.10183/abstract

Atkins, S., Pillay, N. & Peddemors, V. M. (2004). *Spatial Distribution of Indo-Pacific Humpback Dolphins (Sousa chinensis) at Richards Bay, South Africa: Environmental Influences and Behavioural Patterns.* Journal of Aquatic Mammals, 30, 84 – 93.

Au, D. W. T., Pollino, C. A., Shin, P. K. S., Lau, S. T. F. & Tang, J. Y. M. (2004). *Chronic effects of suspended solids on gill structure, osmoregulation, growth, and triiodothyronine in juvenile green grouper Epinephelus coioides.* Journal of Marine ecology progress series, 266, 255-264.

Bejder, L., Samuals, A., Whitehead, H., Gales, N., Mann, J., Connor, R., Heithaus, M., Watson-Capps, J., Flaherty, C. & Krutzen, M. (2006). *Decline in relative abundance of bottlenose dolphins exposed to long-term disturbance*. Journal of Conservation Biology, 20, 1791-1798.

Bilotta, G. S. & Brazier, R. E. (2008). *Understanding the influence of suspended solids on water quality and aquatic biota.* Journal of Water Research, 42, 2849 – 2861.

BMT (2009). Hong Kong Offshore Wind Farm in Southeastern Waters. Environmental Impact Assessment Report for HK Offshore Wind Limited.

Brzorad, J. & Burger, J. (1994). *Fish and shrimp populations in the Arthur Kill*. In: *Before and after an oil spill: The Arthur Kill* (ed. by Burger, J.), pp.178-200. Rutgers University Press, New Brunswick, NJ.

Busbee, D., Tizard, I., Stott, J. & Ferrick, D. (1999). *Environmental pollutants and marine mammal health: the potential impact of hydrocarbons and halogenated hydrocarbons on immune system dysfunction.* In: *Chemical pollutants and cetaceans* (ed. by Reijnders, P. J. H., Aguilar, A. & Donovan, G. P.), pp. 223-248. Journal of Cetacean Research and Management.

Calleson, C. S. & Frohlich, R. K. (2007). *Slower boat speeds reduce risks to manatees.* Endangered Species Research, 3, 295-304. Retrieved from https://www.fll.net/Manatees/Documents/calleson_and_frohlich_2007.pdf

Caltrans (2006). Marine mammal and acoustic monitoring for the marine foundations at Piers E2 and T1 - San Francisco-Oakland Bay Bridge East Span Seismic Safety Project. State of California Department of Transportation.

Capuzzo, J. M. & Lancaster, B. A. (1981). *Physiological Effects of South Louisiana Crude Oil on Larvae of the American Lobster (Homarus americanus)*. In: *Biological Monitoring of Marine Pollutants* (ed. by Vernberg, F. J., Calabrese, A., Thurberg, F. P. and Vernberg, W. B.), pp. 405 – 423. Academic Press, New York.

Capuzzo, J. M., Davidson, J.A.and Lawrence, S.A. (1977). *The differential effects of free and combined chlorine on juvenile marine fish.* Estuarine and Coastal Marine Science, 5, pp. 733 – 741.

Carrillo, M. & Ritter, F. (2010). *Increasing numbers of ship strikes in the Canary Islands: Proposals for immediate action to reduce risk of vessel-whale collisions.* Journal of Cetacean Research and Management, 11, 131-138.

CCPC (2001). *Consultancy Study on Fisheries and Marine Ecological Criteria for Impact Assessment*. Centre for Coastal Pollution and Conservation, City University of Hong Kong. Prepared for Agriculture, Fisheries and Conservation Department.

CCPC (2002). *Consultancy Study on Marine Benthic Communities in Hong Kong.* Centre for Coastal Pollution and Conservation, CityU Professional Services Limited. Submitted to Agriculture, Fisheries and Conservation Department.

CEDD (2013). Environmental Monitoring & Audit for Contaminated Mud Pit V at Sha Chau. Retrieved on October 10, 2013 from http://www.cmp-monitoring.com.hk/EM&A%20Data/Marine%20Biota%20Monitoring/Marine%20Biota%20Monitoring.html

Chan, Y. (2007). *The Ecology and Biology of Amphioxus in Hong Kong*. Unpublished Mphil Thesis. City University of Hong Kong, Hong Kong.

Chen, T., Hung, S. K., Qiu, Y., Jia, X. & Jefferson, T. A. (2010). *Distribution, abundance, and individual movements of Indo-Pacific humpback dolphins (Sousa chinensis) in the Pearl River Estuary, China.* Mammalia, 74, 117-125.

Choi, H. W. (2006). *The current status of demersal fishery resources in Tolo Harbour & Tolo Channel with implications for their management*. MSc Thesis. The University of Hong Kong, Hong Kong.

Cockcroft, V. G. (1989). *Biology of Indopacific humpback dolphin (Sousa plumbea) off Natal, South Africa.* Abstracts of the Biennial Conference on the Biology of Marine Mammals, 8, 13.

Corkeron, P. J. & Van Parijs, S. M. (2001). *Vocalizations and Behaviour of Pacific Humpback Dolphins Sousa chinensis.* Ethology, 107(8), 701-716. Retrieved from http://onlinelibrary.wiley.com/doi/10.1046/j.1439-0310.2001.00714.x/full

Dungan, S. Z., Hung, S. K., Wang, J. Y. & White, B. N. (2012). *Two social communities in the Pearl River Estuary population of Indo-Pacific humpback dolphins (Sousa chinensis).* Canadian Journal of Zoology, 90, 1031–1043.

EPD (2012). Marine Water Quality in Hong Kong in 2012.

ERM (1995). Proposed Aviation Fuel Receiving Facility at Sha Chau: Environmental Impact Assessment. Prepared for the Provisional Airport Authority.

ERM (1998). Fisheries Resources and Fishing Operations in Hong Kong Waters – Final Report. Prepared for Agriculture, Fisheries and Conservation Department.

Fellowes, J. R., Lau M. W-N., Dudgeon, D., Reels, G. T., Ades, G. W. J., Carey, G. J., Chan, B. P-L., Kendrick, R. C., Lee, K. S., Leven, M. R., Wilson, K. D. P. & Yu, Y. T. (2002). *Wild animals to watch: terrestrial and freshwater fauna of conservation concern in Hong Kong.* Memoirs of the Hong Kong Natural History Society, 25, 123-160.

Fishbase (2013). Retrieved on October 9, 2013, from http://www.fishbase.org/

Fong, T. C. W. (1998). *Distribution of Hong Kong seagrasses*. Porcupine!, 18, 10-12.

Fontaine, M. C., Tolley, K. A., Michaux, J. R., Birkun, A., Ferreira, M., Jauniaux, T., Llavona, A., Ozturk, B., Ozturk, A. A., Ridoux, V., Rogan, E., Sequeira, M., Bouqegneau, J. M. & Baird, S. J. E. (2010). *Genetic and historic evidence for climate-driven population fragmentation in a top cetacean predator: The harbour porpoises in European water.* Proceedings of the Royal Society of London, 277 (Series B), 2829-2837.

Geraci, J. R. & St. Aubin, D. J. (1987). *Effects of offshore oil and gas development on marine mammals and turtles*. In: *Long Term Environmental Effects of Offshore Oil and Gas Development* (ed. by Boesch, D. F. & Rabalais, N. N.), pp. 587 – 617. Elsevier Applied Science Publishers, London, UK and New York.

Geraci, J. R. (1990). *Cetaceans and Oil: Physiologic and Toxic Effects*. In: *Sea Mammals and Oil: Confronting the Risks* (ed. by Geraci, J. R. & St. Aubin, D. J.), pp. 167-197. Academic Press, San Diego, CA.

Gladwin, D. N., Asherin, D. A. & Manci, K. M. (1987*). Effects of aircraft noise and sonic booms on fish and wildlife: results of a survey of U.S. Fish and Wildlife Service Endangered Species and Ecological Services Field Offices, Refuges, Hatcheries, and Research Centers*. NERC-88/30. U.S. Fish Wildl. Serv., National Ecology Research Center, Fort Collins, CO. 24 pp.

Green Power and Ecological Education and Resource Centre (2012). Hong Kong's First Systematic Survey of Pipefish and Seahorses Press Release dated 20 January 2012.

Greene, C. R. (1987). *Characteristics of oil industry dredge and drilling sounds in the Beaufort Sea*. Journal of the Acoustical Society of America, 82, 1315-1324.

Greene, C. R. J. & Moore, S. E. (1995). *Man-made noise*. In: *Marine Mammals and Noise* (ed. by Richardson, W. J., Greene, C. R. J., Malme, C. I. & Thomson, D. H.), pp. 101-158. Academic Press, San Diego.

Harmelin-Vivien M, Le Diréach L, Bayle-Sempere J, Charbonnel E, García-Charton JA, Ody D, Pérez-Ruzafa A et al. (2008). *Gradients of abundance and biomass across reserve boundaries in six Mediterranean marine protected areas: evidence of fish spill-over?* Biological Conservation 141: 1829 – 1839.

Hawker, D. W. & Connell, D. W. (1992). *Standards and Criteria for Pollution Control in Coral Reef Areas*. In: *Pollution in Tropical Aquatic Systems* (ed. by Connell, D. W & Hawker, D. W.). CRC Press, Inc.

HKIEd (1999). *Study on the Suitability of South West Lantau to be Established as Marine Park or Marine Reserve*. Prepared for Agriculture, Fisheries and Conservation Department of the HKSAR Government.

Hong Kong Herbarium and South China Botanical Garden (eds.) (2011). *Flora of Hong Kong Volume 4*. Agriculture, Fisheries and Conservation Department, Government of the Hong Kong Special Administrative Region, Hong Kong.

Honma, Y., Ushiki, T., Takeda, M. & Shindo, J. (2001). *Notes on a jetfoil collision and strandings of marine mammals in waters of Niigata, Sea of Japan- 1*. Nihonkai Cetology, 11, 31-36.

Hoyt, E. (2009). *Whale watching*. In: *Encyclopedia of Marine Mammals (Second Edition)* (ed. by Perrin, W. F., Wursig, B. & Thewissen, J. G. M.), pp. 1223-1227. Academic Press.

Hoyt, E. (2011). *Marine Protected Areas for Whales, Dolphins and Porpoises, Second Edition*. Earthscan.

Hu, Q. M., Wu, T. L., Xia, N. H., Xing, F. W., Lai, P. C. C. & Yip, K. L. (2003). *Rare and Precious Plants of Hong Kong.* Agriculture, Fisheries and Conservation Department, HKSAR Government, Friends of the Country Parks and Cosmos Books Ltd., Hong Kong.

Huang, S. L., Karczmarski, L., Chen, J., Zhou, R., Zhang, H., Li, H-Y. & Wu, Y. (2012). *Demography and population trends of the largest population of Indo-Pacific humpback dolphins.* Biological Conservation, 147, 234-242.

Huang, Z. G. (ed.) (2006). *Diversity of Species in Xiamen Bay, China*. Ocean Press, Beijing, China, pp. 587.

Hung, S. K. & Jefferson T. A. (2004). *Ranging Patterns of Indo-Pacific Humpback Dolphins (Sousa chinensis) in the Pearl River Estuary, People's Republic of China.* Aquatic Mammals, 30, 159 – 174.

Hung, S. K. Y. (2008). *Habitat use of Indo-Pacific humpback dolphins (Sousa chinensis) in Hong Kong*. Doctoral dissertation, University of Hong Kong, pp. 253.

Hung, S. K. Y. (2012). Monitoring of marine mammals in Hong Kong waters (2011-12): Final report (1 April 2011 to 31 March 2012). Submitted to the Agriculture, Fisheries and Conservation Department of the Hong Kong SAR Government. Retrieved from http://www.afcd.gov.hk/english/conservation/con_mar/con_mar_chi/con_mar_chi_chi/files/FinalReport2011to12pp1to120.pdf

Hung, S. K. Y. (2013). Monitoring of marine mammals in Hong Kong waters (2012-13): Final report (1 April 2012 to 31 March 2013). Submitted to the Agriculture, Fisheries and Conservation Department of the Hong Kong SAR Government. Retrieved from http://www.afcd.gov.hk

HyD (2011). Proposed Marine Park in the Brothers Island. ACE Paper 17/2011. For discussion by the Advisory Council on the Environment on 30 December 2011.

Hyder Consulting Limited and Mott Connell Limited. (2007). Agreement No. CE25/2001 Hong Kong 2030: Planning Vision and Strategy Strategic Environmental Assessment: Revised Concept Plan for Lantau (LCP) – Broad Brush Environmental Appraisal of the LCP. Prepared for the Planning Department of the Hong Kong SAR Government.

Hyder- Meinhardt JV. (2013). Agreement No. CE 38/2008 (HY). Trunk Road T2 – Final Environmental Impact Assesment Report. Prepared for Civil Engineering and Development Department of the Hong Kong SAR Government.

IUCN (2013). IUCN Red List of Threatened Species Version 2013.2. Retrieved on 19 September 2013, from www.iucnredlist.org

Janik, V. M. (2000). *Source levels and the estimated active space of bottlenose dolphin (Tursiops truncatus) whistles in the Moray Firth, Scotland.* Journal of Coomparative Physiology A, 186, 673-680.

Jefferson, T. A. (1998). *Population biology of the Indo-Pacific hump-backed dolphin (Sousa chinensis Osbeck, 1765) in Hong Kong waters: final report.*

Jefferson, T. A. (2000). *Population biology of the Indo-Pacific hump-backed dolphin in Hong Kong waters*. Wildlife Monographs, 144, pp. 65.

Jefferson, T. A. & Karczmarski, L. (2001). *Sousa chinensis*. Mammalian Species, 655, 1-9.

Jefferson, T. A. & Hung, S. K. (2004). *A review of the status of the Indo-Pacific humpback dolphin (Sousa chinensis) in Chinese waters*. Aquatic Mammals, 30, 149-158.

Jefferson, T. A. (2005). Biopsy sampling of humpback dolphins in Hong Kong, October-November 2004: Final report of the trial program. Unpublished contract report.

Jefferson, T. A., Hung, S. K. & Lam, P. K. S. (2006). *Strandings, mortality and morbidity of Indo-Pacific humpback dolphins in Hong Kong, with emphasis on the role of environmental contaminants*. Cetacean Research and Management, 8, 181-193.

Jefferson, T. A. (2007). Monitoring of Chinese white dolphins (Sousa chinensis) in Hong Kong waters - biopsy sampling and population data analysis: final report, pp. 171.

Jefferson, T. A., Hung, S. K. & Würsig, B. (2009). *Protecting small cetaceans from coastal development: Impact assessment and mitigation experience in Hong Kong.* Marine Policy, 33, 305-311.

Kannan, K., Tanabe, S., Borrell, A., Aguilar, A., Focardi, S. & Tatsukawa, R. (1993). *Isomer-specific analysis and toxic evaluation of polychlorinated biphenyls in striped dolphins affected by an epizootic in the western Mediterranean Sea.* Archives of Environmental Contamination and Toxicology, 25, 227-233.

Kemp, N. J. (1996). *Habitat loss and degradation*. In: *The conservation of whales and dolphins: science and practice* (ed. by Simmonds, M. P. & Hutchinson, J. D.), pp. 263-280. John Wiley and Sons.

Kennedy, S. (1999). *Morbilliviral infections in marine mammals*. In: *Chemical pollutants and cetaceans* (ed. by Reijnders, P. J. H., Aguilar, A. & Donovan, G. P.), pp. 267-273. Journal of Cetacean Research and Management.

KFBG (2013). Ecological and Conservation Importance of Tung Chung, Lantau.

Kwok, W. P. W., Yang, J. K. Y., Tong, P. Y. F., & Lam, C. P. (2005). *Distribution of Seagrasses in Hong Kong*. Hong Kong Biodiversity, 8, 12-14.

Kwok, W. P. W. & Tang, W. S. (2005). *An introduction to Common Sesarmine Crabs of Hong Kong.* Hong Kong Biodiversity, 9, 1-6.

Lahvis, G. P., Wells, R. S., Kuehl, D. W., Stewart, J. L., Rhinehart, H. L. & Via, C. S. (1995). *Decreased lymphocyte responses in free-ranging bottlenose dolphins (Tursiops truncatus) are associated with increased concentrations of PCBs and DDT in peripheral blood.* Environmental Health Perspectives, 103, 67-72.

Laist, D. W., Knowlton, A. R., Mead, J. G., Collet, A. S. & Podesta, M. (2001). *Collisions between ships and whales.* Marine Mammals Science, 17(1), 35-75. Retrieved from http://mhk.pnl.gov/wiki/images/6/6f/Laist_et_al._2001.pdf

Lee, V. L. F., Lam, S. K. S., Ng, F. K. Y., Chan, T. K. T. and Young, M. L. C. (2004). Field Guide to the Freshwater Fish Of Hong Kong. Friends of the Country Parks and Cosmos Books Limited, Hong Kong.

Li, S., Wang, D., Wang, K., Taylor, E. A., Cros, E., Shi, W., Wang, Z., Fang, L., Chen, Y. & Kong, F. (2012). *Evoked-potential audiogram of an Indo-Pacific humpback dolphin (Sousa chinensis).* Journal of Experimental Biology, 215, 3055-3063.

Lu, Z., Yan, Y. & Du, Q. (1998). *Variation of Fishery Resources and Estimation of Suitable Fishing Efforts in XiamenCoastal Waters*. Journal of Oceanography of Taiwan Strait, 17, 309-316.

Lukenburg, J. A., & Parsons, E. C. M. (2009). *The effects of aircraft on cetaceans: Implications for aerial whalewatching*. International Whaling Commission Scientific Committee Report SC/61/WW2 (unpublished).

Maldini, D., Scoles, R., Eby, R. & Cotter, M. (2012). *Patterns of sea otter haul-out behaviour in a California tidal estuary in relation to environmental variables*. Northwestern Naturalist, 93, 67-78.

Maunsell (2002). Agreement No. CE55/2000 EIA Study for Construction of Lung Kwu Chau Jetty: Final EIA Report. Prepared for Civil Engineering Department of the HKSAR Government.

McClanahan TR, Mangi S (2000). Spillover *of exploitable fishes from a marine park and its effect on the adjacent fishery*. Ecological Applications 10: 1792 – 1805.

Mizrock, B. (1995). *Alterations in Carbohydrate Metabolism during Stress: A Review of the Literature*. American Journal of Medicine, 98, 75 - 84.

Mott MacDonald (2010). Agreement CE 63/2008 (CE) Providing Sufficient Water Depth for Kwai Tsing Container Basin and its Approach Channel - EIA Report. Prepared for Civil Engineering and Development Department of the HKSAR Government.

Mott MacDonald (2012). Contract P540 - Deep Cement Mixing Trail Works environmental monitoring report (Final). Unpublished contract report to the Airport Authority, Hong Kong, 170 pp.

Morton, B. & Lee, C. N. W. (2003). The Biology and Ecology of Juvenile Horseshoe Crabs along the Northwestern Coastline of the New Territories, Hong Kong: Prospects and Recommendations for Conservation. Final Report to China Light and Power Company Limited.

Mouchel (2001). Castle Peak Road Improvement between Area 2 and Ka Loon Tsuen Wan Marine Ecology Baseline Survey EIA. Prepared for Highways Department.

Mouchel. (2002a). Final EIA for Permanent Aviation Fuel Facility. Prepared for Airport Authority.

Nadeeshani Nanayakkara KG, Zheng YM, Khorshed Alam AKM, Zou S, Chen JP (2011) *Electrochemical disinfection for ballast water management: Technology development and risk assessment.* Marine Pollution Bulletin 63: 119 – 123

National Research Council (2003). *Ocean Noise and Marine Mammals*. National Academy Press.

Ng, S. L. & Leung, S. (2003). *Behavioural response of Indo-Pacific humpback dolphin (Sousa chinensis) to vessel traffic.* Marine Environmental Research, 56, 555-567.

Norris, K. S., Würsig, B., Wells, R. S. & Würsig, M. (1994). *The Hawaiian Spinner Dolphin*. University of California Press.

Parsons, E. C. M. & Jefferson, T. A. (2000). *Post-mortem investigations on stranded dolphins and porpoises from Hong Kong waters*. Journal of Wildlife Diseases, 36, 342-356.

Parsons, E. C. M. (2004). *The potential impacts of pollutants on humpback dolphins, with a case study on the Hong Kong population.* Aquatic Mammals, 30, 18-37.

Piwetz, S., Hung, S., Wang, J., Lundquist, D. & Würsig, B. (2012). *Indo-Pacific humpback dolphin (Sousa chinensis) movements off Lantau Island, Hong Kong: Influences of vessel traffic.* Aquatic Mammals, 38, 325-331.

Popper, A. N. & Hastings, M. C. (2009). *The effects of anthropogenic sources of sound on fishes*. Journal of Fish Biology, 75, 455 – 489.

Put, OA, Jr., Wong, C. K., Lin, T. P., Ma, W. C., Li, F. S. & Hung, S. (2004). Biological monitoring in Sha Chau and Lung Kwu Chau Marine Park. Final Report for Agriculture, Fisheries and Conservation Department of the HKSAR Government.

Put, OA, Jr., Wong, C.K., Lin, T. P., Ma, W. C., Li, F. S. & Hung, S. (2005a). Biological monitoring in Sha Chau and Lung Kwu Chau Marine Park. Final Report for Agriculture, Fisheries and Conservation Department of the HKSAR Government.

Put, OA, Jr., Lin, T. P., Ma, W. C., Li, F. S. & Hung, S. (2005b). Biological monitoring in Sha Chau and Lung Kwu Chau Marine Park. Final Report for Agriculture, Fisheries and Conservation Department of the HKSAR Government.

Put, OA, Jr., Ma, W. C., Lin, T. P. & Li, S. F. (2006). Biological monitoring in Sha Chau and Lung Kwu Chau Marine Park. Final Report for Agriculture, Fisheries and Conservation Department of the HKSAR Government.

Quintana-Rizzo, E., Mann, D. A. & Wells, R. S. (2006). *Estimated communication range of social sounds used by bottlenose dolphins (Tursiops truncatus).* Journal of the Acoustical Society of America, 120, 1671-1683.

Reeves, R. R., Dalebout, M. L., Jefferson, T. A., Karczmarski, L., Laidre, K., O'Corry-Crowe, G., Rojas-Bracho, L., Secchi, E. R., Slooten, E., Smith, B. D., Wang, J. Y. & Zhou, K. (2008). *Sousa chinensis*. In: *IUCN 2009. IUCN Red List of Threatened Species. Version 2009.2.* Retrieved from www.iucnredlist.org

Reijnders, P. J. H., Leopold, M. F., Camphuysen, C. J., Heessen, H. J. L. & Kastelein, R. A. (1996). *The status of the harbour porpoise, Phocoena phocoena, in Dutch waters and the state of related research in the Netherlands: an overview.* Reports of the International Whaling Commission, 46, 607-612.

Richardson, W. J., Würsig, B. & Greene, C. R. (1990). *Reactions of bowhead whales (Balaena mysticetus) to drilling and dredging noise in the Canadian Beaufort Sea*. Marine Environmental Research, 29, 135-160.

Richardson, W. J., Greene, C. R., Malme, C. I. & Thomson, D. H. (1995). *Marine Mammals and Noise*, Academic Press.

Richardson, W. J. & Würsig, B. (1997). *Influences of man-made noise and other human actions on cetacean behaviour.* Marine and Freshwater Behaviour and Physiology, 29, 183-209.

Ritter, F. (2010). *Quantification of ferry traffic in the Canary Islands (Spain) and its implications for collisions with cetaceans*. Journal of Cetacean Research and Management, 11(2), 139-146.

Sadovy, Y. & Cheung, W .L. (2003). *Near extinction of a highly fecund fish: the one that nearly got away*. Fish and Fisheries, 4(1), 86 – 99.

Scott Wilson (1999). Agreement No. CE 32/96 - Study on Tonggu Waterway, Final Report. Unpublished report submitted to CEDD of HKSAR Government.

Sheehy, D. J. (2009). *Potential impacts to Sousa chinensis from a proposed land reclamation along the west coast of Taiwan*. Aquabio Technical Report, 09-24, pp. 26.

Sims, P. Q., Vaughn, R., Hung, S. K. & Würsig, B. (2011). *Sounds of Indo-Pacific humpback dolphins (Sousa chinensis) in West Hong Kong: A preliminary description.* JASA Express Letters, 131, E48-E53.

Sims, P. Q., Hung, S. K. & Würsig, B. (2012). *High-speed vessel noises in West Hong Kong waters and their contributions relative to Indo-Pacific humpback dolphins (Sousa chinensis).* Journal of Marine Biology, 2012, pp. 11.

Slabbekoorn, H., Bouton, N., Opzeeland, L. V., Coers, A., Cate, C. T. & Popper, A. N. (2010). *A noisy spring: the impact of globally rising underwater sound levels on fish.* Trends in Ecology & Evolution, 25, 419 – 427.

Smith, T. G., Geraci, J. R. & St. Aubin, D. J. (1983). *Reaction of Bottlenose Dolphins, Tursiops truncatus, to a Controlled Oil Spill.* Canadian Journal of Fisheries and Aquatic Sciences, 40(9), 1522-1525. Retrieved from http://www.nrcresearchpress.com/doi/abs/10.1139/f83-175

Smultea, M. A. & Würsig, B. (1992). *Observations on the reaction of bottlenose dolphins to the Mega Borg oil spill, Gulf of Mexico, 1990*. In: *The Mega Borg oil spill: fate and effect studies* (ed. by I. Research Planning), pp. 90-119. Research Planning, Inc. Prepared for the Damage Assessment Center, NOAA.

Smultea M. A. & Wursig B. (1995). *Behavioral Reactions of Bottlenose Dolphins to the Mega Borg Oil Spill, Gulf of Mexico 1990*. Aquatic Mammals, 21, 171 – 181.

Sogabe, A., Mohri, K. & Sohji, J. (2012). *Reproductive seasonality of the seaweed pipefish Syngnathus schlegeli (Syngnathidae) in the Seto Inland Sea, Japan*. Ichthyological Research, 59, 223 – 229.

Southall, B. L. (2005). Shipping noise and marine mammals: A forum for science, management, and technology, NOAA, Arlington, Virginia, U.S.A.

Tam YK, N IH, Yau C, Yan MY, Chan WS, Chan SM, Lu HJ, 2013. *Tracking the changes of a fish* community *following a megascale reclamation and ensuing mitigation measures*. ICES Journal of Marine Science 70: 1206 – 1219.

Tanabe, S. & Tatsukawa, R. (1991). *Persistent organochlorines in marine mammals*. In: *Organic contaminants in the environment: environmnental pathways and effects* (ed. by K.C. Jones), pp. 275-289. Elsevier Applied Science, London.

To, A., Ching, K. & Shea, S. (2013). Hong Kong Reef Fish Photo Guide. Eco-Education & Resources Centre, Hong Kong.

Tsang, E., Lui, K., Maria, M. & Marc, S.E. (2000). Sha Chau and Lung Kwu Chau Marine Park Monitoring Programme. Final Report for Agriculture, Fisheries and Conservation Department of the HKSAR Government.

Tsang, E. P. K., Lui, K. & Maria, M. (2001). Sha Chau and Lung Kwu Chau Marine Park Monitoring Programme. Final Report for Agriculture, Fisheries and Conservation Department of the HKSAR Government.

Tsang, E. P. K., Lui, K. & Maria, M. (2002*). Sha Chau and Lung Kwu Chau Marine Park Monitoring Programme. Final Report for Agriculture*, Fisheries and Conservation Department of the HKSAR Government.

Tsang, E. P. K. & Douglas, B. (2003). Sha Chau and Lung Kwu Chau Marine Park Monitoring Programme. Final Report for Agriculture, Fisheries and Conservation Department of the HKSAR Government.

University of Rhode Island (2013). Discovery of Sound in the Sea. Retrieved from http://www.dosits.org/animals/animalsandsoundsummary/

Vanderlaan, A. S. M. & Taggart, C. T. (2007). *Vessel collision with whales: The probability of lethal injury based on vessel speed.* Marine Mammal Science, 23(1), 144-156. Retrieved from http://www.nero.noaa.gov/shipstrike/doc/Vanderlaan%20and%20Taggart%202007_speed.pdf

Van Waerebeek, K., Baker, A. N., Felix, F., Gedamke, J., Iniguez, M., Sanino, G. P., Secchi, E., Sutaria, D., Van Helden, A. & Wang, Y. (2007). *Vessel collisions with small cetaceans worldwide and with large whales in the Southern Hemisphere, an initial assessment.* Latin American Journal of Aquatic Mammals, 6, 43-69.

Wang S. & Xie Y. (2004). *China Species Red List*. Higher Education Press, China.

Watanabe, S. & Watanabe, Y. (2002). *Relationship between male size and newborn size in the seaweed pipefish, Syngnathus schlegeli*. Environmental Biology of Fishes, 65, 319 – 325.

Weir, C. R. & Dolman, S. J. (2007). *Comparative review of the regional marine mammal mitigation guidelines implemented during industrial seismic surveys, and guidance towards a worldwide standard*. Journal of International Wildlife Law and Policy, 10, 1-27.

Wells, R. S. & Scott, M. D. (1997). *Seasonal incidence of boat strikes on bottlenose dolphins near Sarasota, Florida.* Marine Mammal Science, 13, 475-480.

Wen, W., Huang, X.X., Chen, Q.K., Feng, L.F. and Wei, L.K. (2013). *Temperature effectson early development and biochemical dynamics of a marine fish, Inimicus japonicas.* Journal of Experimental Marine Biology and Ecology, 442, 22 – 29.

Whipple, J.A., Eldridge, M.B., Benville, .P (1981). *An ecological perspective of the effects of monocyclic hydrocarbons on fishes*. In: *Biological Monitoring of Marine Pollutants* (Vernberg, F.J., Calabrese, A., Thurberg, F.P., Vernberg, W.B. eds.) Academic Press, London, pp. 483-551.

Wiggins, S. M. & Hildebrand, J. (2007*). High-frequency Acoustic Recording Package (HARP) for broad-band, long-term marine mammal monitoring*. In: *Symposium on Underwater Technology and Workshop on Scientific Use of Submarine Cables and Related Technologies* (Anonymous ed.), pp. 551-557.

WoRMS (2013). World Register of Marine Species. Retrieved on December 3, 2013 from http://www.marinespecies.org/

Wright, A. J., Aguilar Soto, N., Baldwin, A. L., Bateson, M., Beale, C. M., Clark, C., Deak, T., Edwards, E. F., Fernández, A., Godinho, A., Hatch, L. T., Kakuschke, A., Lusseau, D., Martineau, D., Romero, L. M., Weilgart, L. S., Wintle, B. A., Notarbartolo-di-Sciara, G. & Martin, V. (2007). *Do Marine Mammals Experience Stress Related to Anthropogenic Noise?* International Journal of Comparative Psychology, 20(2/3), 274-316. Retrieved from http://web.a.ebscohost.com/abstract?direct=true&profile=ehost&scope=site&authtype=crawler&jrnl=08893667&AN=37168571&h=QMPDrzdOHX13GCvRr2zYmXUGZ%2fWyL9IAQNVtpq8ywR0vCkshcOY3ZbPyz0yW%2f14CBpOWW0S9fzMoLsQ8UiOiAg%3d%3d&crl=c2b9z1VIqo99BllOwBj6xobCyIc40bdKJ895quh4enixQ%3d%3d&crl=c

Würsig, B. (1990). *Cetaceans and oil: ecologic perspectives*. In: *Sea Mammals and Oil: Confronting the Risks* (ed. by Geraci, J. R. & St. Aubin, D. J.), pp.129–165.

Würsig, B., Lynn, S. K., Jefferson, T. A. & Mullin, K. D. (1998). *Behaviour of cetaceans in the northern Gulf of Mexico relative to survey ships and aircraft*. Aquatic Mammals, 24, 41-50.

Würsig, B., Greene, J., C. R. & Jefferson, T.A. (2000). *Development of an air bubble curtain to reduce underwater noise of percussive piling.* Marine Environmental Research, 49, 79-93.

Würsig, B. & Evans, P. G. H. (2001). *Cetaceans and humans: Influence of noise*. In: *Marine Mammals: Biology and Conservation* (ed. by Evans, P.G.H. & Raga, J. A.), pp. 565-587. Kluwer Academic/Plenum Press, New York, NY, USA.

Würsig, B. & Greene, Jr. C. R. (2002). *Underwater sounds near a fuel receiving facility in western Hong Kong: relevance to dolphins.* Marine Environmental Research, 54(2), 129-145. Retrieved from http://www.sciencedirect.com/science/article/pii/S0141113602000995

Würsig, B. & Richardson, W. J. (2009). *Noise, effects.* In: *Encyclopedia of Marine Mammals, Ed. 2* (ed. by Perrin, W. F., Würsig, B. & Thewissen, J. G. M.), pp. 765-773. Academic Elsevier Press, Amsterdam Netherlands.

Xing, F. W., Ng, S. C. & Chau, L. K. C. (2000). *Gymnosperms and angiosperms of Hong Kong.* Memoirs of the Hong Kong Natural History Society.

Zheng, G. J. & Richardson, B. J. (1999). *Petroleum hydrocarbons and polycyclic aromatic hydrocarbons (PAHs) in Hong Kong marine sediments.* Chemosphere, 38(11), 2625–2632. Retrieved from http://www.sciencedirect.com/science/article/pii/S0045653598004706