Expansion of Hong Kong International Airport into a Three-Runway System

Marine Travel Routes and Management Plan for High Speed Ferries of SkyPier

June 2015
Airport Authority Hong Kong

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1. Introduction

1.1 Background

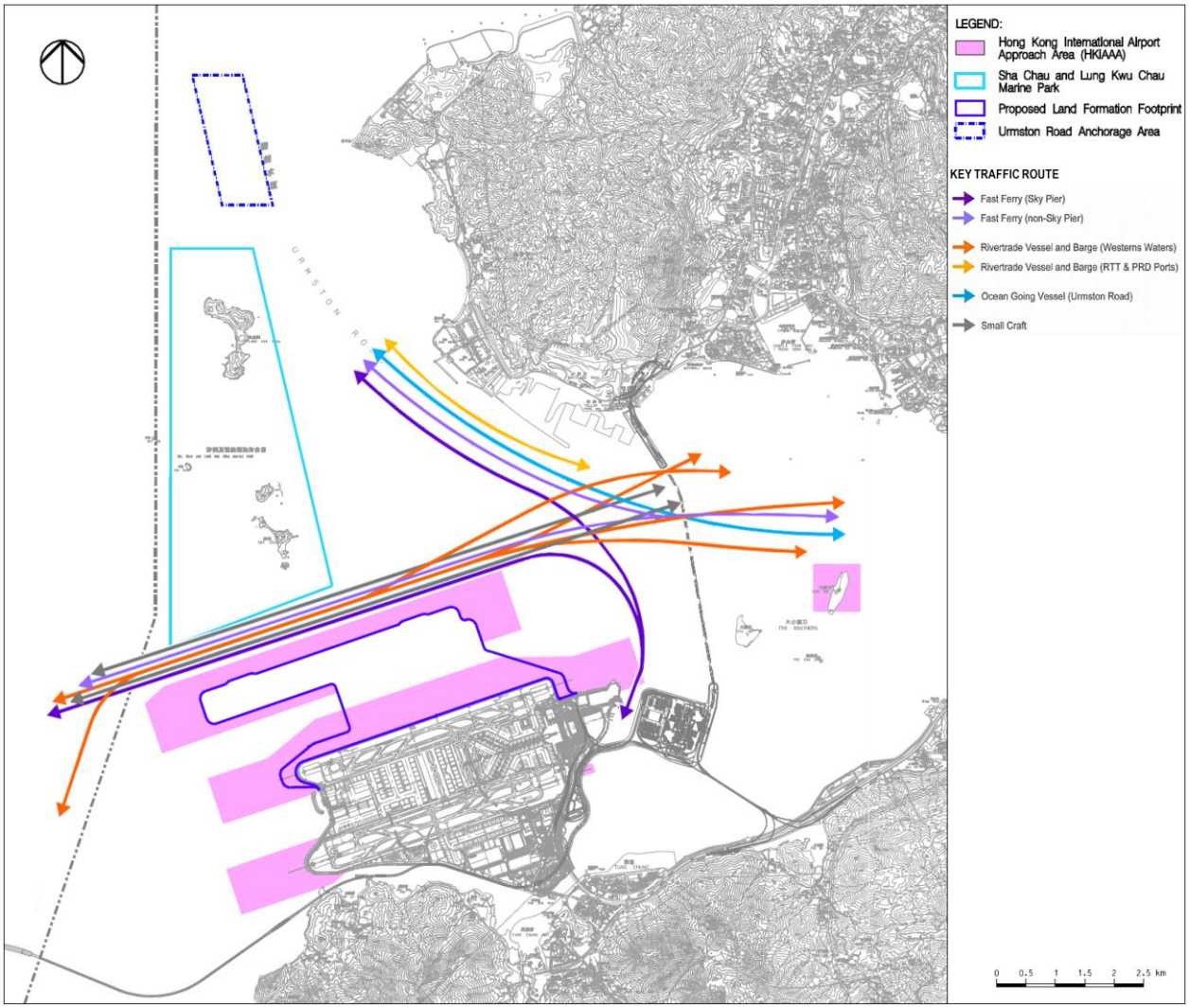
Government of the Hong Kong Special Administrative Region (HKSAR) approved in principle the adoption of the Three-Runway System (3RS) as the future development option for Hong Kong International Airport (HKIA) for planning purposes on 20 March 2012, and also approved the recommendation of Airport Authority Hong Kong (AAHK) to proceed with the statutory environmental impact assessment (EIA). An EIA study brief (ESB-250/2012) for the 3RS project (henceforth referred to as the 'project') was issued by the Environmental Protection Department (EPD) on 10 August 2012. The EIA report has been prepared according to the EIA study brief requirements, which identified 12 key environmental assessment aspects to be addressed as part of the EIA study. On 7 November 2014, the EIA for the project (EIA Register No.: AEIAR-185/2014) was approved and an Environmental Permit (EP) (Permit No.: EP-489/2014) was issued for the project.

The project is proposed to be located on a new land formation immediately north of HKIA in North Lantau, covering a permanent footprint of approximately 650 ha. As stated in the approved EIA, the project primarily comprises:

- New third runway with associated taxiways, aprons and aircraft stands;
- New passenger concourse building;
- Expansion of the existing Terminal 2 (T2) building; and
- Related airside and landside works, and associated ancillary and supporting facilities.

The area around HKIA is well used by a variety of vessel types, of which High Speed Ferries (HSFs) pose the most significant collision threat to Chinese White Dolphins (CWDs) and are also known to generate the loudest underwater noise. During the 3RS land formation, works area will be designated and demarcated by floating booms 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 Hong Kong International Airport Approach Area (HKIAAA; **Figure 1-1**), although no change to the direction of traffic flows are expected, these continuing to comprise two-way transits east and west.

Figure 1-1 Key Traffic Routes for Future Traffic Environment



1.2 Objectives of the Marine Travel Routes and Management Plan

In accordance with Clause 2.10 of the EP, the permit holder shall submit a Marine Travel Routes and Management Plan (The Plan) for high speed ferries (HSF) of the SkyPier. The Plan shall include at least the following information/specifications:

i. The imposition of a speed limit within Hong Kong waters which are hotspots of the CWD during the construction phase so as to minimize chances of collision and disturbance to the CWD;

ii. To cap the number of SkyPier HSF at the current level of operation (i.e. an annual daily average of 99) prior to designation of the proposed marine park; and

iii. Explore the feasibility of imposing a daily cap on the number of HSF leaving the SkyPier and imposing further speed restriction at different spots along the marine routes after detailed study.

This Plan has been prepared to detail the information/specifications listed above to fulfil the EP requirement Clause 2.10.

2. Impact of High Speed Ferries and Proposed Mitigation Measures

2.1 High Speed Ferries of SkyPier

SkyPier, which is located at north-east of Hong Kong International Airport (HKIA), provides HSF service for transfer passengers to eight ports in Pearl River Delta (PRD) and Macao include Dongguan Humen, Guangzhou Nansha, Macao Maritime Ferry Terminal, Macao Taipa, Shenzhen Fuyong, Shenzhen Shekou, Zhongshan and Zhuhai Jiuzhou. The draft of SkyPier HSFs travelling in the waters north of Lantau Island is approximately 1 – 2 m.

Photo 2-1 Photo of High Speed Ferry

2.2 Impact of High Speed Ferries on Chinese White Dolphin

2.2.1 Behavioural Change Induced by High Speed Ferries

The EIA for 3RS described that the HSFs utilising the SkyPier would move up to full speed of 30 - 40 knots in 1-1.5 km after leaving the pier and would slow down within approx. 1 km of approaching the pier. The HSFs would move at high speed while navigating through the waters north of the airport island. Data from the AFCD long-term studies (Hung 2012, 2013) and the intensive one-year study conducted for the 3RS EIA identify that such vessel movements caused intermittent behavioural changes in CWDs as they attempt to avoid rapid and noisy ferry approaches, especially while foraging or transiting across ferry lanes. However, the EIA recognised that the risks to CWDs decrease as vessel speeds are reduced and therefore, any reduction in speed from 30-40 knots will reduce potential adverse impacts on CWDs.

2.2.2 Injury / Mortality from High Speed Ferries

Based upon the newly constrained stretch of marine waters between the new HKIAAA and Sha Chau and Lung Kwu Chau Marine Park (SCLKCMP) that HSFs and CWDs would have to share, and the increased risk of collision leading to serious injury and mortality for the CWDs, the issue is considered a high impact and effective mitigation measures, as detailed in **Section 2.3**, will be needed.

2.2.3 Acoustic Disturbance from High Speed Ferries

The 3RS EIA described the data presented by Sims et al. (2012) show that the HSFs of Hong Kong release a lot of noise energy into the marine environment along their travel route, with a ferry approaching at a speed greater than 20 knots at 166 m distance from the hydrophones, resulting in an overall sound pressure level of around 120 dB re. 1 μPa, with levels still being as high as 100-105 dB at a distance of

565m, in the CWD communication range of about 3 kHz and higher. CWD sounds have been measured as about 168 dB re. 1ųPa 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 a potential that fast ferries mask or restrict the range of CWD communications. It was hence concluded that the noise impacts from SkyPier HSFs on CWDs is considered to be of moderate impact significance during construction phase and of moderate-high impact significance during operation phase, requiring mitigation as detailed in **Section 2.3**.

The effects of vessel traffic on cetaceans around the world have been well documented in the past. Behavioural changes such as spatial avoidance, increase in swimming speed, changes in diving behaviour and acoustic behaviour, which could be regarded as impact, have been studied extensively in various studies (Hung, 2012). While the general idea that vessel noise affects cetaceans is well-established (Jensen et al., 2009), there is currently no published study which has investigated the impact of noise level and speed of HSF specifically on CWD behaviour. However, a number of studies as discussed below identifies that speed reduction of HSF can reduce the underwater noise level generated, and subsequently the impact on CWD communication and behaviour is anticipated to be lessened.

A recent study measured the underwater radiated noise from a high-speed jet propelled watercraft while the vessel passed at speeds of 12, 24 and 37 knots (Rudd et al., 2014). The broadband (0-22kHz) sound pressure levels of the ship at all directions (i.e. bow aspect, broadside aspect and stern aspect) decreased up to 20dB, when the speed was reduced from 37 knots to 12 knots. Evidence from the passive acoustic monitors termed Ecological Acoustic Recorders (EAR) data collected during the 3RS EIA shows comparable information. High speed ferries were tracked by the land-based theodolite station at the northeast of the HKIA, with the underwater sound simultaneously recorded by the nearest EAR Station at approximately 500 m from the existing HSF route. Sound pressure levels in the 4-8 kHz octave band (important for CWD whistle communication) proportional to HSFs speed were recorded, with each sound level calculated as a mean from 5 ferries per speed category from 6-8 knots to 26-30 knots (see **Table 2-1**). A reduction of about 60% underwater sound energy in the CWD whistle communication frequency were found by comparing of the measurement results of 26-30 knots HSF speed and that of 15 knots, and similar underwater noise reduction will be expected by slowing the HSFs from 30-40 knots to 15 knots. Therefore both literature and field data show that slowing the HSFs from 30-40 knots to 15 knots will substantially reduce the noise levels approximately by 60% underwater sound energy or 4dB so as to alleviate the acoustic disturbance to the CWDs.

Table 2-1Speed of High Speed Ferry and the Corresponding Sound Pressure Level

Speed of HSF (knots)	Sound Pressure Level (dB)*
6-8	97
11-20	99
21-25	100
26-30	103

* sound pressure levels in the 4-8 kHz octave band at an average distance of 500 m from the EAR station

A Cumulative Effects Assessment (CEA) taking data from 1996 to 2013 conducted by Marcotte et al. (2015) indicated a long-term effect of HSF traffic on CWD travelling behaviour and distribution, as operation of SkyPier HSFs was linked by these authors to reduced dolphin occurrence especially in the Brothers Islands area to the east of the existing airport, and at the same time as dolphin density within SCLKCMP increased. However, Marcotte et al. (2015) provided the appropriate caveat that their CEA is a correlational study, and does not prove cause and effect between HSFs and dolphin lowered densities.

An Australian study revealed the indirect impact of transiting boat traffic (i.e. the boats which travelled through the CWD habitat without approaching the dolphins for the purpose of viewing them) on the acoustic behaviour of CWDs (Van Parijs and Corkeron, 2001). The boats' passage did not affect the rates at which CWDs produced click trains and burst pulse vocalizations, however, CWDs significantly increased their whistling rate immediately after a boat had passed through but was still within 1.5 km from the CWD

groups. The study suggested that the noise from transiting vessels affected the CWD group cohesion, and the dolphins need to re-establish vocal contact with associates after the masking noise of the vessel had passed. In particular, mother-calf pairs produced the highest whistle rate, probably demonstrating their greater need to reassure each other of their presence. With the attenuation in noise levels associated with HSF speed reduction, it is anticipated that due to the reduction on underwater noise energy generated, the impact on CWD communication would be diminished, and the dolphins probably would not need to expend as much energy in adjusting the timing of their signals.

In addition, underwater noise shifts in loudness and pitch attendant with vessel speed changes present a particularly-strong disturbance as gear shifts are found to produce broadband (0 -35 kHz) and high-level sound (peak-peak source levels of up to 200 dB re 1µPa) of high amplitude, short-duration and reverberant nature (Jensen et al. 2009). Therefore, rapid and frequent speed changes should be avoided to reduce both disturbance to CWDs and also potential vessel/CWD collisions. The simple change in speeds (change in "closing-in distance") may also present an extra physical danger to marine mammals because of the added unpredictability of where the boat will be relative to the animals (Rudd et al. 2014). In other words, it is likely that dolphins can anticipate the imminent arrival of a vessel from the approaching noise (estimated as a distance of about 1.37 km for a HSF travelling at 40 knots; Scheer and Ritter 2013), but would be confused as to anticipation of when the boat would be above or near them by a sudden change in boat speed (see also Würsig and Evans, 2001 for a general discussion of boat operations near cetaceans).

2.3 Proposed Mitigation Measures

In the approved EIA report, route diversions to the north of SCLKCMP for SkyPier HSFs operating to / from Zhuhai and Macau were proposed to mitigate the potential impacts on CWD with HSFs using a narrower corridor between SCLKCMP and the new 3RS land formation which results in closer spacing of the vessels and less area for CWD to surface without increasing risk of being hit by HSFs. For the section of diverted route which passes through high CWD abundance grid squares, a 15-knot speed controlled zone is proposed to reduce potential adverse impacts on CWDs within these areas. The reduction in speed to 15 knots will reduce the collision risk, behavioural disturbance and also acoustic disturbance on CWD. 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. This 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 constitutes up to 60% of the HSFs) in this area.

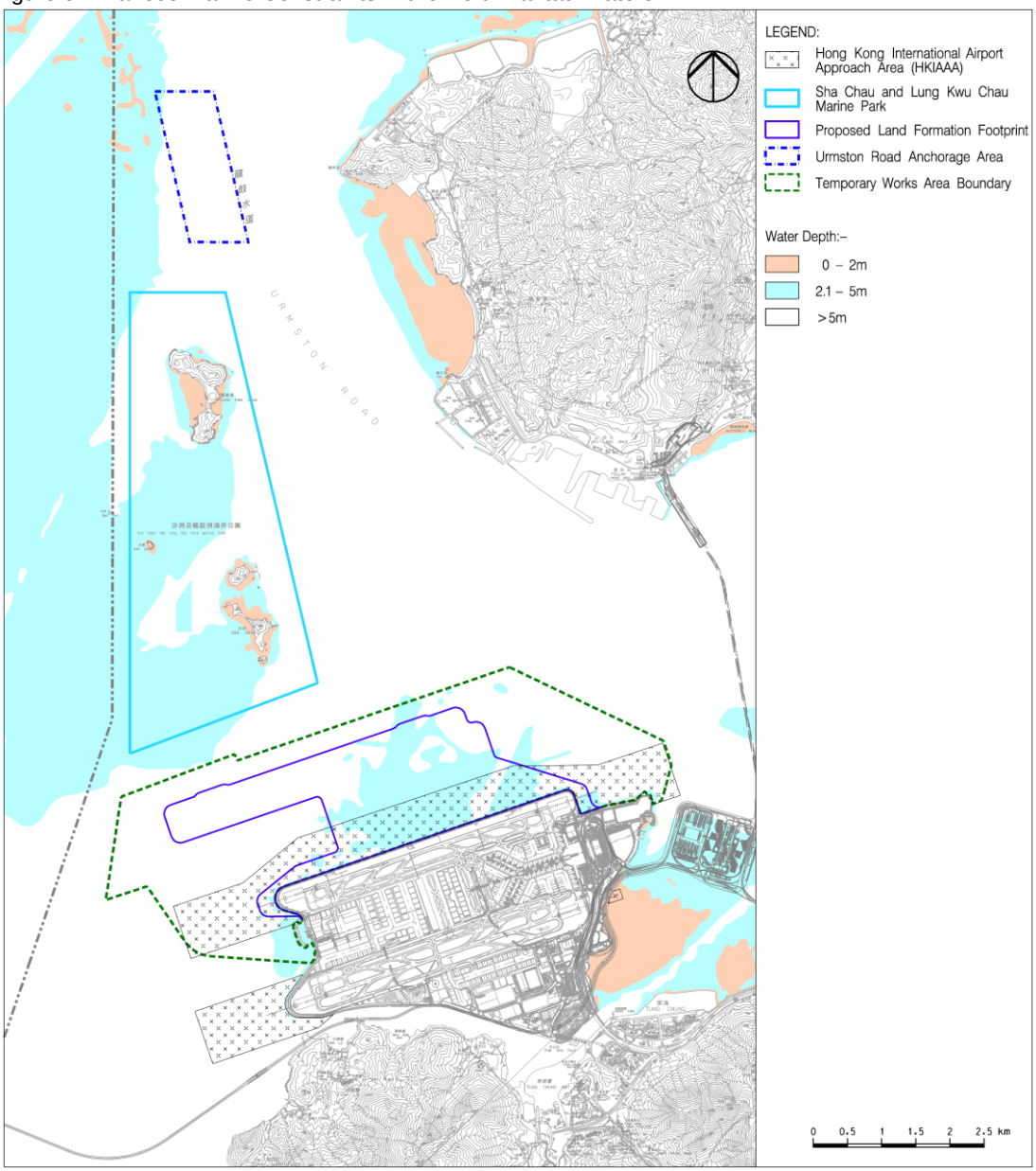
3. Design of Marine Travel Route and Speed Controlled Zone

3.1 Considerations for Setting Marine Travel Route

3.1.1 Shallow Water Zones

It is considered unsafe for HSFs (with a draft of approximately 1 - 2m) to travel in shallow water zones where water depth is less than 2m. The western and northwestern waters of Urmston Road Anchorage Area contain several shallow water zones with general water depth of less than 2 m (see **Figure 3-1**). Therefore, the diverted route of HSFs should avoid those areas due to safety concerns.

Figure 3-1 Various Marine Constraints in the North Lantau Waters



3.1.2 Hong Kong International Airport Approach Area

There are restricted areas in the vicinity of Hong Kong International Airport (i.e. HKIAAA) where vessels are not allowed to pass through without authorization. The diverted route shall avoid the HKIAAA as shown in **Figure 3-1**.

3.1.3 Other Marine Facilities

The local constraints imposed by the works area of the 3RS project or adjacent projects (e.g. the Hong Kong-Zhuhai-Macao-Bridge HKBCF/ Tuen Mun-Chek Lap Kok Link (TM-CLKL)), SCLKCMP, and other marine facilities such as the Urmston Road Anchorage (see **Figure 3-1**) shall also be considered in designing marine travel routes for SkyPier HSFs.

The proposed temporary works area of the 3RS project will be demarcated by floating booms, and the route of HSFs need to be designed to avoid entering any construction works area for safety reasons.

According to the Marine Parks Ordinance (Cap.476) and the Marine Parks and Marine Reserves Regulation (Cap. 476A), any operating vessels are not allowed to travel at speed exceeding 10 knots inside Marine Park. Besides, to minimise disturbance to the SCLKCMP, the route alignment of SkyPier HSFs shall avoid the Marine Park.

For the Urmston Road Anchorage, in view of the marine vessels that may anchor at this area, it is proposed to avoid routing the diverted route through this area due to safety concerns and potential operational impacts.

3.1.4 Ecological Concerns

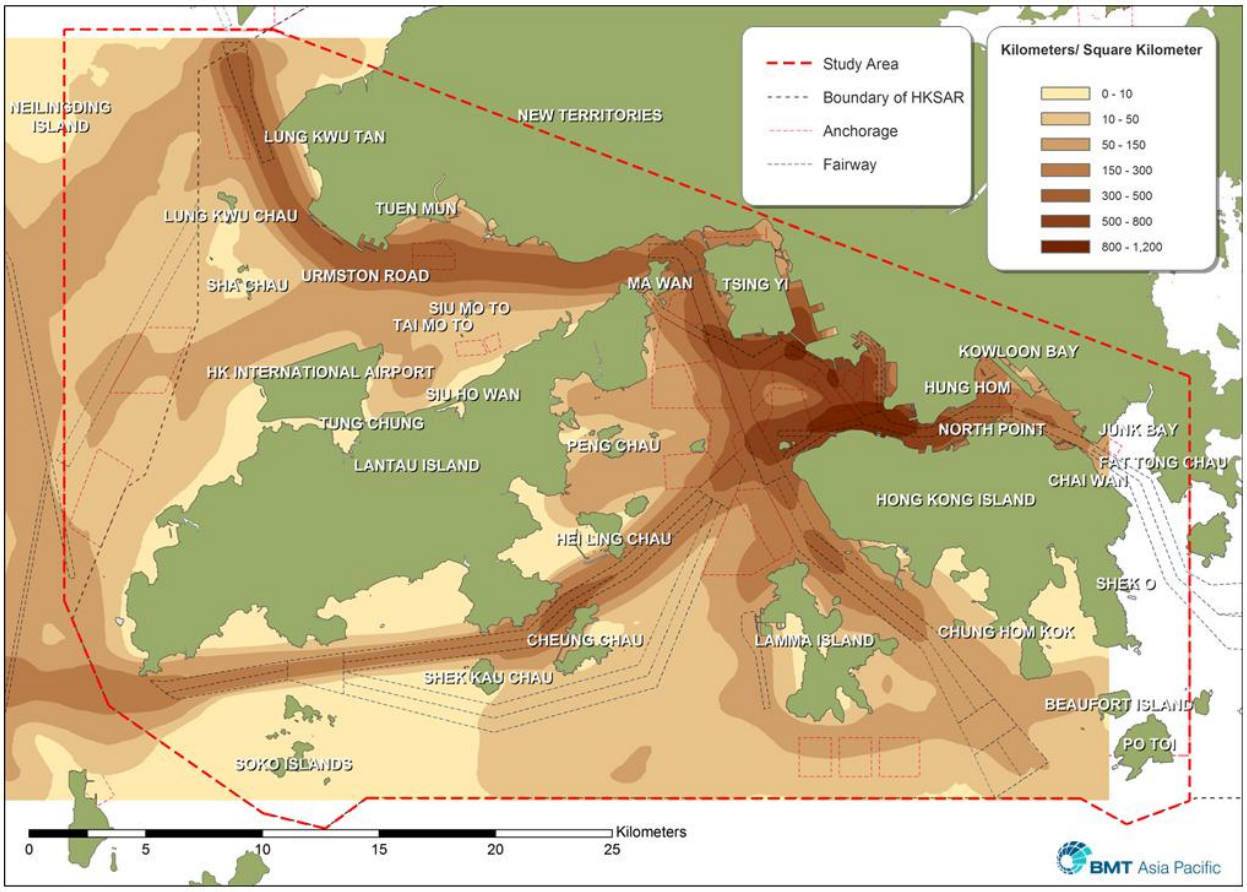
Areas with high CWD abundance (e.g. in and around Sha Chau and Lung Kwu Chau Marine Park) form another constraint to be considered during the design of the marine traffic route. As discussed in the sections above, other issues such as water depth, HKIAAA and other facilities are absolute constraints that have to be avoided due to safety concerns and potential operational impacts. However it is feasible for the diverted route to pass through areas with high CWD abundance provided that there is suitable mitigation measure (i.e. speed reduction) to minimise the impact of the HSFs on CWDs in these areas. In **Section 3.3**, a dolphin habitat rating system is developed based on recent data for designation of speed controlled zone along the proposed diverted route, which can reduce the impact on CWDs. With the provision of proper training to HSF captains that they can strictly follow the pre-defined travel route (see **Section 4.3.1**) The disturbance to dolphins (which would presumably adapt to the predictable routes) due to vessel movements would be reduced.

3.2 Design of Marine Travel Route for SkyPier HSFs Operating to / from Zhuhai and Macau

The design of proposed marine travel route for SkyPier HSFs has taken into account the various marine constraints as discussed in **Section 3.1**.

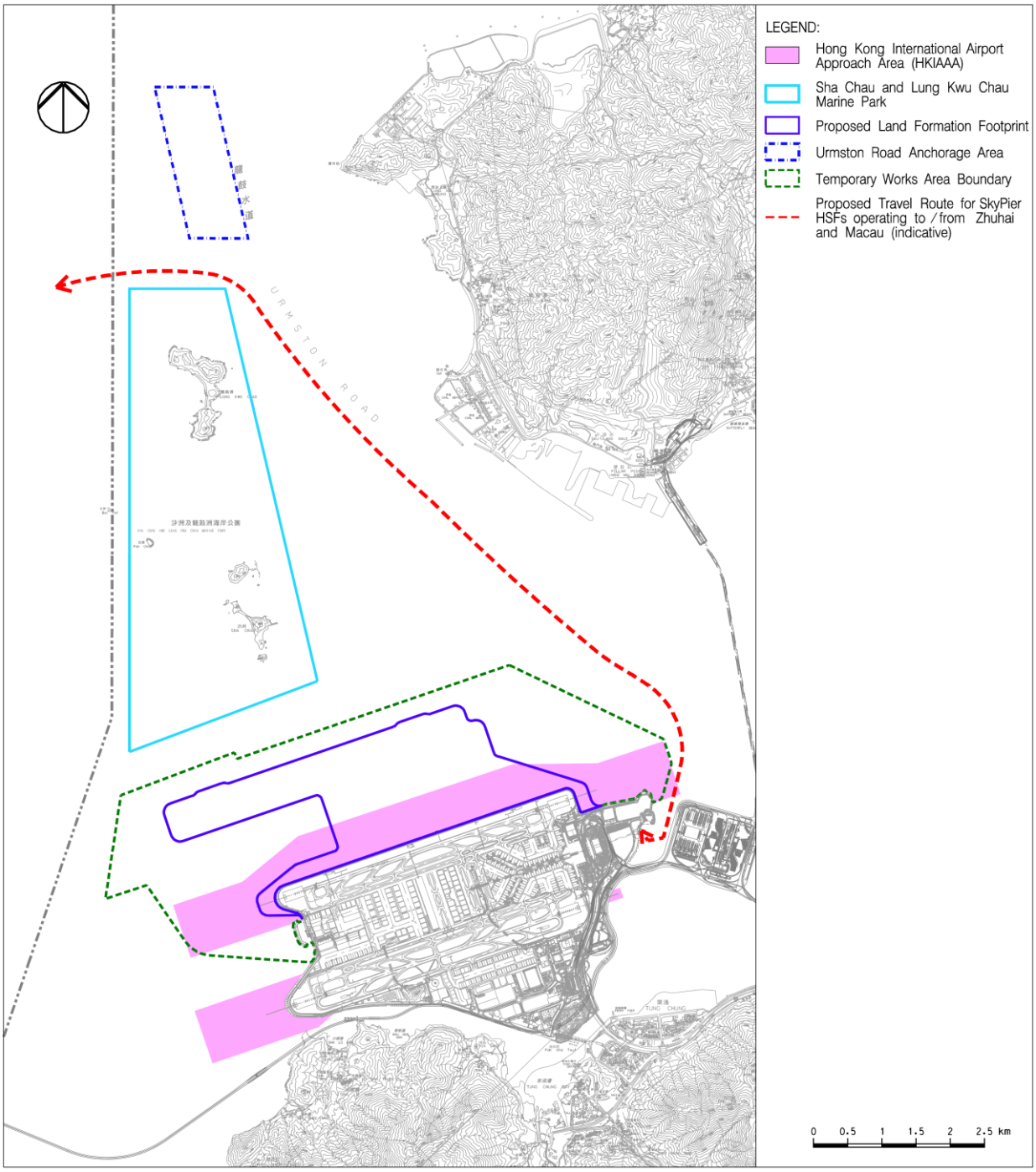
The captain shall strictly follow all navigation safety requirements and international practices. The marine travel route will be fine-tuned locally for safety reasons, taking into account other marine vessels that may be encountered. For instance, at Urmston Road where the traffic density is relatively high (see **Figure 3-2**), sudden sharp angle turning with high speed is not encouraged. The navigation route may also be affected by natural conditions such as wind, current, wave, poor visibility, extreme weather event etc.; special events such as closure of routes due to fireworks and other events; and avoidance of shallow water areas and stranded ships.

Figure 3-2 Existing Marine Traffic Plan (BMT, 2014)



An indicative diverted marine travel route for HSFs travelling between SkyPier and Zhuhai or Macau is shown in **Figure 3-3**. Upon leaving or arriving at SkyPier, the HSFs have to make a slight detour around the HKIAAA and temporary works area of the 3RS project. For the water space between HKIA and Pillar Point/ Castle Peak Power Station, sharp angle turning in high speed is avoided in Urmston Road due to safety navigation issues. In order to avoid going through the Urmston Road Anchorage and SCLKCMP, the proposed route has to pass through the channel between these two areas. As discussed in **Section 3.1.1**, it is not feasible to divert the route to north of Urmston Road Anchorage as the HSFs then have to transit through northwest and west of the Urmston Road Anchorage, which are shallow water zones with general water depth less than 2 m. Doing so would be unsafe.

Figure 3-3 Pre-defined Marine Travel Route for SkyPier HSFs operating to / from Zhuhai and Macau



3.3 Chinese White Dolphin "Hotspot" Areas

In order to determine the area to which HSF speed limits should be applied for reducing impacts on CWDs, data from the AFCD long-term surveys (see Hung 2014 for a description of these data) have been evaluated to make the best possible determination of the relative value of each 1 x 1 km grid for use in this exercise. The latest available data including the recent marine mammal monitoring report (Hung, 2015) has been taken into account for developing the dolphin habitat index.

It was decided that, in order to avoid potential biases from any single measure, a matrix of four measures of dolphin use of each grid would be used. For each 1 x 1 km grid in the potential HSF route area, four factors have been considered:

1) Current density by DPSE, i.e. the number of CWDs per 100 units of survey effort in the 1 x 1 km grid (**Figure 3-4**; from Hung 2015)
2) Historical density by DPSE (**Figure 3-5**; from Hung 2014)
3) Habitat rating (**Figure 3-6**; from Hung 2014)
4) 50% core area usage by CWDs (**Figure 3-7**; from Hung 2014)

All of these four factors are based on dolphin numbers per unit effort, but including data on the four factors helps to ensure the analysis has broad temporal and biological relevance, and minimizes impacts of potential data anomalies from using just a single factor. A matrix of the relevant data was compiled. For each 1 x 1 km grid, there are four values presented, corresponding to the four factors listed above, and for each one evaluated as "Low", "Medium" or "High" (note that these are subjective descriptive terms, though objective quantitative values for building the matrix were used). For densities (both current and historical), the corresponding values for "Low" were 0.0-20.0, 20.1-40.0 for "Medium", and 40.1 or above for "High". For habitat ratings, the corresponding values for "Low" were 0-10, 11-20 for "Medium", and 21 or above for "High". For 50% core areas, the corresponding values for "Low" were 0-10, 11-30 for "Medium", and 31 or above for "High". Relevant raw data are presented in detail in Hung (2014) and Hung (2015). The dolphin habitat index is then developed for each grid as shown in **Table 3-1**.

Table 3-1 Criteria for each 1 km^2 grid in defining the dolphin habitat index, based on the ranking of four factors (i.e. current density by DPSE, historical density by DPSE, habitat rating and 50% core area usage by CWDs)

Dolphin habitat index	Criteria
Least Critical	• 3 "Low"; or • 4 "Low"
Less Critical	• 2 "Medium" and 2 "Low"; or • 2 "Low" and 1 "Medium" and 1 "High"
Moderately Critical	• 1 "Low" and 1 "Medium" and 2 "High"; or • 1 "Low" and 2 "Medium" and 1 "High"; or • 3 "Medium"
Highly Critical	• 3 "High"; or • 4 "High"

The resulting matrix (see **Figure 3-8**) demonstrates a highly critical CWD habitat to the northeast of SCLKCMP. It is well-known that HSFs can adversely impact cetaceans, both by behavioral disturbance and ship strikes (see Van Waerebeek et al. 2007, Ritter 2010, Carrillo and Ritter 2010). SkyPier ferries can significantly reduce impacts on dolphins by slowing to 15 knots in this section of important dolphin habitat extending all the way to the HK/PRC boundary.

Figure 3-4 Current density of Chinese White Dolphins with corrected survey effort per km^2 in waters around Lantau Island between January – December 2014 (number within grids represent "DPSE" = no. of dolphins per 100 units of survey effort; from Hung, 2015). In the dolphin habitat index developed for this plan, DPSE of 0.0 – 20.0 is rated as "Low", 20.1 – 40.0 as "Medium" and 40.1 or above as "High".

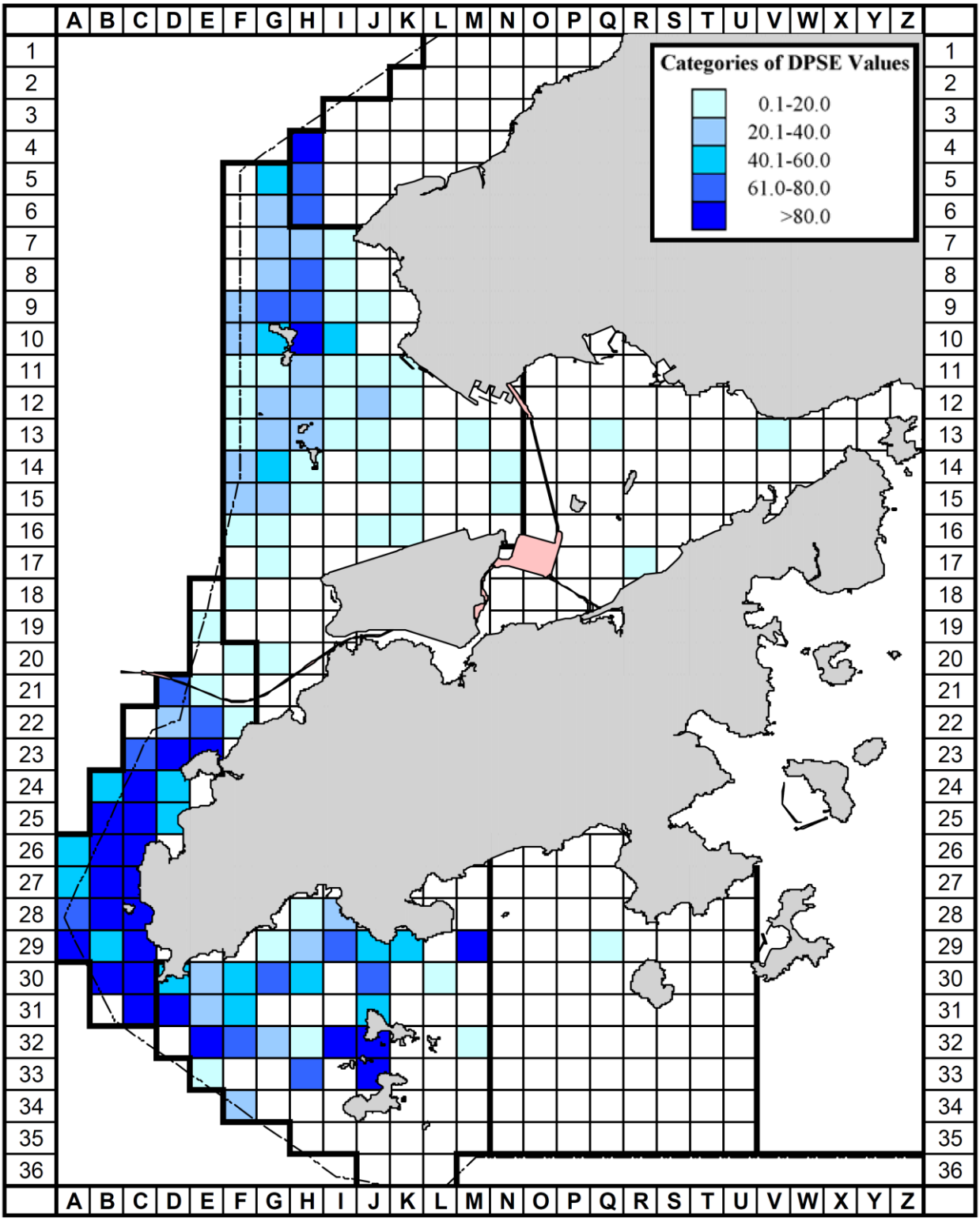


Figure 3-5 Historical density of Chinese White Dolphins with correct survey effort per km^2 in waters around Lantau Island during 2001 – 2012 (numbers within grids represent "DPSE" = no. of dolphins per 100 units of survey effort; from Hung, 2014). In the dolphin habitat index developed for this plan, DPSE of 0.0 – 20.0 is rated as "Low", 20.1 – 40.0 as "Medium" and 40.1 or above as "High"

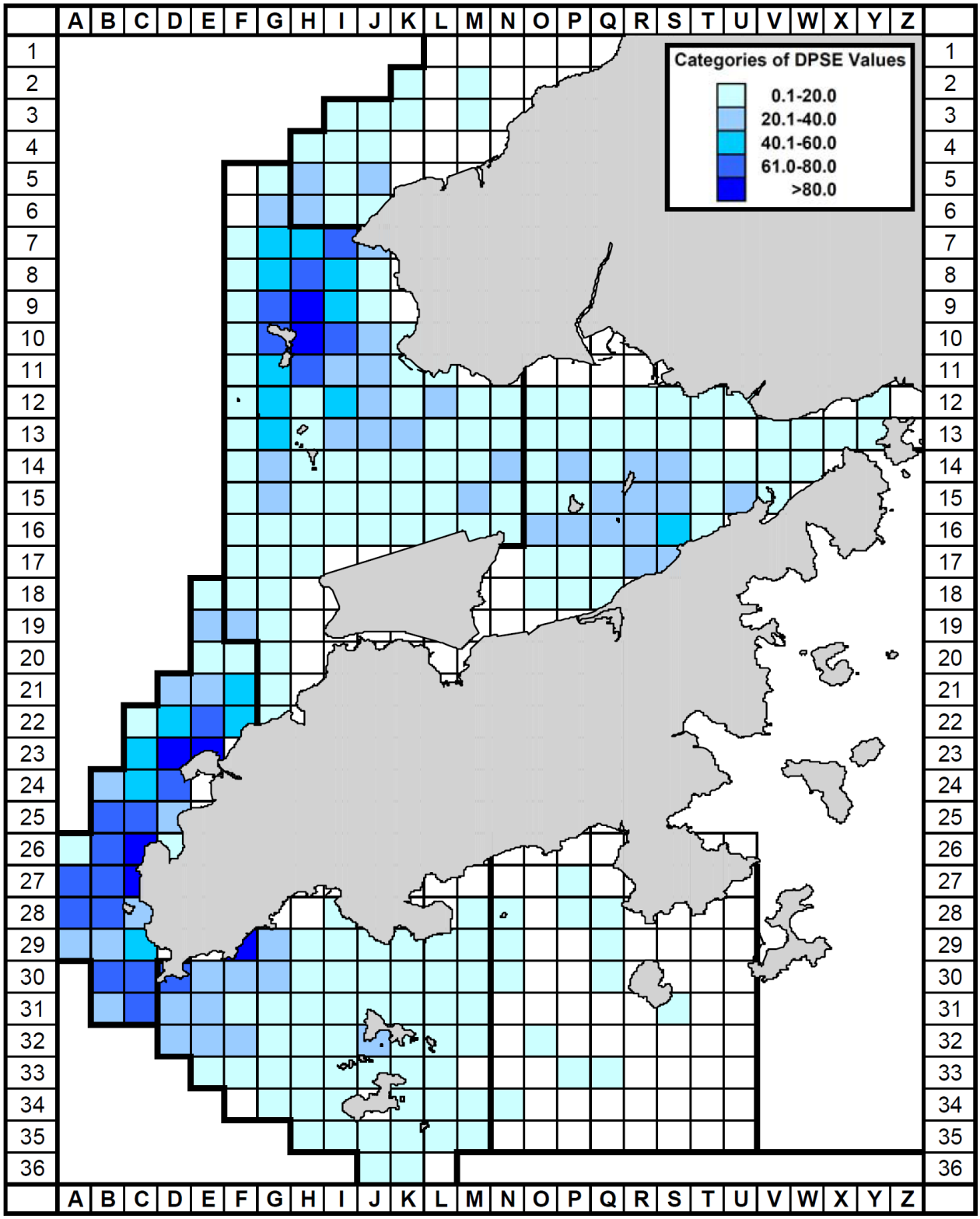


Figure 3-6 Habitat rating of Chinese White Dolphins in Hong Kong using quantitative habitat use information collected during 2001 – 2012 (number with grids represents the sum of scores totalled from 10 selection criteria; from Hung, 2014). In the dolphin habitat index developed for this plan, habitat rating of 0 – 10 is rated as "Low", 11 – 20 as "Medium", and 21 or above as "High"

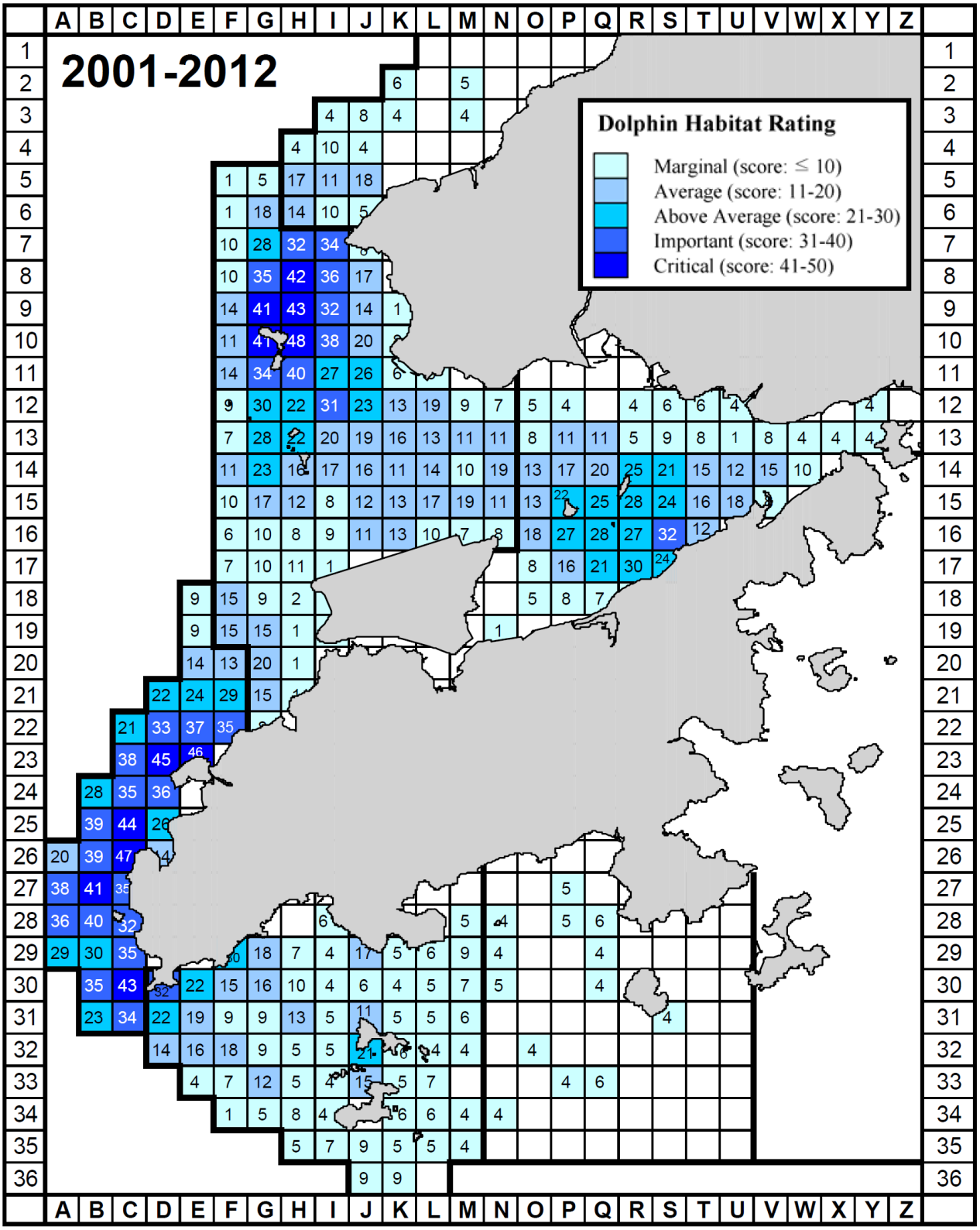


Figure 3-7 Number of individual Chinese White Dolphins with their 50% utilization distribution (UD) core areas overlapped with each 1 km^2 grid in waters around Lantau Island from 2001 – 2012 (Hung, 2014). In the dolphin habitat index developed for this plan, 50% core area of 0-10 is rated as “Low”, 11-30 as “Medium”, and 31 or above as “High”

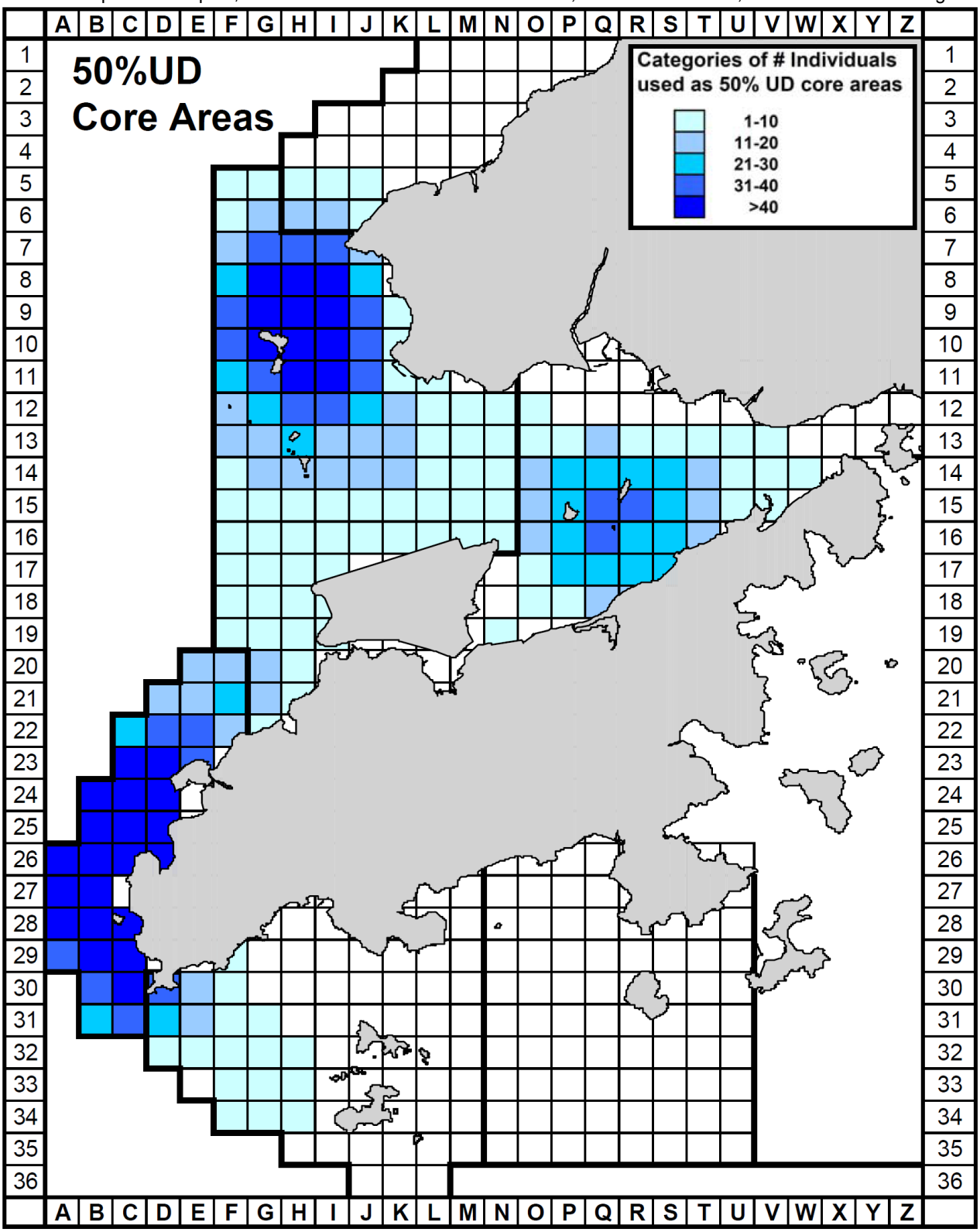
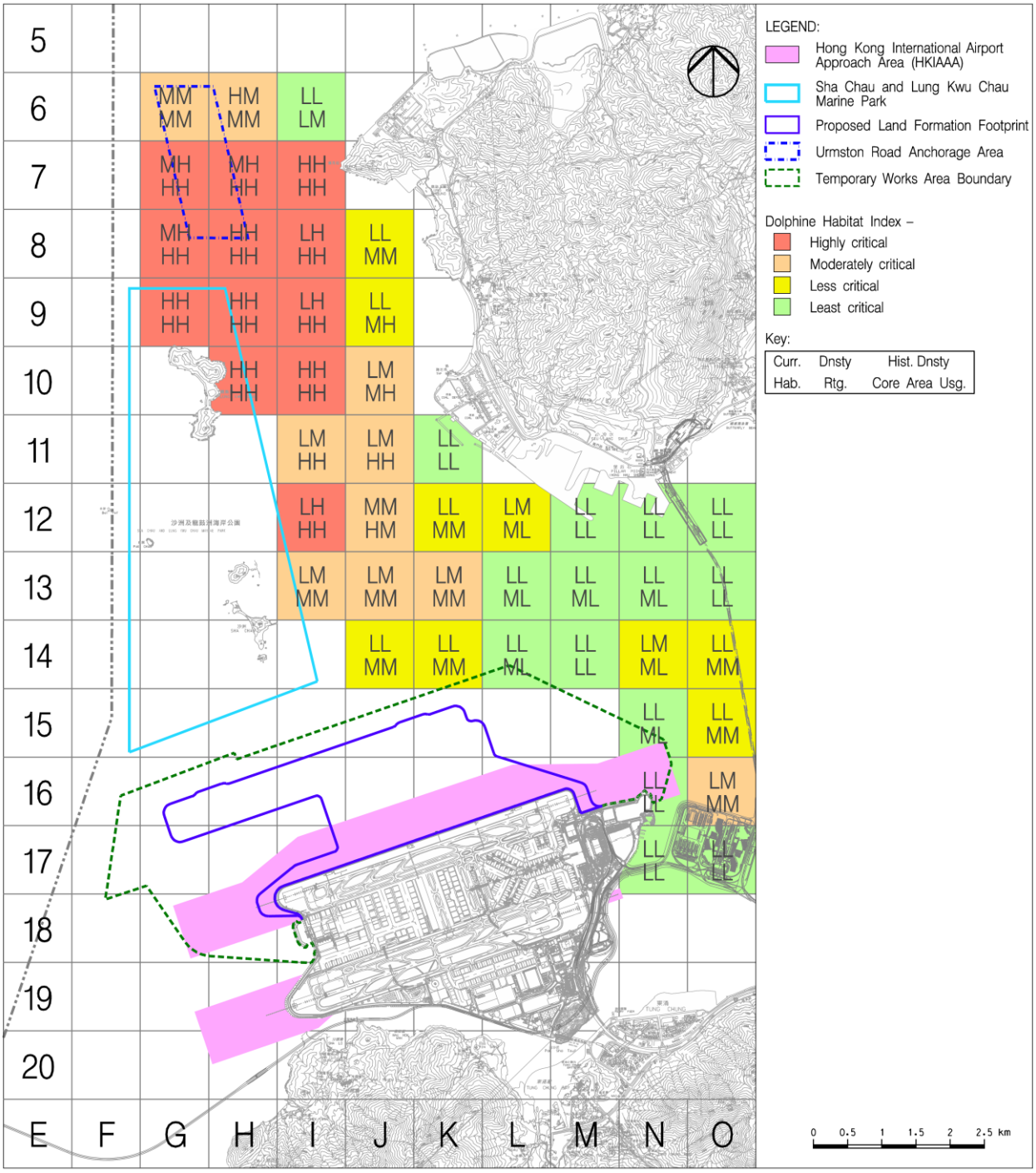


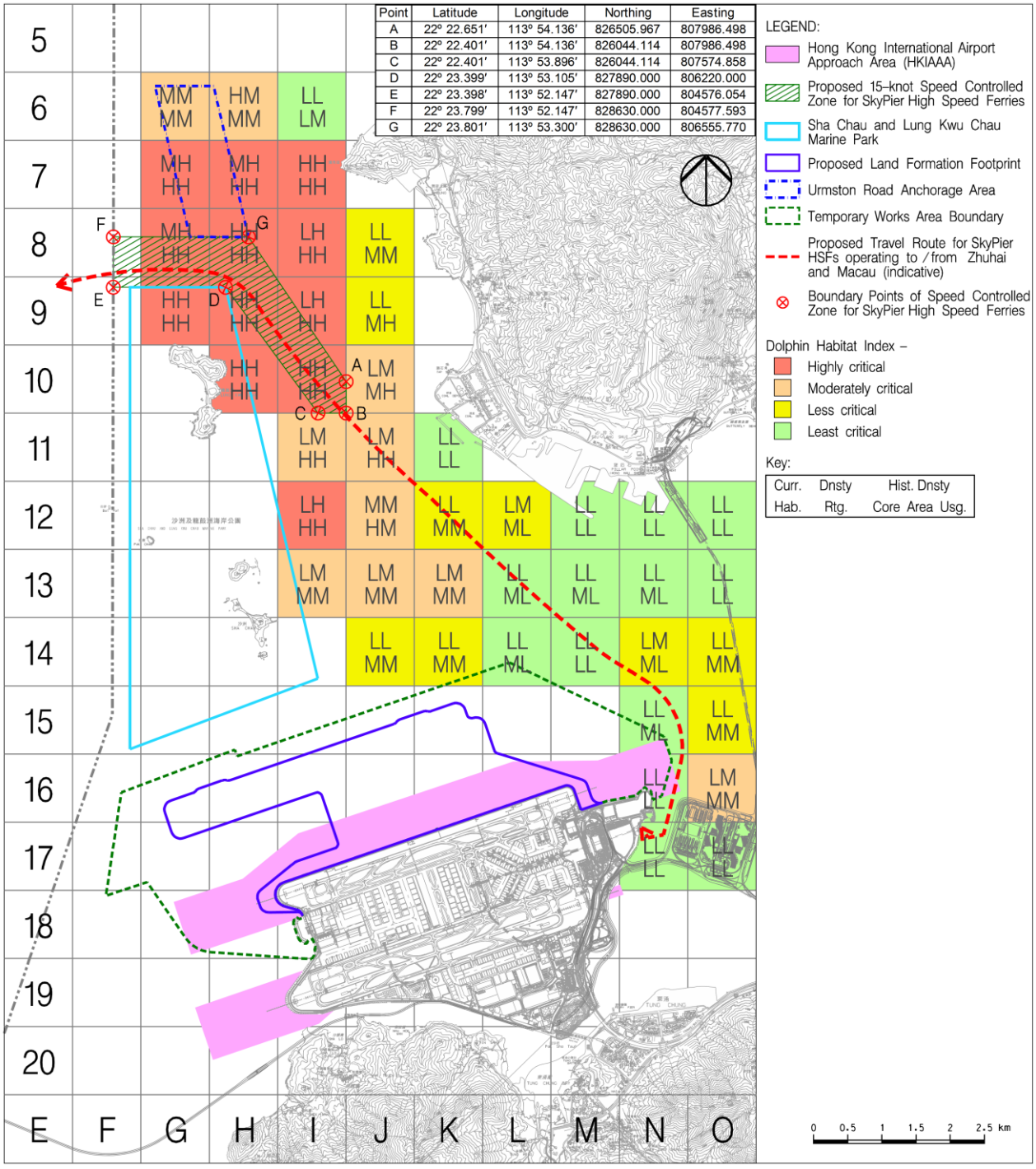
Figure 3-8 Dolphin Habitat Index Developed for this Plan



3.4 Design of Speed Controlled Zone for SkyPier HSFs

The indicative diverted marine travel route in **Section 3.2** is overlaid with the Dolphin Habitat Index developed in **Section 3.3** to determine the location of speed controlled zone (SCZ) along the route. The proposed marine travel route together with the 15-knot SCZ is shown in **Figure 3-9**.

Figure 3-9 Speed Controlled Zone for SkyPier HSFs

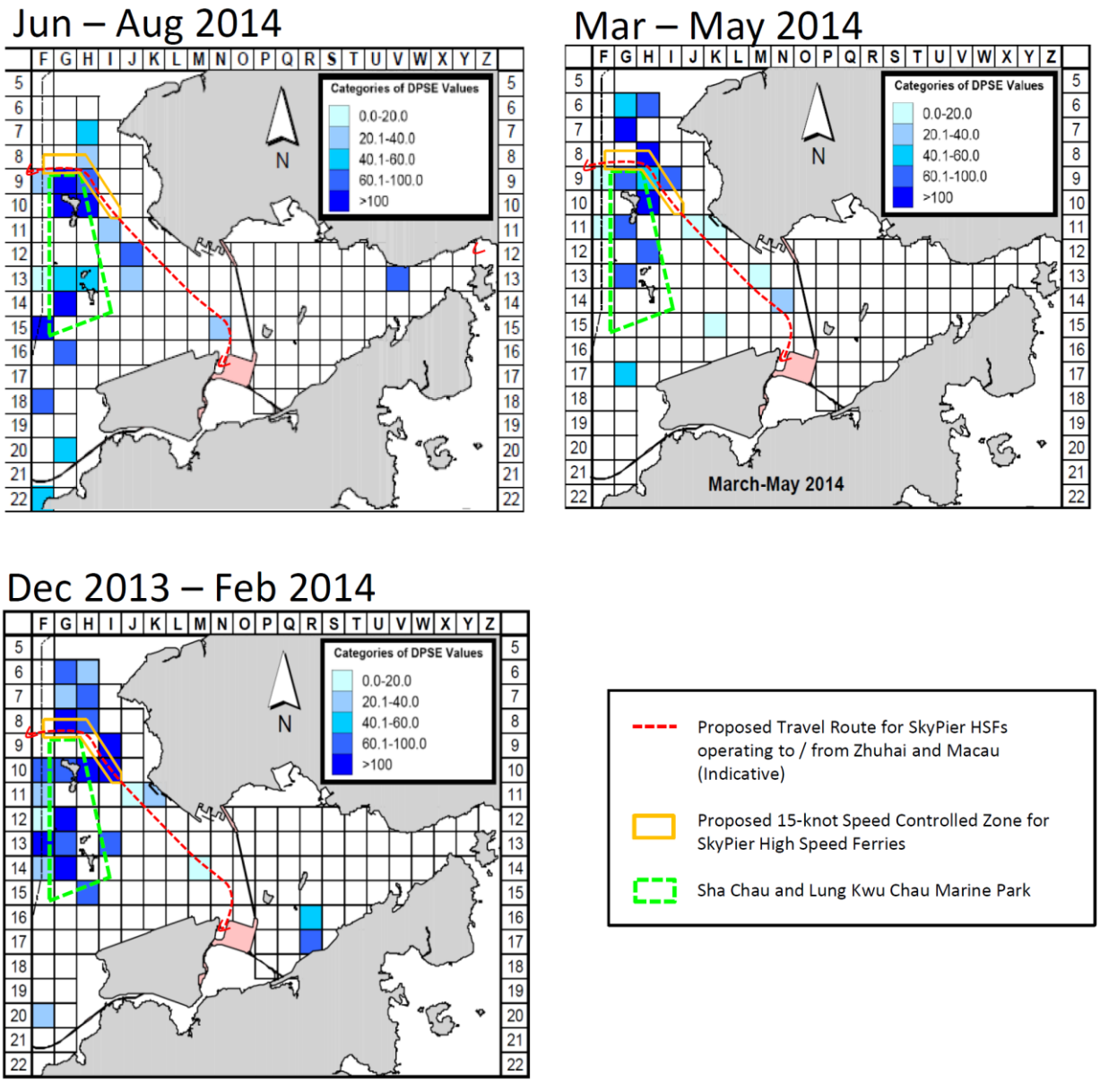


As illustrated in **Figure 3-9**, for the waterspace between HKIA and Pillar Point/ Castle Peak Power Station, the route shall mainly transit through the "Least Critical" dolphin habitat grids. When leaving and/ or approaching the SkyPier terminal at the HKIA, ferries should gradually increase and/ or decrease speed. On approaching the "Highly Critical" dolphin habitat grids around SCLKCMP, they are required to enter a defined 15-knot SCZ at the north and northeast of SCLKCMP. They are required to enter and/ or leave the SCZ through Gates A-B-C and E-F (see **Figure 3-9**), hence their movement through the "Highly Critical" dolphin habitat is restricted, which would minimise their chances of encounter with CWDs (and may allow dolphins to habituate to these predictable routes). When travelling through the SCZ, they must adhere to the speed limit of 15 knots, and as such they have to decelerate gradually before entering the SCZ, and can only increase the speed to over 15 knots upon leaving the SCZ gradually to avoid rapid speed changes. As mentioned in **Section 2.2.3**, rapid and frequent speed changes should be avoided to reduce

both disturbance to CWDs and also potential vessel / CWD collisions, and it will be communicated to HSF captains during the skipper training workshops that they need to reduce speed gradually reaching 15 knots or less before entering the SCZ, and increase speed gradually also upon leaving the SCZ. 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.

The CWD density grids from the Hong Kong-Zhuhai-Macao Bridge Hong Kong Link Road Environmental Monitoring & Audit (EM&A) reports have also been reviewed. As these data only cover short survey periods and there is no annual data available, they were not used in the establishment of the habitat rating index in **Section 3.3**. However, these data provide further support on the design of the marine travel route and SCZ. Results of EM&A reports show that all grids with high CWD density pass through by the proposed travel route are covered by the proposed 15-knot SCZ. Besides, the section of marine travel route with no speed restriction generally crosses grids with no or low CWD density (see **Figure 3-10**). The latest CWD data from HZMB EM&A are consistent with the habitat rating index and support the design of the marine travel route and 15-knot SCZ.

Figure 3-10 Density of Chinese white dolphins from HZMB-HKLR Monitoring Reports



The EIA projected continued growth in SkyPier HSF traffic up to 2030 (to approximately 130 annual average daily HSF movements) and impact assessments were based on these increasing traffic levels. Even taking into account traffic growth, the EIA determined that the route diversion and speed control zone proposed would be able to reduce impacts from HSFs to acceptable levels in affected marine waters. Further to receiving feedback on this aspect during the EIA public comment period, AAHK has committed to an additional precautionary measure of capping SkyPier HSF movements based on historic operations data (i.e. an annual daily average of 99 movements), this to be effective in the period before designation of the proposed marine park.

During the main ACE and ACE EIA Sub-committee discussions on the 3RS EIA, members also recommended that AAHK should further explore the feasibility of imposing a maximum daily cap on the number of HSF leaving the SkyPier and imposing further speed restrictions at different spots along the diverted marine route after detailed study. Although the EP specifies exploring the feasibility of the daily cap for HSFs leaving the SkyPier, the annual daily average cap of 99 and the maximum daily cap being proposed in this plan refer to HSF movements at SkyPier. One movement comprises a SkyPier departure or an arrival.

3.5 Daily Cap on HSF Numbers

As required in the EP, AAHK will cap the SkyPier HSF movements at an annual daily average of 99 prior to designation of the proposed marine park in addition to the route diversion and speed restrictions in high-density CWD areas. The commitment to an annual daily average of 99 SkyPier HSF movements has taken into account a number of operational considerations, for example expected seasonal fluctuations above and below the annual daily average and to allow some capacity for operations recovery after inclement weather events (e.g. typhoons) and expected peak demand periods during any year, for example Lunar New Year or the Golden Week holiday when very high traffic demand is expected. A further maximum daily movement cap has been explored. It is recognised that imposing an absolute cap on maximum daily movements at SkyPier may present a significant operational challenge in particular during busy periods each year for example the golden week holiday or to accommodate HSF service recovery in the aftermath of inclement weather events. In order to establish a reasonable maximum daily capping commitment, scheduled and actual HSF movements at SkyPier since 2010 have been reviewed.

The history of SkyPier HSF movements since 2010 shows that actual daily HSF movements only vary up and down slightly (within +/- 5 movements) from the annual average daily movements for the vast majority of days in any year. Yet there are rare occasions over this period when larger fluctuations have been experienced and these had to be handled. During this period the highest number of scheduled movements in any one day was 123, although actual movements on the day in question were a little below this. Over the period since 2010, days with HSF movements above 110 totalled less than 30. Thus, in order to allow similar levels of flexibility for SkyPier HSF operators as has previously been possible it is proposed to adopt 125 movements as the maximum daily movement cap in conjunction with the overall commitment to 99 annual daily average HSF movements. Setting this target will provide operational flexibility for handling any unexpected and rare operational challenges. It is again stressed that the proposal for a maximum daily cap of 125 movements does not alter the main commitment to 99 annual daily average HSF movements.

In order to ensure that the annual daily average HSF movements can be kept within the target of 99 per day – or 36,135 movements during one whole year (with 365 calendar days) - AAHK intends to work closely with SkyPier HSF Operators to ensure that during ‘normal’ operations, daily movements are slightly below the 99 target such that a buffer of extra movement slots develops that balances both the expected days when several extra movements above the 99 target will be experienced and to offset the very rare peak service days when more than 110 movements may need to be handled by HSF operators.

The annual daily average limit and the maximum daily movement cap would be implemented from the start of construction and will be in effect during the period before designation of the proposed Marine Park.

3.6 Imposing Further Speed Restrictions

The current route diversions and speed controlled zones as proposed in this plan represent the full extent of the proposed route diversion and speed control mitigation measures at this stage. With the proposed route diversion, the SkyPier HSFs are prohibited from entering the Marine Prohibited Zone as defined in **Figure 3-11**. This Marine Prohibited Zone is developed based on the dolphin protection area proposed during the construction phase in response to the ACE comments, within which there is stringent management control on SkyPier HSFs. This Marine Prohibited Zone covers much of the "Moderately Critical" and "Highly Critical" dolphin habitats that are in the vicinity of the proposed route alignment for diverted HSFs, and hence serve to protect these areas from disturbances by the HSFs.

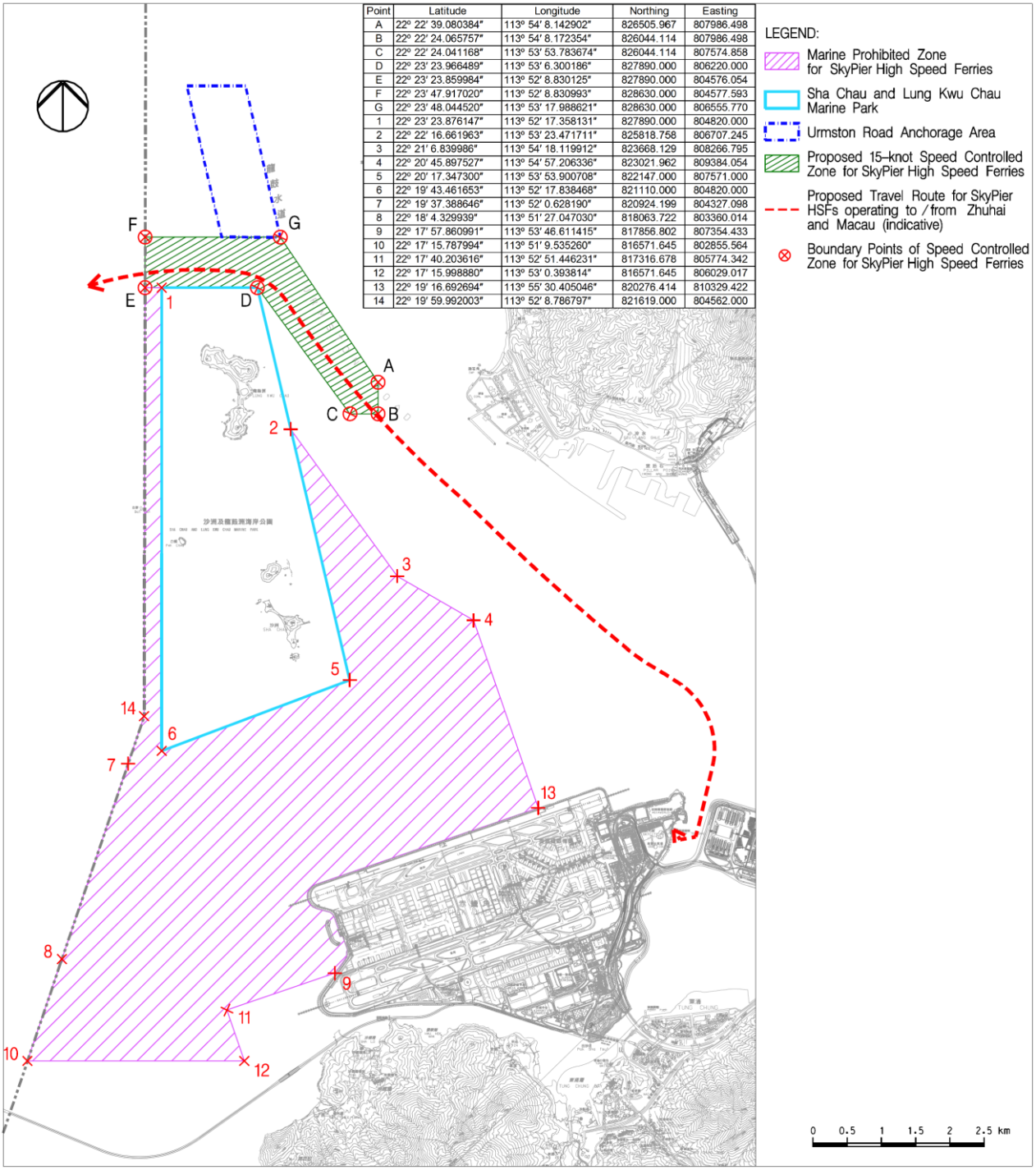
The route alignment for diverted HSFs within Hong Kong boundary will not encounter "Highly Critical" dolphin habitat grids except inside the SCZ as proposed in **Section 3.4** where a 15-knot speed restriction shall apply (most of the remaining diverted route falls in least or less critical dolphin habitat index areas). It has been established through both literature review and field data that slowing HSFs from 30-40 knots to 15 knots can substantially reduce the noise levels by approximately 60% (underwater sound energy) or 4dB thereby alleviating acoustic disturbance to CWDs. However, gear shifts are found to produce broadband (0-35 kHz) and high-level sound (peak-peak source levels of up to 200 dB re 1μPa) of high-amplitude, short-duration and reverberant nature, and as such it is recommended that frequent and rapid HSF speed changes (requiring gear shifts) should be avoided if possible. When entering and leaving the SCZ, it is recommended that HSFs should reduce speed gradually to 15 knots or less before entering the SCZ, increasing speed gradually on leaving the SCZ. Because frequent speed changes with more gear shifts can result in higher disturbance to CWDs, the imposition of further speed restrictions on any additional sections along the pre-defined travel route between SkyPier and the entrance gate to the SCZ may be counterproductive during the construction phase, The gradual deceleration of HSFs before entering the SCZ and gradual acceleration after leaving the SCZ is expected to be effective in further minimising disturbance to CWDs and hence further speed restriction zones along the relatively short travel route between SkyPier and the SCZ are not recommended.

With the precautionary measures as described in **Section 4.3** in place, potential impacts of SkyPier HSFs on CWDs could be further reduced.

It is recognised that the density and hence the habitat index of CWDs is dynamic and will change over time. As 3RS marine construction works are expected to be underway for a number of years, it is proposed that the Environmental Team shall review the density and habitat index from time to time during the construction period and make suggestions on appropriate changes / alterations to what is defined in this plan based on identified changes (for example to be adopted in new agreements with Ferry Operators using SkyPier.

In the operation phase, 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.

Figure 3-11 Marine Prohibited Zone for SkyPier HSFs



Point	Latitude	Longitude	Northing	Easting
A	22° 22′ 39.080384″	113° 54′ 8.142902″	826505.967	807986.498
B	22° 22′ 24.065757″	113° 54′ 8.172354″	826044.114	807986.498
C	22° 22′ 24.041168″	113° 53′ 53.783674″	826044.114	807574.858
D	22° 23′ 23.966489″	113° 53′ 6.300186″	827890.000	806220.000
E	22° 23′ 23.859984″	113° 52′ 8.830125″	827890.000	804576.054
F	22° 23′ 47.917020″	113° 52′ 8.830993″	828630.000	804577.593
G	22° 23′ 48.044520″	113° 53′ 17.988621″	828630.000	806555.770
1	22° 23′ 23.876147″	113° 52′ 17.358131″	827890.000	804820.000
2	22° 22′ 16.661963″	113° 53′ 23.471711″	825818.758	806707.245
3	22° 21′ 6.839986″	113° 54′ 18.119912″	823668.129	808266.795
4	22° 20′ 45.897527″	113° 54′ 57.206336″	823021.962	809384.054
5	22° 20′ 17.347300″	113° 53′ 53.900708″	822147.000	807571.000
6	22° 19′ 43.461653″	113° 52′ 17.838468″	821110.000	804820.000
7	22° 19′ 37.388646″	113° 52′ 0.628190″	820924.199	804327.098
8	22° 18′ 4.329939″	113° 51′ 27.047030″	818063.722	803360.014
9	22° 17′ 57.860991″	113° 53′ 46.611415″	817856.802	807354.433
10	22° 17′ 15.787994″	113° 51′ 9.535260″	816571.645	802855.564
11	22° 17′ 40.203616″	113° 52′ 51.446231″	817316.678	805774.342
12	22° 17′ 15.998880″	113° 53′ 0.393814″	816571.645	806029.017
13	22° 19′ 16.692694″	113° 55′ 30.405046″	820276.414	810329.422
14	22° 19′ 59.992003″	113° 52′ 8.786797″	821619.000	804562.000

4. Implementation and Monitoring

4.1 Implementation

The proposed route diversions and speed controlled zones will be implemented by AAHK and the SkyPier Ferry Operators (FOs) for both construction and operation phases. The FOs will be required to track compliance regularly and this will be specified in the supplemental agreement to ensure FOs follow all agreed restrictions. In the operation phase, 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.

In addition, AAHK and the SkyPier FOs will cap the number of SkyPier HSF at an annual daily average of 99 prior to designation of the proposed marine park.

4.2 Method of Implementation and Monitoring

The requirements in **Section 3** will be specified in a 'supplemental agreement' with the Ferry Handling Agent for all SkyPier FOs. The following management commitments and requirements that are relevant to the implementation of the proposed route diversion and speed control section shall be stipulated in the supplemental agreements to the existing Ferry Operator agreements and will be included in future FO agreements:

- All HSFs using the diverted route shall install and operate GPS receivers / AIS transponders to facilitate accurate route tracking and record keeping;
- Ferry Operators shall provide information on the number and type of ferry taking the diverted route for AAHK to verify on a monthly basis;
- Any non-compliance with the requirements and arrangements for diversion and speed control shall initially result in warnings to operators, with any repeated non-compliance leading to suspension of that particular movement until submission of report explaining the reason of non-compliance with preventive measures in place to the satisfaction of the AAHK.
- Vessel captain may decide to deviate from the proposed route in response to an emergency or in the interest of public safety, e.g. in case of adverse sea conditions. The ferry operators have to provide valid reasons to AAHK for such case or otherwise the non-compliance shall lead to warnings or suspension as indicated above.

The ET will audit the actual numbers of HSFs operating from SkyPier and the implementation of the SkyPier high speed ferries' speed and routing restrictions in accordance with this Plan and the 3RS EM&A Manual.

In addition, all ferry operators shall comply with the relevant international conventions, and local regulations and requirements of the Marine Department, including:

- Merchant Shipping (Local Vessels) Ordinance, Cap 548;
- The International Regulations for Preventing Collisions at Sea 1972;
- The Shipping and Port Control Ordinance (Cap 313);

- The Shipping and Port Control Regulations (Cap 313A); and
- The Merchant Shipping (Launches and Ferry Vessels) Regulations (Cap 313E)

4.3 Precautionary Measures for High Speed Ferry

4.3.1 Skipper Workshops

Under the Marine Ecology and Fisheries Enhancement Plan which was submitted to the ACE in August 2014, AAHK proposed to fund and support initiatives in promoting environmental education and eco-tourism in relation to the marine ecological and fisheries resources in the North Lantau coast and Northwest Lantau waters. One of the proposed initiatives was to develop and conduct skipper workshops to alert HSF captains / drivers on the risk of collisions with CWDs and Finless Porpoises, and ways of reducing such risks.

During the workshop, the following information would be included:

- General education on local cetaceans;
- Guidelines for avoiding adverse water quality impact; and
- Guidelines for operating vessels safely in the presence of CWD.

In addition, several precautionary measures are recommended to HSF operators for the route to / from Zhuhai and Macau:

- Ensure that all captains of HSF are well trained so that they can strictly follow the pre-defined travel route and speed restriction rules;
- The vessel captains should make sure that there is sufficient distance for slowing down prior to passing CWD hotspots and take action to avoid collision; and
- Vessel captains need to make sure that all reasonable efforts (within safety parameters) are taken to minimise the risk and disturbance to CWDs along the whole route, not just within the speed controlled zone.

5. Conclusion

This Plan has been developed pursuant to 3RS Project Environmental Permit (EP-489/2014) Clause 2.10 requirements. The 3RS Project EIA made a commitment that, from the start of construction, 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 areas.

The design and alignment of the marine travel route for the diverting HSFs has taken into account a number of marine constraints. Recently available data from AFCD long-term surveys has been evaluated to determine a Dolphin Habitat Index (DHI) for North Lantau Waters, allowing further differentiation on the value of different habitat areas to CWDs. A speed limit of 15 knots is proposed for the section of the diverted marine travel route that corresponds with 'highly critical' dolphin habitat (i.e. a speed control zone).

AAHK is firmly committed to ensuring that an annual daily average of 99 SkyPier HSF movements is not exceeded prior to designation of the proposed Marine Park. AAHK will ensure that HSF movements are kept within the annual daily average target of 99 per day – or 36,135 movements during each year (with 365 calendar days). Given the actual history of SkyPier HSF movements since 2010 and to provide reasonable operational flexibility for handling unexpected and rare operational challenges in future years, AAHK has proposed 125 as the maximum allowable movement number for any day, recognising that days with HSF movements of more than 110 totalled less than 30 since 2010. The annual daily average limit and the maximum daily movement cap would be implemented from the start of construction and will be in effect during the period before designation of the proposed Marine Park.

Additional sections of speed control have been evaluated, however the remainder of the diverted route alignment in Hong Kong waters falls largely in least or less critical DHI areas and in these areas there is support that further HSF speed changes may result in higher underwater noise impact / nuisance to CWDs; HSFs will however be recommended to reduce speed / speed up gradually when entering / leaving the speed control zone.

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