8 MARINE ECOLOGY

8.1 INTRODUCTION

8.1.1 This chapter assess the impacts of the Project upon intertidal ecology and subtidal ecology including coral communities.

8.1.2 Ecological surveys were conducted in February and June of 2003 representing dry and wet seasons, respectively. The results collected from these surveys served as supplement information to ecological data collected at other pertinent ecological studies in the area. A detailed assessment on marine ecology are carried out based on these combined baseline conditions.

8.2 RELEVANT LEGISLATION, POLICIES, PLANS, STANDARD AND CRITERIA

8.2.1 HKSAR Government ordinances and regulations relevant to this assessment include the following:

- The Wild Animals Protection Ordinance (Cap. 170);
- The Animals and Plants (Protection of Endangered Species) Ordinance (Cap. 187);
- The Environmental Impact Assessment Ordinance (Cap. 499) and the associated Technical Memorandum on Environmental Impact Assessment Process (TMEIAP), Annexes 8 and 16.

8.2.2 This study also makes reference to the following standards, guidelines and other documents of the HKSAR Government:

- Hong Kong Planning Standards and Guidelines (HKPSG) Chapter 10, "Conservation", which provides guidelines on incorporating nature conservation objectives into landuse planning and new development;
- PELB Technical Circular 1/97 / Works Branch Technical Circular 4/97, "Guidelines for Implementing the Policy on Off-site Ecological Mitigation Measures" ("the TC"), which sets out guidelines for implementation of Government policy on ecological mitigation, particularly off-site mitigation;
- EIAO Guidance Note No. 6/2002, "Some Observations on Ecological Assessment from the Environmental Impact Assessment Ordinance Perspective", dated January 2002, AFCD in conjunction with EPD; and
- EIAO Guidance Note No. 7/2002, "Ecological Baseline Survey for Ecological Assessment", dated January 2002, Nature Conservation & Marine Conservation Divisions, AFCD in conjunction with EPD.

8.2.3 Attention is also drawn to the commitments of the Convention of Biological Diversity.

8.3 BASELINE CONDITIONS

8.3.1 The baseline marine ecological conditions are established based on review of literatures on the marine ecology and the marine ecological surveys conducted specifically for this project in the vicinity of Peng Chau and Tai Lei Island.

Studies Conducted Prior to Project Commencement

Benthic Community

8.3.2 The following studies were reviewed to provide baseline information on benthic communities in the vicinity of Peng Chau.

- Benthic surveys were previously undertaken at two locations off the western coastline of Tai Lei during August 1996 as part of Outlying Islands Sewerage Stage 1 Phase 1 – EIA Study (Maunsell, 1997). The sampling locations are shown in **Figure 8-1**. Large variability was evident during the sampling event. Replicate samples collected at the first location were dominated by shell fragments, whereas replicates collected from the second location were dominated by fine mud and silt. Little substrate was retained in the sieves.

  The total number of individuals recorded per m^2 at the two locations was 24 and 9, respectively. One species of sea pen (Pteroeides), eleven species of Polychaete, one Corophida species, three species of Amphipoda, one shrimp species and one species of sea urchin were recorded. The most abundant polychaete family recorded was Hesionidae; however all the polychaete families were represented by few individuals. Diversity and evenness indices were 2.68 and 1.98, and 0.17 and 0.28, respectively at the two locations.

- A comprehensive survey of the benthos of Hong Kong was undertaken by Shin and Thompson. This survey included 200 sampling stations from which 5 replicate grabs were taken. This study also looked at particle size distributions of sediments to look at habitat characteristics. No sampling locations were located in close vicinity to Peng Chau. However samples were collected east of Peng Chau. The surveys found that sediments east of Peng Chau contained <80% silt-clay.

  The data collected by Shin and Thompson were classified using the Bray-Curtis similarity level, which sorted the 200 stations into 5 groups. The area east of Peng Chau fell into a category called west-central Hong Kong where the mean silt content was 77.2%. This group comprised 64 of the 200 stations. The polychaetes *Aglaophamus lyrochaeta, Nephtys* sp. and *Tharyx* sp. dominated the samples within this category and overall these were some of the commonest species found throughout Hong Kong. Shin cited many benthic studies around the world showing polychaete composition to be mostly influenced by sediment grain size with increasing diversity associated with coarser sediments although his own study in Hong Kong did not find any strong correlation for this.

  A territory wide study of the benthos of Hong Kong was recently completed. The results are documented in the Final Report of Marine Benthic Communities in Hong Kong (AFCD, 2002). The study included 120 sampling stations from which

5 replicate grabs were taken. Three of the sampling stations were located in the vicinity of Peng Chau (stations 44 , 45, and 47), shown in **Figure 8-2**. Station 44 is located closest to the stations sampled for the current study. The median diameter of sediment particle size collected at the 3 stations ranged between 4.94 – 6.18 MDΦ indicating that sediment at the three sites was generally dominated by fine sand. A summary of the benthic data for the three stations is provided in **Table 8-1**.

Table 8-1 Benthic Data Summary

Variable	Site					
	44		45		47	
	Summer	Winter	Summer	Winter	Summer	Winter
Abundance	56	130	136	76	44	50
# Taxa	17	20	24	18	10	15
MDΦ	5.61 (very fine sand)	4.94 (very fine sand)	4.98 (very fine sand)	5.00 (very fine sand)	6.19 (very fine sand)	6.18 (very fine sand)

Of the three stations, abundance and diversity were lowest at Station 47, and highest at station 45.

The study delineated five station groups from the 120 stations sampled based on benthic assemblages. The three stations located in the vicinity of Peng Chau were grouped together with the majority of the sampling stations in Hong Kong waters. The group was represented by polychaetes (eg *Mediomastus* sp., *Aglaophamus dibranchis*, *Cossurella dimorpha* and *Sigambra* sp.), the echinoderm *Amphipodia obtecta*, crustaceans (*Callianassa japonica* and *Neoxenophthalmus obscurus*), and the sipunculan (*Apionsoma trichocephalus*).

Stations 44 and 45 showed positive *W* values during both summer and winter months indicating an 'undisturbed' condition. In comparison, station 47 showed a negative *W* value during the summer survey suggesting that this is a more 'disturbed' area.

Diversity and evenness indices for station 44 over the winter and summer surveys ranged between 1.93-2.68 and 0.64-0.95, respectively.

Coral Community

8.3.3 Two previous studies on coral communities were conducted around the Peng Chau area.

- Coral surveys were previously undertaken through reconnaissance dives around Tai Lei and Peng Chau in February 2001 (Oceanway, 2001a). The survey results indicated that hard coral communities exist at a number of locations around Peng Chau.

The February 2001 dive surveys were conducted at 6 locations around Tai Lei Island and one location on the adjacent shore of Peng Chau (**Figure 8-3**). The location of live and dead corals was recorded along with details of depth and species composition. Dives were restricted to the shallow, rocky and soft substratum in approximately -1 to -5 m CD depths.

The live coral community recorded from Tai Lei Island was of low coverage but relatively high species richness. A thin veneer of live coral was found of hard substratum in the shallow sublittoral area (1-3m depth) at Site 1 (east Tai Lei Island). Isolated coral colonies were also recorded within Sites 1, 2 (north Tai Lei Island) and 6 (a boulder outcrop on western side of Tai Lei Island in the vicinity of the sewage outfall). A total of 14 species of scleratinian corals (stony corals) were recorded. The species composition and coral growth-forms were typical of the highly turbid conditions recorded in the western waters of Hong Kong and similar to those recorded from northern Lantau.

The dive survey showed that at Site 1 (east facing shoreline of Tai Lei Island) scattered scleractinians were recorded with a total live coral coverage of <5%. Corals were recorded on small rocks based on a soft seabed composed of sand and shell fragments. Coral growth was slightly higher on the boulder sublittoral area on the leeward side of the rocky outcrop separating the two beaches. Aggregated patches (approx 10% cover) of encrusting growth forms of common faviid corals were recorded. A total of 13 scleractinian coral species were recorded at the Site 1, with the dominant species *Favites pentagona, Platygyra* spp, *Cyphastrea* sp. and *Leptastrea purpurea*. A low level of partial mortality was exhibited by faviid corals, particularly *Cyphastrea* sp. However, the majority of corals colonies appeared healthy with many feeding as indicated by the extended polyps. No bleaching was observed. Numerous colonies of *Cyphastrea* sp. and *Platygyra* spp. were of a large size (>25 cm diameter). There were signs of sediment rejection behaviour with some faviid colonies showing distended tissue. Abnormal growths were recorded on the majority of *Platygyra* spp. colonies.

Isolated hard coral was recorded at Site 2 (exposed rocky north-facing shoreline of Tai Lei Island) with colonies on the hard boulder substratum including *Favites pentagona, Platygyra* spp., *Cyphastrea* sp., *Plesiastrea versipora* and *Goniopora columna*. Colonies of the soft coral *Dendronephthya* sp. and one gorgonian seawhip, *Euplexaura* sp., were also recorded.

No live coral communities were present at Sites 3 and 4 (north Tai Lei Island). Evidence of fringing coral communities with coral remains under a layer of sediment was recorded at these sites. The remains were not resulted from a recent die off and the corals probably died several years ago (i.e. about 3-4 years from 2001).

No live coral was recorded at Site 5 (north and west facing sides of Tai Lei Island) or Site 7 (Peng Chau coastline) during the February 2001 survey. A few isolated coral colonies were recorded at Site 6 (located in the vicinity of the sewage outfall). *Perna* and bryozoans dominated the shallow boulder substratum; however five scleratinian species were recorded. All coral colonies encountered were isolated encrusting growth-forms, of which the majority were faviids. Older dead skeletal remains were recorded at Sites 5 (north and west facing sides of Tai

Lei Island) and 7 (west Peng Chau coastline), with no live coral recorded. The skeletal remains were eroded and encrusted with coralline algae and encrusting benthos such as bryozoans.

- Underwater dive surveys of Peng Chau and neighbouring islands were conducted during April and June 2001 (Oceanway, 2001b). The survey adopted a two-tiered approach of rapid ecological assessment method. Low coral cover was observed at all locations during the survey.

  The nearshore substratum types identified at Tai Lei Island were as follows:

  - east Tai Lei – boulders and bedrock with sand patches;
  - north east Tai Lei – boulders, sand and dead standing coral;
  - north Tai Lei - silt covered boulders and dead coral; and
  - boulder outcrop, south west of Tai Lei – boulders or bedrock with small scattered patches of sand and/or cobbles.

  The island of Tai Lei was found to support low species richness of hard and soft corals as compared to Peng Chau, with 10 species recorded as compared with 24 at Peng Chau. It was also noted that the northern shore of Tai Lei Island had lost all live coral coverage, with the dead remains covered in silt. The boulder outcrop close to Tai Lei was found to be covered in the green-lipped mussel *Perna viridis* with only one or two colonies of hard and soft coral present. One hard coral species (*Favites pentagona)* and several colonies of *Dendronephthya* sp. and one gorgonian seawhip, *Euplexaura* sp., were recorded but as isolated colonies with extremely low abundance. The boulder outcrop and the northern coastline of Tai Lei were characterised as a community type having little or no hard or soft coral records, typically dominated by one other invertebrate species. The community occurring on eastern coast of Tai Lei was categorized as having low hard coral coverage with scattered individual colonies.

Intertidal Community

8.3.4 Intertidal surveys were previously undertaken at two locations on the western coastline of Tai Lei in August 1996 (Maunsell, 1997, EIA Report for the Outlying Islands Sewerage Stage 1, Phase 1). The results of the 1996 survey indicated that the intertidal fauna was sparse and the number of species low. One species of bivalvia, 13 species of gastropoda, 1 species of polyplacophora, 2 species of cirripedia, 2 species of malacostraca, 1 species of anthozoa, and 2 species of polychaeta were identified. At transect 1 there was a higher abundance and diversity of gastropods. The details are given in **Table 8-2**.

Table 8-2 Species Recorded from Hard/cobble Shore: Transects 1 and 2, Tai Lei (Peng Chau) August 1996 (Maunsell, 1997)

Species: Transect 1	Species: Transect 2
Bivalvia	
Perna viridis	
Gastropoda	
Cellana grata *Cellana toreuma* *Collisella dorsuosa* *Monodonta labio* *Nerita albicilla* *Nodilittorina vidua* *Nodilittorina trochoides* *Patelloida saccharina* *Siphonaria japonica* *Siphonaria sirius* *Thais spp.*	*Nodilittorina trochoides* *Nodilittorina radiata* *Chlorostoma rustica*
Polyplacophora	
Acanthopleura japonica	
Cirripedia	
Tetraclita squamosa *Capitulum mitella*	
Malacostraca	
Ligia exotica	*Ligia exotica* *Clibanarius sp.*
Anthozoa	
Haliplanella luciae	*Haliplanella luciae*
Polychaeta	
	Spirorbis foraminosus *Hydroides elegans*

Cetaceans

8.3.5 Cetaceans sightings around the area have been recorded and documented by AFCD. Cetaceans found in Hong Kong include the Chinese White Dolphin *Sousa chinensis* and finless porpoise *Neophocaena phocaenoides*. Chinese white dolphins are found predominantly to the north of Lantau, but is also found in the area around Peng Chau. Finless porpoises are generally found to the south of Lantau and around Peng Chau. The sighting areas of these cetaceans are shown in **Figure 8-4**.

Studies Conducted under the Project

8.3.6 Marine ecological surveys in the immediate surrounding environment of Tai Lei Island were conducted specifically for this EIA. Surveys included both dry season and wet season surveys on benthic community and intertidal community. Benthic and intertidal survey locations are shown in **Figure 8-5**. The coral dive survey was conducted in the dry season only (**Figure 8-6**) as there is minimal seasonal variation. Photos of each habitat types are provided in Appendix 8A.

8.3.7 The dry season surveys were conducted in February 2003 and the wet season surveys were conducted in June 2003. Methods are presented and results are summarised and discussed below.

Benthic Community

8.3.8 For each season, five replicate benthic samples were taken along a transect of the proposed outfall which were then sieved, preserved, counted and identified to species level or the lowest practicable taxon. The locations of these samples along the outfall are sufficiently close to be considered as replicates. During the dry season survey, at 3 of the 5 replicate sites a full grab was obtained, but at 2 sites 2 grabs were taken per sample because the substrate was extremely coarse and it was not possible to obtain a full grab.

8.3.9 A modified Van Veen grab Sampler ($0.1m^2$) was used to collect sediment samples from 5 stations along a transect of the proposed outfall. The co-ordinates for each of the stations, as taken from the GPS used on the boat are presented in **Table 8-3**.

Table 8-3 Co-ordinates of Benthic Sampling Stations

Station ID	Co-ordinates in HK Grid '80 (as measured by GPS)
A	821 345E 816 640N
B	821 290E 816 675N
C	821 280E 816 615N
D	821 235E 816 645N
E	821 230E 816 570N

8.3.10 Results and a general summary are provided in Table 8-4. The most striking feature of the data is the relatively higher abundance and diversity of sites A, B and D compared with C and E in the dry season survey. The same pattern is not apparent in the wet season survey. However abundance levels and number of taxa are significantly reduced in this season which makes detection of these sorts of patterns much more difficult. Sites C and E also coincide with finer sediment size and this holds true in both the wet and dry seasons (even though there are differences between seasons for any one site).

8.3.11 Comparison of biota with sediment grain size shows that there is a correlation between MDϕ and abundance and diversity in the dry season (see Figure 8-7), however, these patterns are not detectable for the wet season surveys. The

correlation values for these two relationships in the dry season are relatively high (0.87 and 0.85 respectively), indicating that the relationship is likely to have biological meaning. Thus, a finer sediment grain correlates with lower diversity and abundance and this translates to Sites C and E having the lowest abundance and lowest diversity.

Table 8-4 Benthic Data Summary (Dry and Wet Seasons)

Variable	Site				
	A	B	C	D	E
DRY SEASON					
Abundance	169	271	47	154	29
# Taxa	39	66	23	41	17
Biomass (g)	0.69	0.72	2.43	1.03	0.83
MDϕ	3.89 (fine sand)	2.25 (medium sand)	6.06 (fine sand)	1.84 (coarse sand)	7.59 (silt)
WET SEASON					
Abundance	37	26	16	94	40
# Taxa	17	11	11	28	14
Biomass (g)	0.152	0.24	10.33	0.19	0.75
MDϕ	-1.43 (gravel)	-0.70 (gravel)	1.70 (coarse sand)	-0.14 (gravel)	8.03 (clay)

8.3.12 A similar relationship is superficially apparent for the 1997 (Maunsell) survey data where the highest total abundance (24) correlated with a higher shell fragment and the lower abundance level (9) was associated with a fine mud substrate. The Maunsell Study samples were collected in 1996 which suggests that the community dynamics in the area have been stable since at least 1996. Other studies have found similar relationships between the amount of sand/shell within the habitat and diversity and abundance of benthic infauna (e.g. Penny's Bay Reclamation Stage 1, Benthic Ecology of the East Lamma Channel Baseline Survey, Milicich and Co. 2000).

8.3.13 The current survey suggests that abundance and diversity may be higher compared with 1996 conditions. However, there are many confounding factors involved here such as seasonality. A better comparison is with relevant data from the recently completed study, Marine Benthic Communities in Hong Kong, commissioned by AFCD. The survey conducted within this current project was designed to mesh with the AFCD study and so the same methods were used. This allows a better direct comparison. The major difference between the surveys is that the dry season surveys were conducted in different months (November-December versus April) and the surveys are 18 months apart (AFCD survey completed fieldwork in 2001).

8.3.14 A comparison between the surveys of significant features of the biota and their habitat is shown in **Figure 8-8**. The strongest difference is between the sites surveyed for this study (A-E) and the sites surveyed for the AFCD's Marine Benthic

8.3.15 Communities study. Abundance, diversity and biomass are all higher at the stations near the proposed works. However, grain size at these locations is also higher (lower MDϕ) with sediment being typically far more sandy and gravely than at other sites. Given the relationship between sediment grain size and diversity and abundance shown in this study and others, this result is not surprising.

8.3.16 In summary, the habitat around the proposed location appears to be different to that further out. However, there is also strong variance among the sites surveyed in this study. Thus, C and E are made of finer sediment type and this correlates with lower abundance and diversity, a pattern discernible in the dry season when far more organisms were collected.

Coral Community

8.3.17 The aim of the dive survey undertaken for this project was to identify and verify the sensitive receivers on subtidal hard substrate typically found close to shore.

8.3.18 The dive surveys were undertaken on 17 February 2003. Conditions during the survey were overcast with trace of rainfall. Wind was ENE, Beaufort F.4. Tidal heights varied between 1.4m over datum at 10.00hrs approx. and 1.0m over datum at 15.00hrs, taken from the nearest tide station at Chi Ma Wan. Underwater horizontal visibility varied between 0.5 and 1m.

8.3.19 A tiered methodology survey technique was used to assess sub-littoral coral communities to form the baseline data for this EIA. It consists of a suite of three standardized 'nested' survey methods: spot-check dives, Rapid Ecological Assessment (REA) and video transects. In an effort to increase survey efficiency the spot –check dives were used to identify the sites for the REA and video assessments.

8.3.20 The spot dive covers the entire coast of Tai Lei Island, as shown in Figure 8-6. Five REA transects sites were then selected based on the findings of spot dive survey (Figure 8-6) and they are:

East of Tai Lei Island – A1

Northeast of Tai Lei Island – A2

Northwest of Tai Lei Island – A3

Southwest of Tai Lei Island – A4

Outcrops to the southwest of Tai Lei Island – A5

8.3.21 REA specified for the project was intended to collect quantitative data on ecological attributes of subtidal habitat efficiently for relatively large areas. This was achieved by assigning categories to each the ecological and substratum attributes. Five categories were used for ecology and seven for substratum, shown in **Table 8-5**.

Table 8-5 Ecological and Substratum Attributes

Ecology	Substratum
Hard coral	Hard substrate
Dead standing coral	Continuous pavement
Soft coral	Bedrock/boulders/sand
Anemone beds	Coral rubble
Macroalgae	Cobbles
	Sand with gravel
	Mud

8.3.22 Each category was ranked (modified ordinal) for percentage cover, as per **Table 8-6**.

Table 8-6 Ordinal Ranks of Percentage Cover

Rank	% cover
0	None recorded
0.5	1 – 5
1	6 – 10
2	11 – 30
3	31 – 50
4	51 – 75
5	76 – 100

8.3.23 An inventory of benthic taxa along the transect was made *in situ*, in keeping with the 'rapid' designation of the assessment. The following taxonomic levels are preferred:

- Hard (scleratinian) corals: species, where possible;
- Soft (alcyonacean) corals, ahermatypic corals, anemones and conspicuous macroalgae: genus level where possible or by morphological features;
- Other benthos, including sponges, ascidians, zoanthids, bryozoans etc.: genus level where possible or phylum and growth-form.

8.3.24 The inventory was then ranked by taxon for relative abundance. The ranks are qualitative, in that they are subjective assessments of abundance rather than the contribution of each taxon to percentage cover.

8.3.25 Percent cover of substratum and ordinal rankings of ecological attributes for each transect are presented in **Table 8-7** and **Table 8-8**.

Table 8-7 Percent Cover of Substratum Type on Dive Survey Transects

Ecological Attributes	A1		A2		A3		A4		A5	
	M	S*	M	S	M	S	M	S	M	S
Bedrock	0	0	0	0	0	0	0	0	0	0
Large Boulders	0	15	15	20	0	10	0	20	0	50
Rocks	5	55	15	30	10	10	1	20	1	10
Rubble	0	0	0	0	0	0	0	0	0	0
Hard Substrate	**5**	**70**	**30**	**50**	**10**	**20**	**1**	**40**	**1**	**60**
Sand	80	30	0	50	0	40	0	20	0	0
Mud/Silt	15	0	70	0	90	40	99	40	99	40
Soft Substrate	**95**	**30**	**70**	**50**	**90**	**80**	**99**	**60**	**99**	**40**

Note: M = medium depth transect; S = shallow depth transects.
* averaged value of two surveyed shallow depth transects

Table 8-8 Ordinal Rankings of Sessile Benthic Biota and Ecological Attributes on Dive Survey Transects

Ecological Attributes	A1		A2		A3		A4		A5	
	M	S	M	S	M	S	M	S	M	S
Hard Coral	0	0.5 to 1[c]	0	0.5	0	0	0	0.5	0	0
Dead coral	0	0.5	0	0.5	0	0	0	0.5	0	0
Soft coral	0	0	1	0	0	0	0	0.5	0	0.5
Anemone beds	0	0	0	0	0	0	0	0	0	0
Macroalgae	0	0	0	0	0	0	0	0	0	0
Coralline algae	0	0.5	0	0.5	0	0	0	0	0	0
Sponges	0	0	0	0	0	0	0	0	0	0

Note: a. 0.5 = 1 – 5% cover (rare); 1 = 6 – 10% cover (rare); 2 = 11 – 30% cover; (uncommon) 3 = 31 – 50% cover (common); 4 = 51 – 75% cover (abundant); 5 = 76 – 100% cover (dominant)
b. M = medium depth transect; S = shallow depth transects.
c. Range of two surveyed shallow depth transects.

8.3.26 Table 8-7 indicates that the biggest difference in substrate type occurs with depth. Deeper sites are always dominated by soft substrate while shallower sites have a far higher proportion of hard substrate. These differences are easily observed in **Figure 8-9**, with deeper sites dominated by mud/silt with some sand (at A1), while shallower sites are dominated more by hard substrate including boulders and smaller rocks. At shallower sites, A1 and A2 have little or no silt and at A1, rocks and large boulders were the only substrate recorded along transect A2. These results are consistent with what occurs throughout most of Hong Kong's coastline, i.e. there is a relatively narrow coastal band of subtidal hard habitat that quickly grades to sand and mud/silt as depth (and distance offshore) increases.

8.3.27 Table 8-8 shows that faunal cover was recorded at the 3 of the 5 shallower sites (A1, A2, A4), albeit at low amounts (less than 5% cover). Such low coverage rates of sessile fauna and flora are typical of much of the western waters of Hong Kong that are under the influence of the Pearl River Delta for much of the year. Significantly, the same ordinal rank was given to live and dead hard coral within all of these 3 sites, indicating significant disturbance, whether natural or anthropogenic. Live coral cover at sites A1 and A2 correlated with the presence of suitable habitat (lack of silt, availability of hard substrate) and these factors do appear to have a structuring effect on the presence and absence of these communities. Within the 3 sites, there were significant differences in the abundance, size and diversity of the live hard coral cover (**Table 8-9**). A list of stony hard coral species is provided in **Appendix 8B**.

Table 8-9 Site Differences in Live Hard Coral Parameters for Shallow Transects

Variable	East of Tai Lei (A1)	North East of Tai Lei (A2)	South West of Tai Lei (A4)
Abundance (% coverage)	1-5 % cover	1-5 % cover	1-5 % cover
Diversity (no. species)/ % of total recorded in HK	12/14%	16/19%	4/5%
Size	In 84% of species, colonies were <10cm diameter	In 56% of species, colonies were <10cm diameter	All colonies <10cm diameter
Ratio Live/dead	50%	50%	50%
Remaining Damage	1 species 10%	In 3 species avge = 2.5% In 2 species avge = 5% In 1 species avge = 20%	0

8.3.28 Thus, live hard corals were predominantly rare and where present, mostly occurred in small isolated patches. More species and colonies of a larger size were recorded at the north eastern area (Site A2). However damage of live coral at this site was also the highest. Lowest coverage, abundance and diversity occurred at site to the southwest of Tai Lei (Site A4).

8.3.29 At deeper sites, sessile eipifauna were only recorded at site A2, being composed of 6-10% coverage of soft coral. Transects at the other sites were devoid of sessile epifauna. At A2, this epifauna was dominated by gorgonian-type corals belonging mostly to the genus *Echinomuricea*. This species is recorded throughout Hong Kong within similar types of habitat.

8.3.30 These data indicate that the area does not form part of a significant coral community. A summary of the data collected previously in 2001 Reconnaissance Dive Survey is provided in **Table 8-10**. Comparison of the previous data with the Project surveyed data confirms that there have been no significant changes (**Table 8-11**).

Table 8-10 Summary of Reconnaissance Dive Survey 2001

Site Description	Findings
East of Tai Lei Island	Live coral was found of hard substratum in the shallow sublittoral area. The coverage is less than 5%.
Northeast Tai Lei Island	Isolated coral colonies were recorded.
North Tai Lei Island	No corals found.
West Tai Lei Island	No corals found.
Outcrops to the southwest of Tai Lei Island	Isolated coral colonies were recorded.

Table 8-11 Summary of Differences between Peng Chau STW Upgrade (2003) and Reconnaissance Dive Survey (2001) Findings

Site	Comment
East of Tai Lei Island	No major difference.
Northeast of Tai Lei Island	No major difference.
Northwest of Tai Lei Island	No coral was recorded in the surveys for either year.
Southwest of Tai Lei Island	The community appears similar or slightly less diverse than 2001. Difference may be an artifact of the sampling technique rather than a biologically significant change.
Outcrops to the southwest of Tai Lei Island	Difference in coral species, but this is likely due to sampling techniques.

Intertidal Surveys

8.3.31 The dry season intertidal survey was undertaken in February 2003, wet season in June 2003. The eastern and southern coastlines of Tai Lei are artificial seawalls and the natural inter-tidal areas remained are north and northwestern area. Quantitative survey was conducted in 5 survey areas, and are indicated in **Figure 8-5** as sites B1-B5. The survey encompassed the main characteristics of each community. For each site the following method was used:

8.3.32 At each site, three numbers of transects were laid parallel to the shore and one each at the following distinct tidal/ecological zones:

- High tidal zone (littoral fringe);
- Middle tidal zone (eulittoral zone); and
- Low tidal zone (sub-littoral zone).

8.3.33 On each 10m long transect tape, laid at a certain zone, 5 quadrats of 0.25m^2 (0.5 x 0.5m) were laid at 2m intervals along the transect, on one side of the transect tape. The start-point of each transect was recorded with a portable GPS unit.

8.3.34 In the dry season, the low tidal zone was characterised by significant cover of erect macroalgae and encrusting algae (**Figure 8-10**). In the wet season, these flora were far less significant in terms of cover and algae were represented almost entirely as a mixed algal/cyanobacterial film (**Figure 8-11**). The mid-zone sites during the dry season also supported significant amounts of algae, particularly encrusting *Hildenbrandia sp* (**Figure 8-10)**. In the wet season, this pattern persisted somewhat, although it was not as consistent across sites (**Figure 8-11**). Algal/cyanobacterial film dominated the high tidal zone during the dry, cool season. However, this was almost eradicated during the hot wet season. These patterns are commonly recorded in Hong Kong and represent a change in conditions from hot to cool weather.

8.3.35 Also as expected, littorinid invertebrates dominated the high shore zones in both seasons, although abundance was lower in the hot wet summer season (**Figures 8-12, 8-13**). In the mid- and low tidal zones, limpets dominated the mobile fauna, with abundances in the mid-shore zone higher in the cold dry season than the hot, wet season (**Figures 8-12, 8-13**).

8.3.36 The flora and fauna recorded at all sites is unremarkable and is typical of fairly protected hard coastline in western Hong Kong waters. The area supports a relatively low number of species and sparse abundance of flora and fauna. No rare species were recorded in the dry or wet season survey. In terms of site differences, there is some evidence to suggest that Site B5 and Site B1 lacked algal diversity even in the dry season, being dominated by the algal/cyanobacterial film. Mobile invertebrates at these sites were also often amongst the lowest. Site B1 is at the proposed alignment and is composed of an artificial rock armour seawall, while B5 is immediately adjacent to the existing pier at the north of the site. This lack of natural habitat plus the closeness of the pier and its concomitant anthropogenic disturbances, may explain these patterns at these sites.

Ecological Importance

8.3.37 The ecological importance of the marine ecological habitats around Tai Lei Island of Peng Chau is provided in **Tables 8-12**, **8-13** and **8-14**. The criteria for evaluating the ecological value/importance of a habitat is provided in Annex 8 of TMEIAP, as follows:

Table 8-12 Ecological Value of Soft Sub-tidal Habitats

Criteria	Soft Sub-tidal Habitats
Naturalness	Ground is trawled. Affected by discharge of existing STW.
Size	0.62 ha (6200 m^2) would likely be affected due to habitat loss.
Diversity	In comparison to other parts of western waters the assemblages are more diverse.
Rarity	Most of the area surveyed falls within the largest Hong Kong grouping of sites. No rare species is recorded.

Criteria	Soft Sub-tidal Habitats
Re-creatibility	Recreation of this sort of habitat in Hong Kong is not documented. However, benthic recolonization of disturbed area is known to be rapid.
Ecological Linkage	Linkage between siltier less valuable habitat and coarser habitat that supports higher diversity. The surrounding environment contains similar subtidal soft bottom habitats.
Potential Value	No conservation interest is anticipated.
Nursery/ breeding ground	None nearby
Age	Low-dynamic seabed and the subtidal fauna is generally short lived
Abundance/ Richness of wildlife	High – diverse and abundant fauna were presented in the northwest of the surveyed area, even compared to regional data. The sediment support high abundance.
Overall Habitat Value	Low to medium

Table 8-13 Ecological Value of Hard Sub-tidal Habitats (Corals)

Criteria	Hard Sub-tidal Habitats (Corals)
Naturalness	Part of the coral area and hard subtidal habitats were disturbed by the construction of northern Tai Lei pier.
Size	The area to be affected is about 225m^2.
Diversity	Medium – Hard corals, soft corals and black corals were recorded.
Rarity	Common coral species were observed. Scattered and small stony colonies were found in two areas. One is on the very shallow water on the north-eastern tip of Tai Lei Island. Another coral area was located in deeper water on the north side of the island. A soft coral community dominated by one genus *Echinomuricea* was located. This community was surviving in a very silty environment with very little substrate.
Re-creatibility	High
Ecological Linkage	The surrounding environment contains similar subtidal hard bottom habitats
Potential Value	Low to medium – high sedimentation and poor visibility, but scattered corals were found in the area.
Nursery/ breeding ground	None known nearby.
Age	Low- likely to be disturbed by the construction of northern Tai Lei. Pier.
Abundance/ Richness of wildlife	Low percentage of cover (0-5%) in 3 out of 5 surveyed sites.
Overall Habitat Value	Medium

Table 8-14 Ecological Value of Intertidal Habitats

Criteria	Intertidal Habitats
Naturalness	Moderate. Disturbed by pollution loading and artificial seawall.
Size	About 0.22 km of natural coastline.
Diversity	The intertidal communities are typical of exposed rocky shores in Hong Kong.
Rarity	No species recorded are considered rare.
Re-creatibility	The habitat can be re-created.
Ecological Linkage	No functionally linked to any high valued habitat.
Potential Value	Unlikely that the site can develop conservation interest.
Nursery/ breeding ground	None identified during the literature review or field surveys.
Age	N/A for these assemblages as the life cycle of the fauna and flora is very short.
Abundance/ Richness of wildlife	Assemblages appears to be typical of other exposed rocky shores in Hong Kong.
Overall Habitat Value	Low

8.3.38 A habitat map in accordance with the above ecological importance is shown in **Figure 8-14**. This map is based on the analytical surveys conducted for this project and represents the our best estimation of the spatial extents of the different habitat types.

8.4 IMPACT IDENTIFICATIONS

Construction Phase

8.4.1 The construction impacts anticipated for this project are habitat loss from laying of submarine and emergency overflow outfalls and short term impacts from sedimentation arising from dredging. The estimated sediment dredged area and volume are approximately 6,200 m^2 and 22,000 m^3, respectively, and the dimensions are shown in **Figure 8-15**. The marine construction works would result in the permanent loss of 6,200 m^2 subtidal hard surface habitats.

8.4.2 Indirect impacts to sensitive species may occur particularly due the increase in suspended solids due to dredging, resulting in increased sedimentation rates. Potential impacts to water quality from sediment release include (1) increase in suspended solids (SS) concentration and (2) decrease in DO concentrations.

8.4.3 Other impact identified which may have adverse effect on cetaceans may be vessel traffic transporting of construction waste off the proposed dredged and construction area.

Suspended Solids

8.4.4 **Soft Subtidal Habitat:** Sessile organism within the benthos will be susceptible to the effects of increased sediment loads. Effects can be lethal or sub-lethal (eg reduction in

reproductive potential due to stress incurred by constantly having to flush out the depositing material). The effects of sedimentation on organism will also depend on other factors, such as organism's tolerance, growth orientation of sessile organisms and water movement. Infaunal benthic assemblages in Hong Kong are located in soft muds and sands which are frequently disturbed by storms, seabed currents and constant trawling activities which reworks the sediments creating high suspended sediment loads in the water column. Benthic invertebrates are therefore not likely to be adversely affected by the dredging activities with respect to sediment suspension and settlement but more so from direct habitat loss from dredging.

8.4.5 **Hard Subtidal Habitat:** Soft corals, gorgonians, hard corals and anemones may be injured by both high suspended sediment concentrations and high deposition rates. Damages (sub-lethal effects) or mortality (lethal effects) can result from a reduction in light penetration which kills the photosynthesising symbiotic algae associated with the hard corals, and also from the deposition of sediment onto the corals surface which physically blocks the respiratory and feeding apparatus. An assessment of the effects of backfilling in Mirs Bay (Binnie, 1992) assumed that prolonged turbidity and a sustained sedimentation rate of 20mg /cm^2/day (=0.2kg /m^2/day) was damaging to corals. Negative impacts to corals may also arise from increased SS in the water column.

It has been predicted in the water quality section that by using open grab dredger with a dredging rate of 365m^3/hr, a dredging period less than 2 weeks is anticipated. However the downstream suspended solid concentrations (from 28.6 mg/L to 572 mg/L within the 1km water quality assessment zone) from the proposed dredging would exceed the WQO of suspended solids significantly. Mitigation measures such as provision of silt curtains with a minimum solid reduction rate of 75% or higher performance, and reduction of dredging rate to 55 m^3/hr are recommended to be implemented during submarine outfall construction. With the implementation of mitigation measures, the predicted SS concentration decrease substantially and the proposed dredging period increase to approximately 2 months. The predicted suspended solids concentration complied the 30% SS elevation 5.9 mg/L at a downstream distance of 200m. The exceedance of suspended solids in the close vicinity of the dredged area is, however, within the annual fluctuation of SS in the area, and the impact to hard corals in the concerned area is not considered significant. Detailed impact assessment is provided in Section 8.5. Although the sedimentation rate of suspended solid is not predicted, the impact is not considered unacceptable due to relatively short construction period.

8.4.6 **Intertidal Habitats**: The area over which these elevated suspended solids might occur is about 200m from the centre of proposed dredging area. Although exceedance of SS is found, the predicted concentration is within the annual fluctuation of SS concentration in the area.

8.4.7 **Cetaceans:** Marine mammals have the ability to avoid areas where SS levels have increased, thus avoiding any impacts. Impacts can occur to these mammals as an indirect result of increased SS levels. The proposed dredging area for outfall construction is small and the SS impact zone is localised within 200 m of construction area, the impacts of elevated SS to the marine mammals are not expected to be unacceptable.

Marine mammals can also be affected by environmental contaminants desorbed from suspended particles. As discussed in the water quality assessment chapter that the sediment quality in the dredged area is of low contamination, impacts from contaminants to cetacean are not envisaged.

Dissolved Oxygen

8.4.8 The relationships between SS and DO are complex, with increased SS in the water column combining with a number of other effects to reduce DO concentrations in the water column. Elevated SS and turbidity reduces light penetration, lowers the rate of photosynthesis by phytoplankton (primary productivity) and thus lowers the rate of oxygen production in the water column. DO depletions are most likely to affect sessile organisms as they cannot move away from areas where DO is low. As reviewed in the chapter of water quality assessment, the area is well oxygenated. Given the relatively small dredging area and short construction time, and with implementation of mitigation measures, oxygen depletion in water column is not expected to be significant.

Vessel Traffic

8.4.9 Increase in marine traffic may disturb normal cetacean movement patterns through potential collision with vessels, increased turbidity generated by propellers and submerged equipment. Both dolphins and porpoise in Hong Kong have been found to have been killed by vessel collisions (Parsons and Jefferson in press). Additionally, vessel passes and noise can cause behavioural disturbance to these animals. Given the small scale of construction at the proposed area, the number of traffic vessel involve in the proposed project would be low and impacts from vessel traffic to marine mammals are unlikely.

Operational Phase

8.4.10 Indirect impacts to the biota may occur due to longer term changes in surrounding water quality. The primary concern would likely be high levels of nutrients (total inorganic nitrogen and ammonia). High nutrient levels can cause rapid increases in phytoplankton and may result in algal bloom. An intense bloom of algae can lead to sharp increases in do levels in surface water. At night and when these algae die there is usually a sharp decrease in the levels of dissolved oxygen in the water as dead algae fall through the water column and decompose on the bottom. Anoxic conditions may result if DO concentrations are already low or are not replenished. This may result in mortality to marine organisms due to oxygen deprivation.

8.4.11 The proposed sewage treatment works upgrade is designed for the capacity of 1,580m^3/day for Average Dry Weather Flow (ADFW) and 4,740m^3/day for Peak Dry Weather Flow (PDWF). A stringent set of effluent water quality requirement has been imposed on the proposed Peng Chau STW upgrade, especially for nitrogen species. The submarine outfall provides relatively high initial dilution for the dispersion of treated effluent. The predicted operational water quality in Chapter 5 shows that total concentration of SS, unionised ammonia and *E.coli* would comply with WQO standards and baseline BOD concentration would not be elevated

significantly after initial dilution. The zone of initial dilution is provided in **Figure 8-15**.

8.4.12 Owing to the high baseline concentration of TIN in the southern water control zone, any additional TIN loading to the surrounding waters would cause exceedance of TIN WQO. The dilution provided by the near field effect allows the TIN concentration to fall within the natural variation/fluctuation range of the water quality monitoring station SM 10. By comparing the current situation where majority of Peng Chau household wastewater is discharged without proper treatment and the TIN loading is significantly larger than the discharge through the proposed project, the predicted TIN exceedances are thus not considered to be unacceptable.

8.4.13 Chlorination has been selected for disinfection of effluent from Peng Chau STW upgrade. Total residual chlorine (TRC) may have detrimental effect on marine organisms due to its toxicity effect if no proper control is in place. The potential impact has of TRC has been described in Section 5. Currently there is no WQO standards for total residual chlorine (TRC- as a toxicant) and the acute toxicity criteria (0.0075 mg/L) and chronic toxicity criteria (0.013 mg/L) suggested by USEPA are adopted at the edge of initial dilution zone. The predicted results show that for all predicted scenarios the proposed criteria can be met if TRC concentration in the treated effluent is reduced to 0.8 mg/L. The residual water quality impact is not considered to be significant.

8.5 IMPACT ASSESSMENT

8.5.1 The assessment area, in accordance with the EIA Study Brief, is defined as 1 km radius from the proposed outfall location. The water quality assessment in Chapter 5 reveals that the zone of water quality impacts would be limited to the vicinity of Tai Lei Island, thus the marine ecology in the affected zones is assessed in this section.

Construction Phase

8.5.2 The construction phase marine ecological impacts are evaluated in accordance with the criteria stipulated in the TMEIAP Annex 8.

8.5.3 Construction of submarine and emergency overflow outfalls would lead to habitat loss. The estimated dredging area is shown in Figure 8-15 (Area A). Another potential impact zone would be the Area B, which is estimated 200m radius from the centre of submarine outfall. The map in **Figure 8-16** overlays the predicted extent of construction impacts onto the habitat map in terms of both the footprint (Area A) and predicted envelope of sedimentation impacts (Area B). This delineates the primary area for which impacts are evaluated in terms of both habitat loss and sedimentation impacts. Where appropriate this evaluation is extended to areas outside this core zone.

8.5.4 The ecological impacts from construction of submarine and emergency overflow outfalls are evaluated against the criteria set forth in Annex 8 of TMEIAP for the marine ecological habitats.

- *Habitat Quality*: Intertidal habitat and soft subtidal and hard subtidal habitats will be lost during dredging and excavation. Based on the preceding baseline analysis which low to medium ecological values are anticipated, the significance of the habitat loss is low.

- *Species*: No coral colonies found in the entire area are considered to be rare or have restricted distribution in Hong Kong. Coral communities of any size are listed as important habitat type in Annex 8 of the TMEIAP. Stony hard corals found in the surveyed area are mostly found in the eastern or northeastern side of Tai Lei Island. Small isolated hard coral colonies are found in the area around the outcrop boulder to the southwest of Tai Lei Island.

  Dredging operation in the southwest area of Tai Lei Island will be performed for outfall construction. As predicted in Chapter 5, areas within 200m of the outfall alignment are likely to be impacted by elevated suspended solids. Although exceedance of suspended solids WQO is envisaged, the concentration is still within the annul fluctuation of SS in the area. In the concerned area four species of stony coral were found. None of them are regarded as rare or uncommon species. Three of them (*Cyphastrea seralia, , Leptastrea purpurea* and *Plesiastrea versipora)* are categorised as ubiquitous species and the remaining one (*Oulastrea crispata*) was commonly found at the western islands, such as Peng Chau, Kau Yi Chau, Siu Kau Yi Chau, Chau Kung To and Silver Island. According to the data collected in spot dive, the coral coverage was less than 1%. Size of colonies revealed from the REA was under 10cm. The diversity and abundance of the stony corals found in the area is very low. The impact from dredging activities on these stony corals are not considered unacceptable.

  Other stony hard corals found are outside the sedimentation zone and impacts are unlikely. All the recorded corals are common species. There were no rare or restricted distribution species recorded anywhere on soft-bottom or intertidal habitats and no species are protected.

- *Size*: Approximately 6,200 m^2 of low-medium ecological valued soft benthic habitat would have direct impact from habitat loss due to dredging. The sedimentation impact are likely to be restricted within 200m of the dredged alignment area where exceedance of WQO on SS concentrations are predicted. This would affect the low ecological valued intertidal area and isolated coral colonies within the area but the impact is not unacceptable. About 225m^2 patched coral areas are located to the north eastern tip of Tai Lei Island. These coral colonies are not likely to be impacted by sedimentation as they are located outside the impact zone.

- *Duration*: As indicted in Chapter 5, the duration of the construction of the outfall (marine works) would be approximately 2 months. Duration of sedimentation impacts is considered temporary and relatively short-term. It is anticipated the impacts from sedimentation would not be more than 2 months. Concentration of suspended solids, after implementation of mitigation measures would fall within the natural SS annual fluctuation ranges and the impact is not considered significant.

- *Reversibility*: Impacts to the biota due to increased sedimentation are anticipated to be short-term. Recolonisation of the soft substrate with a similar infaunal community would be predicted, particularly for that part of the habitat which has a relatively high silt loading at present. The area to the north-east that supports the relatively more diverse and abundant coral colonies in the area of Tai Lai and Peng Chau, is predicted to recover if silt that has accumulated due to the dredging is transported away. Advice from the engineers suggests that this will occur. In terms of the isolated, small corals in the area, they already function in a high sediment load area and they are all encrusting in form. Recovery from a temporary elevation in siltation is predicted once any accumulated sediment is transported away. Wave-action is highest at the intertidal transition point and so impacts to these areas are predicted to be quickly reversed.

  Loss of habitat due to the footprint of the pipeline is not predicted to be permanent for all communities. Hard subtidal habitat will be replaced in the appropriate section (determined by habitat map) by laying small rocks around the pipeline where it does not interfere with its function. For the other communities, this permanent loss is rated as relatively low significance (refer to **Table 8-14**).

- *Magnitude*: No adverse impacts to rare or ecologically significant organisms are predicted. Impacts are deemed likely to be small-scale and local and thus of low magnitude. Largest magnitude impact would be due to increased sedimentation to the higher quality soft bottom habitat to the north-west of the pipeline. The predicted suspended solids concentration complied the 30% SS elevation 5.9 mg/L at a downstream distance of 200m. This impact is predicted to be not significant.

Table 8-15 and **Table 8-16** summarise the impact evaluation due to construction.

Table 8-15 Summary of Impact Evaluation Due to Habitat Loss

Criteria	Intertidal Community	Subtidal Soft Bottom	Subtidal Hard Bottom
Habitat Quality	Low	Low-Medium	Medium
Species Affected	None significant	None significant	None significant
Size/Abundance	Low	Low	Low
Duration	Permanent	Permanent	Permanent
Reversibility	Low	Low	Medium
Magnitude	Low	Low	Low to medium

Table 8-16 Summary of Impact Evaluation Due to Sedimentation

Criteria	Intertidal Community	Subtidal Soft Bottom	Subtidal Hard Bottom
Habitat Quality	Low	Medium	Medium
Species Affected	None significant	None significant	Four identified species of stony hard corals potentially be affected.

Criteria	Intertidal Community	Subtidal Soft Bottom	Subtidal Hard Bottom
Size/Abundance	Medium	Low to medium	Low
Duration	Short-term	Short-term	Short-term
Reversibility	High	High	High
Magnitude	Low	Low	Low to medium

Operational Phase

Discharge Via Submarine Outfall

8.5.5 In terms of operational impacts, zones of initial dilution (ZID) of the effluent discharge are localised in the near vicinity of the outfall. In the wet season, water quality (except TIN) is in compliance with WQO at about 4 m to 27 m distance either side of the discharge. The presence of elevated TIN is due to elevated background concentration. This will not affect any significant marine communities as these communities are adapted to high TIN concentration. The estimated wet season ZID ranges from 160m^2 to 1,080m^2. Benthic biota in the area are lower in diversity and abundance than other areas and there are no significant coral communities in the area. Impacts are rated as minor and do not require mitigation.

8.5.6 During the dry season, the zone of initial dilution would extend further from the outfall (range from 200m^2 to 6,240m^2) but significantly higher dilutions are achieved. The operational phase impact area is provided in **Figure 8-15**. Although the area covers a small portion of the higher valued soft bottom benthic habitat that exists to the north-west of the outfall pipeline, the concentration of discharged species BOD, SS, Ammonia, TIN, TRC and *E. coli* would not be different from the baseline concentration.

Discharge Via Emergency Overflow

8.5.7 Under extreme condition when the submarine outfall fails to operate, treated effluent would be discharged via emergency overflow outfall. It has been predicted that total concentrations of discharged pollutants decrease as the discharged plume migrates further downstream. Although the plume is not dispersed immediately, desirable dilution would be achieved in a relatively short time for all the concerned pollutants except TIN, which the baseline concentration has already exceeded the WQO requirement. A longer time is need for the dispersion of TIN. The concentration of TIN within 2 hours of emergency discharge (300m downstream) would be within the natural fluctuation range recorded in the nearby water quality monitoring stations. The impacts from increase in BOD, SS, ammonium nitrogen, unionised ammonia and *E. Coli* are considered to be acceptable at about 100m downstream. The net increase in total residue chlorine concentration is considered to be acceptable at 200m downstream.

8.5.8 The evaluation of discharge of untreated raw sewage via emergency overflow is also carried out. Prediction of water quality shows that longer dispersion time is required to achieve an adequate dilution. The unionised ammonia concentration violates the WQO at 100m downstream. Compliance of unionised ammonia concentration can be

achieved at about 300m downstream. The predicted results show that concentration of *E. coli* would not comply with the WQO criteria of 610cfu/100mL for secondary contact recreation zone and 180 cfu/100 ml for bathing beach after several hours of dispersion. However, as no decay coefficient was incorporated into the Brooks Equation estimation, the predicted results for *E. Coli* are conservative. It is expected that bacteria die off would occur in the natural marine environment. Discharge parameters BOD, SS, TKN, unionised ammonia and ammonium after far field dispersion of emergency overflow discharge would be within the annual fluctuation ranges after 5.55 hours of dispersion (1000m downstream) and the potential water quality impacts are considered acceptable.

8.5.9 Mitigation measures have been proposed to minimise any chance of emergency overflow discharge occurrence, as follows:

- Under normal circumstance, each process unit will be backed up with a standby unit. The standby generator will ensure the continuous electricity supply for the STW. In-line and/or off-line equalization tanks will be constructed to provide the buffer zone for influent and/or effluent storage. From the water quality point of view, the discharge of treated effluent from the emergency overflow pipe can fully meet the minimum effluent standard for this project. As such, the emergency overflow pipe serves as a standby unit for the submarine outfall pipe from this perspective.

- For conditions where damages occurred in any of the STW unit, standby unit will be operated and the designed treatment capability would be restored immediately to ensure that water quality of the effluent can meet the discharge requirement. Hence, no observable impact to both the submarine outfall and the emergency overflow pipes is anticipated.

- Under abnormal conditions where any treatment units fail to achieve the targeted effluent quality, the impact to the receiving water body can be alleviated through the dilution after discharging from the submarine outfall or emergency overflow pipes. Notwithstanding that the chance of such failure is unlikely to occur, the impact is considered acceptable as the effect will only happen in short-run.

- In an extreme situation where no electricity supply is available (including the failure of the standby generator), the impact from the untreated raw sewage can also be alleviated through the initial dilution after discharging from submarine outfall for emergency overflow pipes. Although the level of *E coli*. may be over the acceptable range, this approach is considered as the best option in view of the low chance of discharging the raw sewage directly to the receiving body in a long run.

- Based on the above, it is extremely unlikely that major duty and standby units of the STW, the submarine outfall pipe and electricity supply would have problem simultaneously. Besides, it is very rare that the event will last for a long time. Hence, the probability of diverting the discharge via emergency overflow is quite low. Nonetheless, any effluent discharge with substandard water quality should notify EPD and DSD at this extreme case.

Impact Evaluation

8.5.10 The operational water quality impacts are rated as insignificant and no mitigation measures are required. Secondary or indirect impacts are not expected due to the low value of the habitat in the area and the dilution effects. In terms of the TM criteria and requirements, the operational phase impacts are presented as follows and are summarised in **Table 8-17**.

Habitat Quality: The marine areas affected during operation of Peng Chau STW Upgrade would be the area of the zone of initial dilution. In these predicted areas (Figure 8-15), only subtidal benthic communities in the area are to be affected, including stony hard coral colonies identified. However, the predicted water quality of concerned parameters except TIN, show compliance with WQO. The elevated TIN is affected by the high background concentration which the benthic communities are adapted to. The habitat quality is not anticipated to be affected.

Species: No coral colonies found in the entire area are considered to be rare or have restricted distribution in Hong Kong. Coral communities of any size are listed as important habitat type in Annex 8 of the TMEIAP. However, all corals recorded in this survey were isolated colonies rather than forming a coherent, established community. There were no rare or restricted distribution species recorded anywhere on soft-bottom or intertidal habitats and no species are protected.

Size: Potentially affected area is shown in Figure 8-15. In wet season, the potentially affected area ranges from 160m^2 to 1,080m^2. Larger potentially affected area in dry season is estimated (ranges from 200m^2 to 6,240m^2).

Duration: design lifetime of the STW.

Reversibility: No irreversible impacts from the operation of Peng Chau STW are predicted to occur, as the concerned parameters in the treated effluent, after initial dilution would comply with WQO. The discharge from emergency overflow (if occurs) would have temporary effect on inter-tidal and subtidal benthic community and the potential impact is also reversible.

Magnitude: No adverse impacts to rare or ecologically significant organisms are predicted. Impacts are deemed likely to be small-scale and local and thus of low magnitude.

Table 8-17 Summary of Impact Evaluation Due to Operation of STW

Criteria	Intertidal Community	Subtidal Soft Bottom	Subtidal Hard Bottom
Habitat Quality	Low	Low-medium	medium
Species Affected	None significant	None significant	None significant
Size/Abundance	Low	Low	Low
Duration	Permanent	Permanent	Permanent
Reversibility	High	High	High
Magnitude	Low	Low	Low

8.6 CUMULATIVE IMPACTS

8.6.1 The construction of Peng Chau helipad by reclamation is scheduled to be within the construction period of the proposed project. In viewing of Helipad's construction programme, the marine works of the proposed project is scheduled after the completion of helipad reclamation. The recommendation of proper scheduling of marine works would be specified in the contract document to contractors. As such, no cumulative water quality impact would be anticipated.

8.7 MITIGATION MEASURES

8.7.1 In accordance with the TMEIAP guidelines for marine ecology impact assessment, the policy for mitigation of impacts is, in the order of priority:

(a) Avoidance of potential impacts to the maximum extent practicable through the adoption of suitable alternatives;

(b) Minimisation of unavoidable impacts through appropriate and practicable measures such as constraints on intensity of works operations (such as dredging) or timing, or works operations;

(c) Compensation for the loss of important species of habitat through provision off-site. Enhancement and other conservation measures should always be considered whenever possible.

8.7.2 On this basis, mitigation measures for this project have been considered as described below.

Avoidance of impact to the part of the site where more corals are found has been achieved. Permanent loss of more valuable soft bottom benthic areas has been minimised, while intertidal communities permanently affected are man-made. In terms of sedimentation impacts, appropriate restrictions on works intensity and dredging practices have already been recommended (refer to the Water Quality Section). With these mitigation measures already in place, this assessment has not uncovered a need for further measures. Compensation is not required and enhancement has been pursued as the re-provisioning of hard habitat around the pipeline after its construction.

8.7.3 In operational terms, the Peng Chau STW Upgrade is itself designed to be a mitigation measure against water quality deteriorating that would result from increases influent load through increased population and connection of previously unsewered areas to sewerage system. The negative impacts of operation with the upgrade online are considered to be substantially less than the default condition of the existing Peng Chau STW continuing to operate to and beyond 2007. Additionally, the discharge from the upgraded Peng Chau STW will be subject to more stringent standards than the current effluent discharge standards.

8.8 RESIDUAL IMPACTS

8.8.1 With the information collected from the dry and wet seasons, direct impacts to hard intertidal and subtidal habitat are predicted to be relatively small-scale, short-term and not considered unacceptable. In the longer term, due to recolonisation, there should be no net loss of biota, other than the small area directly lost to the outfall alignment and not enhanced with hard habitat.

8.9 ENVIRONMENTAL MONITORING AND AUDIT REQUIREMENTS

8.9.1 It is not recommended that there is specific ecological monitoring during construction, as impacts will be dependent on water quality, which will be monitored during the outfall construction period and the first year after operation.

8.10 SUMMARY AND CONCLUSION

Construction Phase

8.10.1 The potential impact on marine ecological communities would be associated with construction of submarine and emergency overflow outfalls.

8.10.2 Impact assessments on the intertidal community, subtidal soft bottom and subtidal hard bottom (including corals) from habitat loss and sedimentation have been carried out. The overall impacts would be acceptable. No mitigation measures for marine ecology would be required if construction water quality impacts are to be mitigated.

Operational Phase

8.10.3 Zones of initial dilution (ZID) of the effluent discharge are localized in the vicinity of outfall. In the wet season, effluent quality after initial dilution for SS, unionised ammonia and *E coli*. would not exceed the WQO while the BOD concentration would not be significantly different from the baseline concentration. The total residual chlorine concentration is also found to be complied with the proposed water quality criteria with the implementation of TRC reduction. Elevated TIN concentration is predicted but it is due to elevated background TIN concentration in the Southern Water Control Zone. Benthic biota in the area are not higher in diversity and abundance than other regional areas and there are no significant coral communities in the ZID zone, impacts are therefore minor and mitigation measures would not be required.

8.10.4 In the dry season the ZID extend further from the outfall and significantly higher dilutions are achieved. A small portion of the higher valued soft bottom benthic habitat that exists to the north west falls within the zone of initial dilution. However, the water quality would be indistinguishable from background, operational impacts are anticipated to be insignificant and no mitigation measures would be required.

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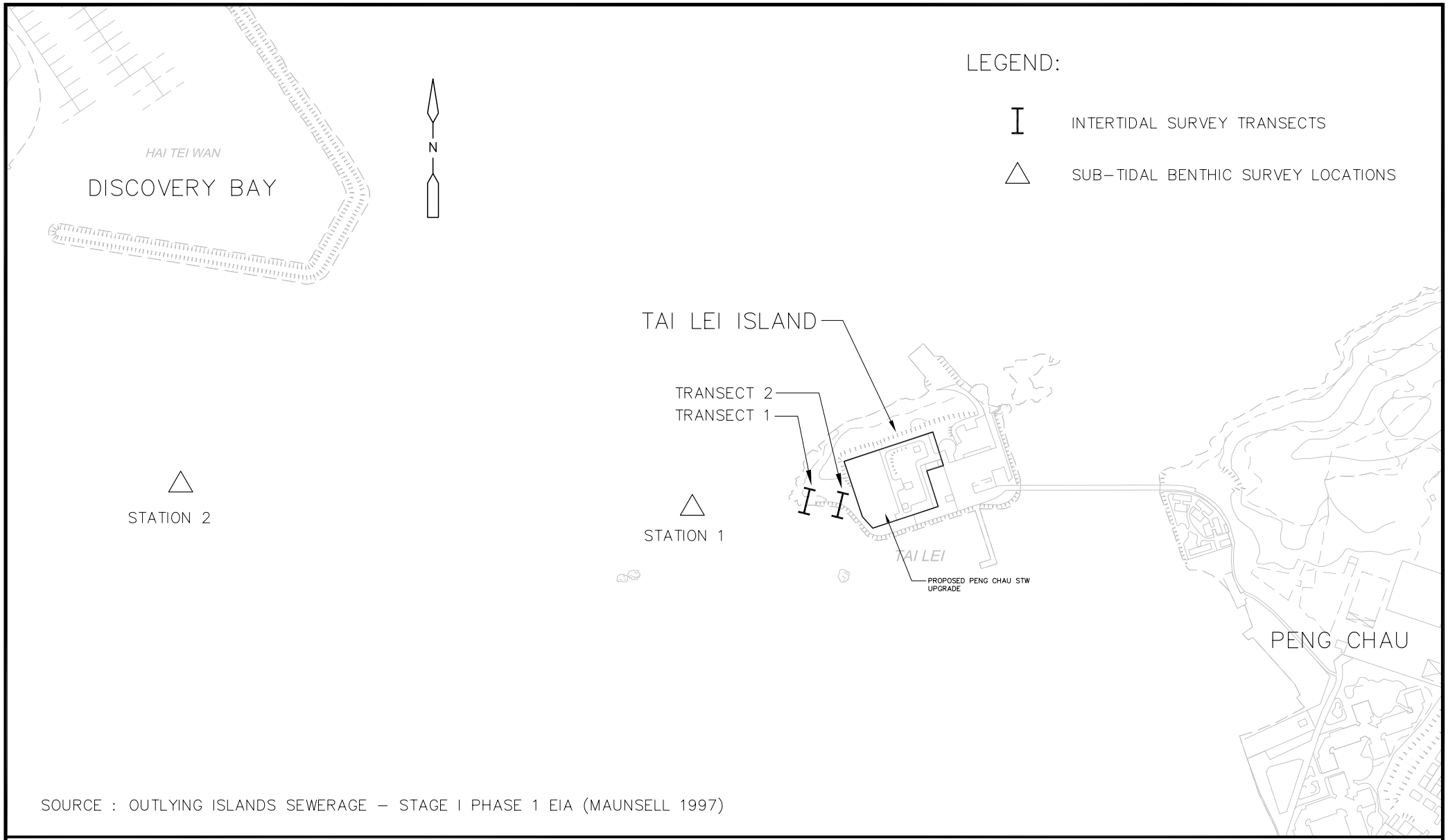

SOURCE : OUTLYING ISLANDS SEWERAGE – STAGE I PHASE 1 EIA (MAUNSELL 1997)

CDM

Figure 8-1

Locations of Intertidal and Subtidal Benthic Surveys in 1996

ACAD2002 REF. : H:\CE8301\M40\130\EIA\Revised1\Section-08\Fig-8-02.dwg 06/02/2004 TIME: 16:17

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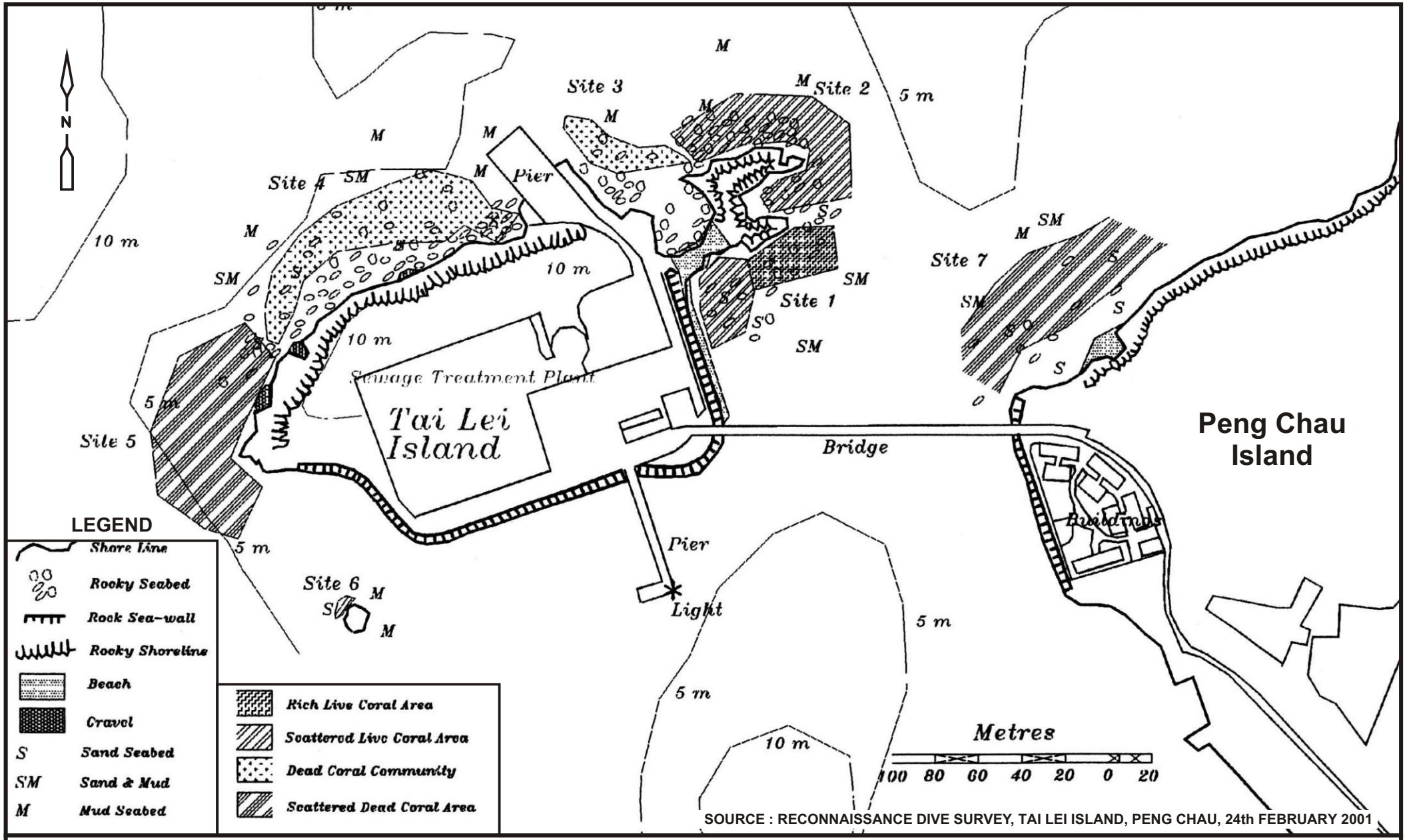
Figure 8-2

Selected Sampling Stations near Peng Chau in the Study of Marine Benthic Communities in Hong Kong



SOURCE : RECONNAISSANCE DIVE SURVEY, TAI LEI ISLAND, PENG CHAU, 24th FEBRUARY 2001

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Figure 8-3

Results of Reconnaissance Dive Survey

ACAD2002 REF. : H:\CE8301\M40\130\EIA\Revised1\Section-08\Fig-8-04.dwg 06/02/2004 TIME: 16:19

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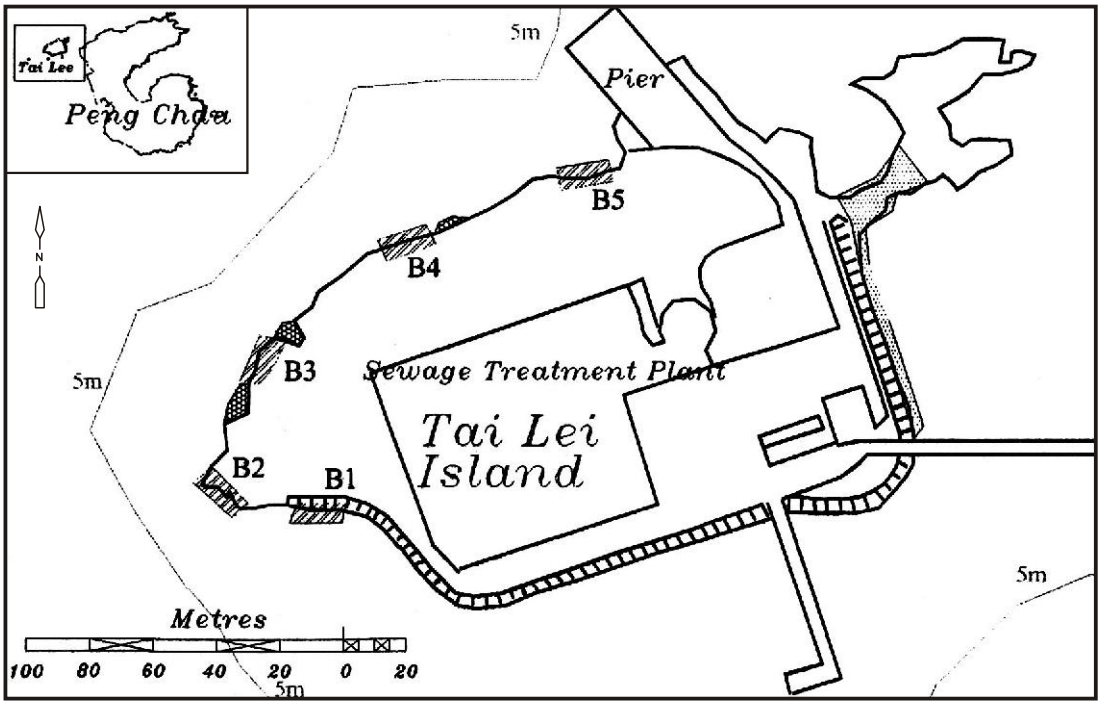
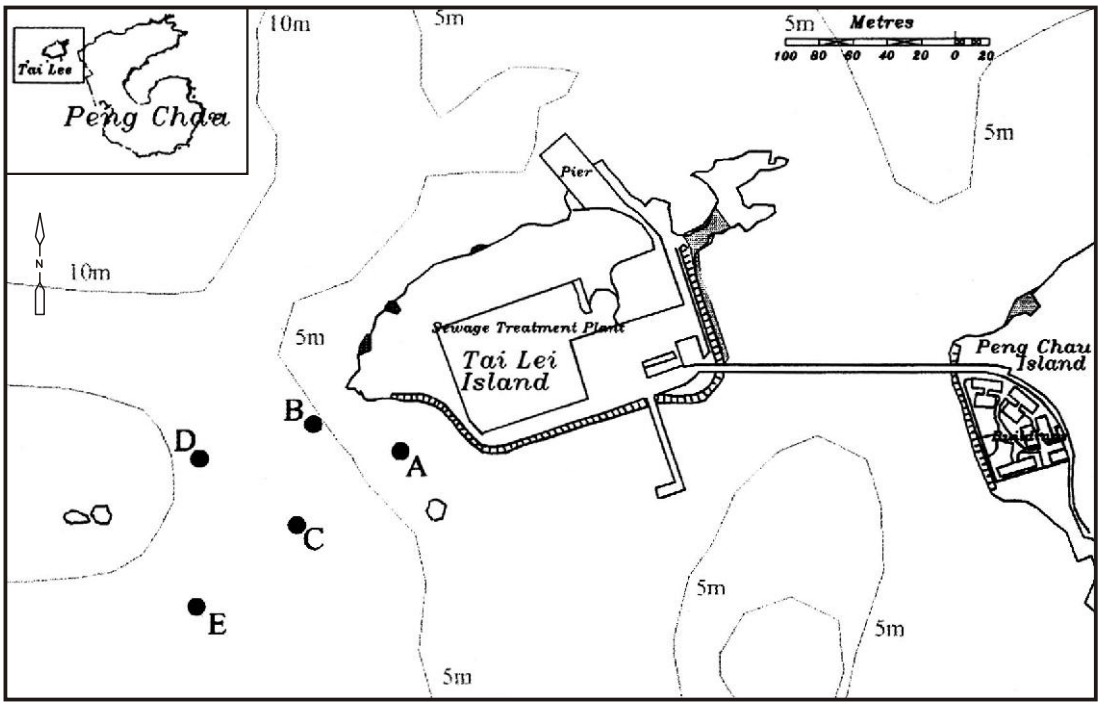
Figure 8-4

Sightings of Chinese White Dolphin and Finless Porpoises around Waters of Peng Chau



INTERTIDAL SURVEY TRANSECTS



● BENTHIC SAMPLING LOCATIONS

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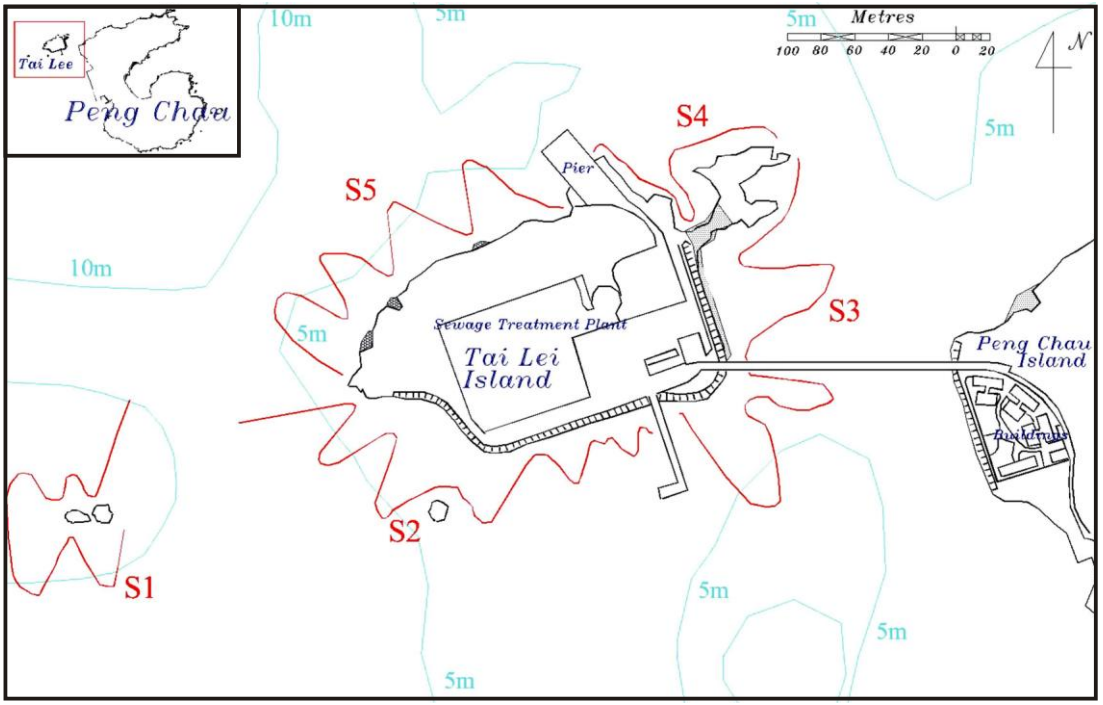
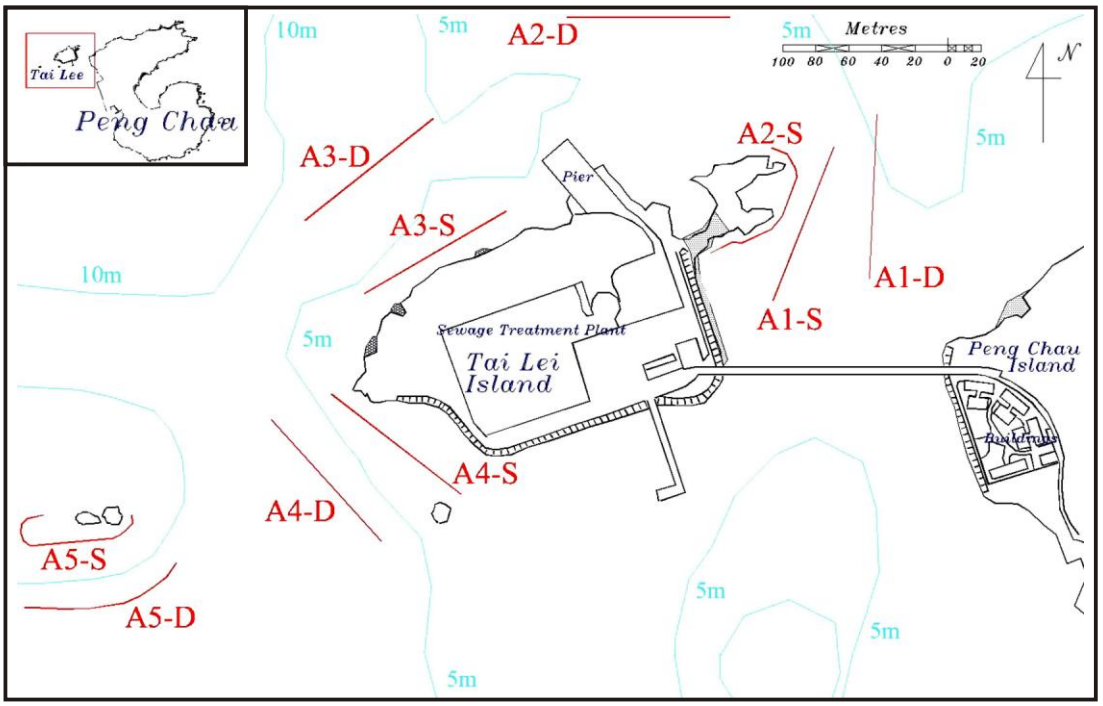
Figure 8-5

Locations of Intertidal and Subtidal Benthic Surveys for the Proposed Project



A map showing the locations of the spot dives in the Tai Lei Island area.



A map showing the locations of the REA surveys in the Tai Lei Island area.

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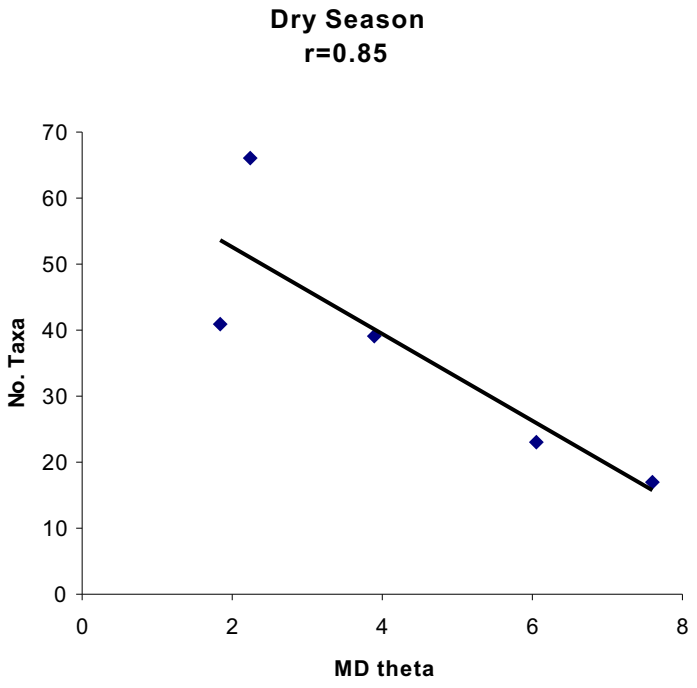
Figure 8-6

Locations of Coral Dive Survey for the Proposed Project



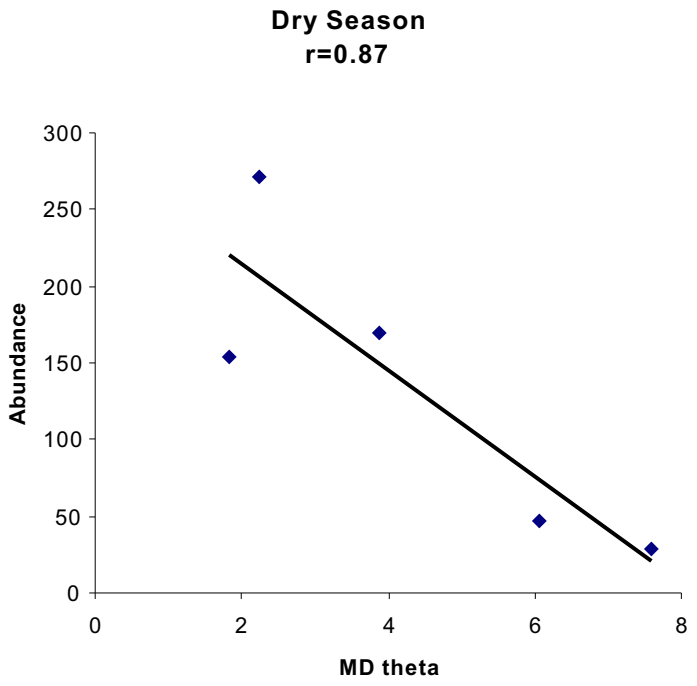


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Figure 8-7

Correlation of Benthic Communities to Physical Habitat

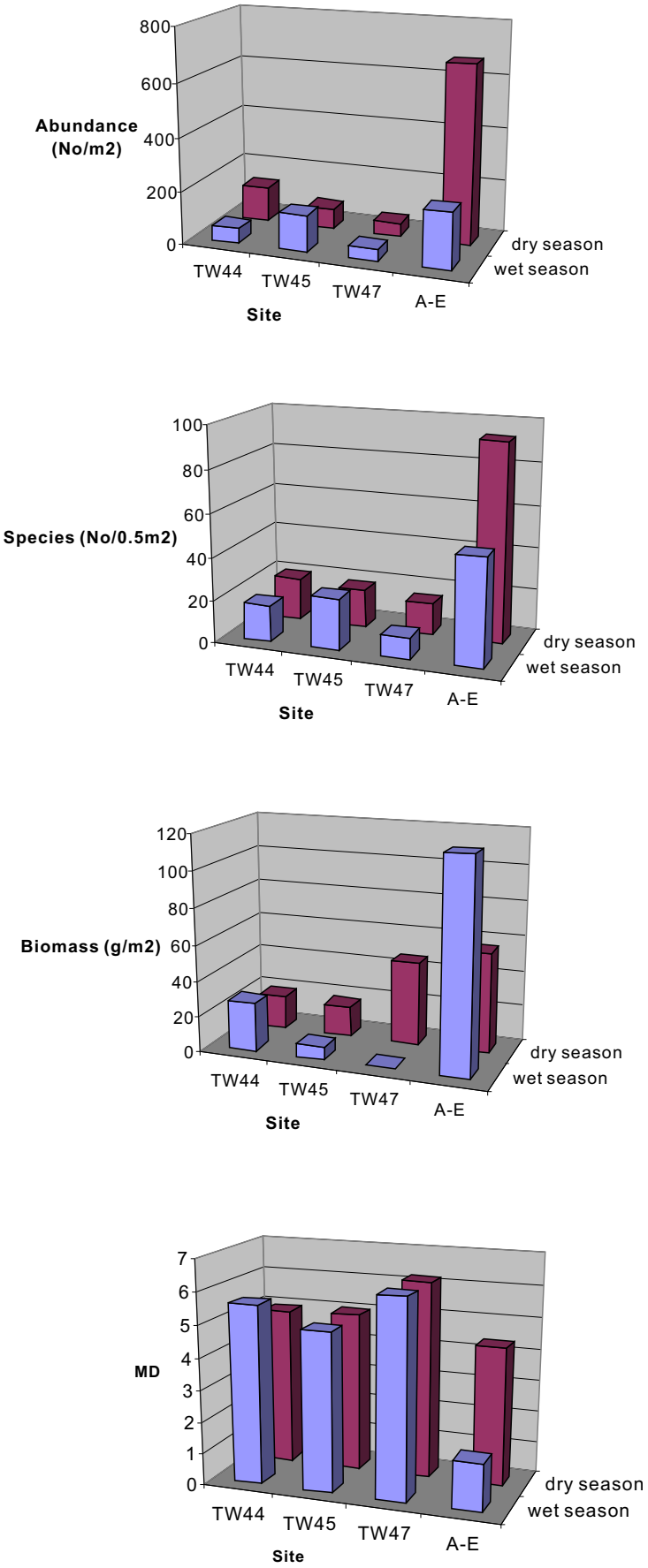

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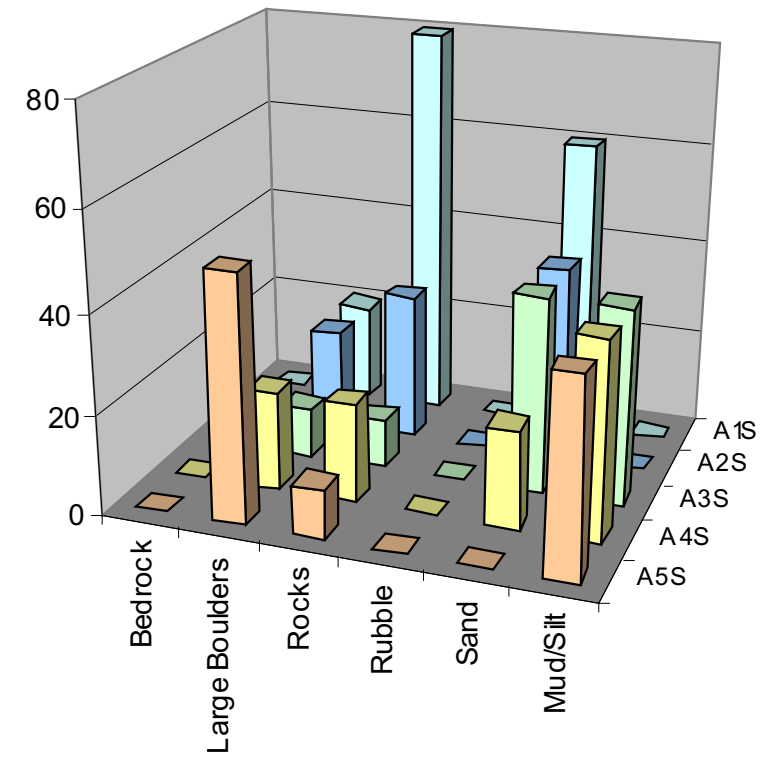
Figure 8-8
Comparison between AFCD Marine Benthic Communities Survey Locations (TW44-TW47) and Survey of the Proposed Project (A-E)



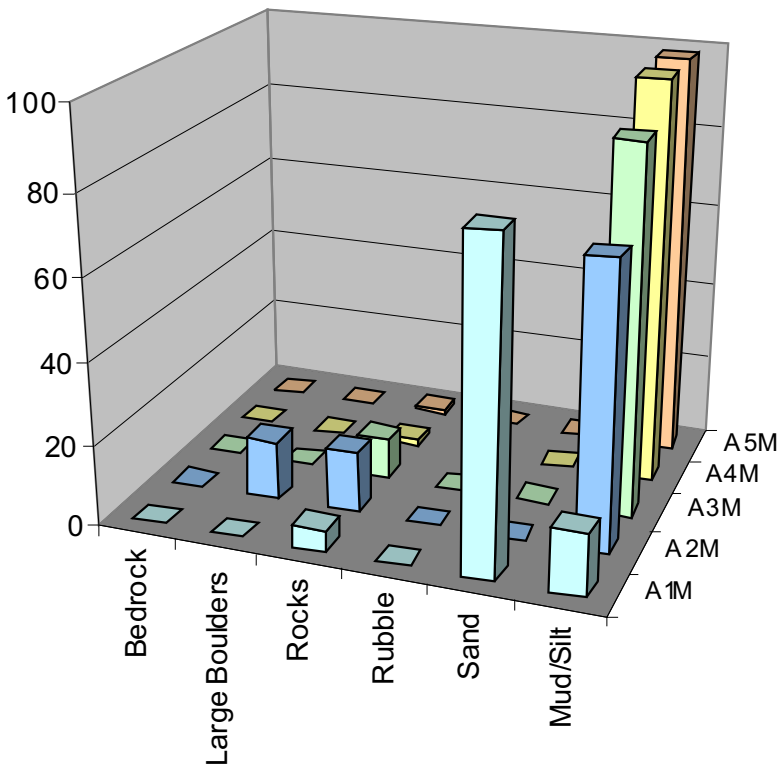


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Figure 8-9

Comparison of Substrate Types among Shallow (Top) and Deeper (Bottom) Sites

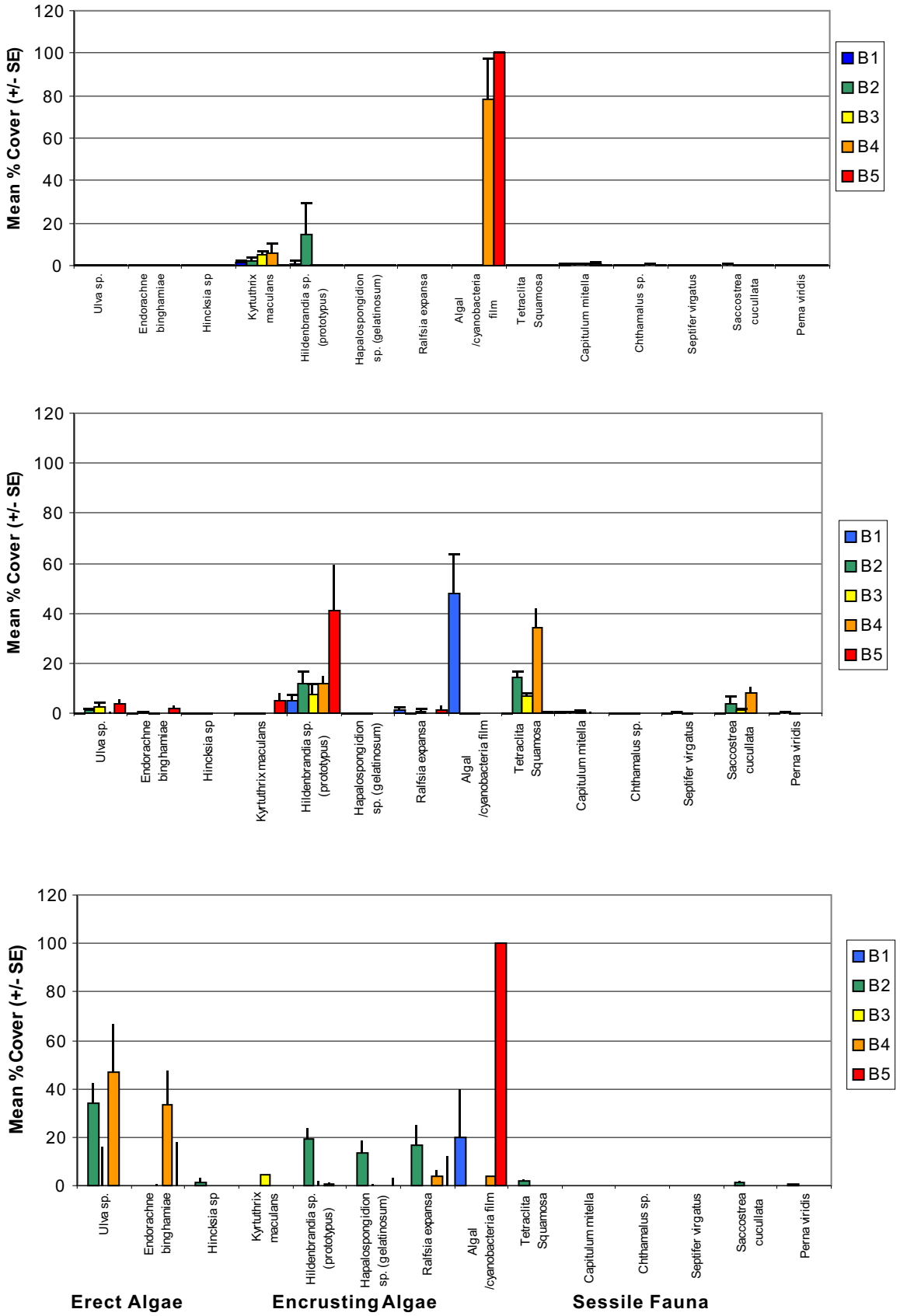

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Figure 8-10
Sessile Intertidal Communities in the High (Top), Mid (Middle) and Low (Bottom) Tidal Zones (Dry Season)

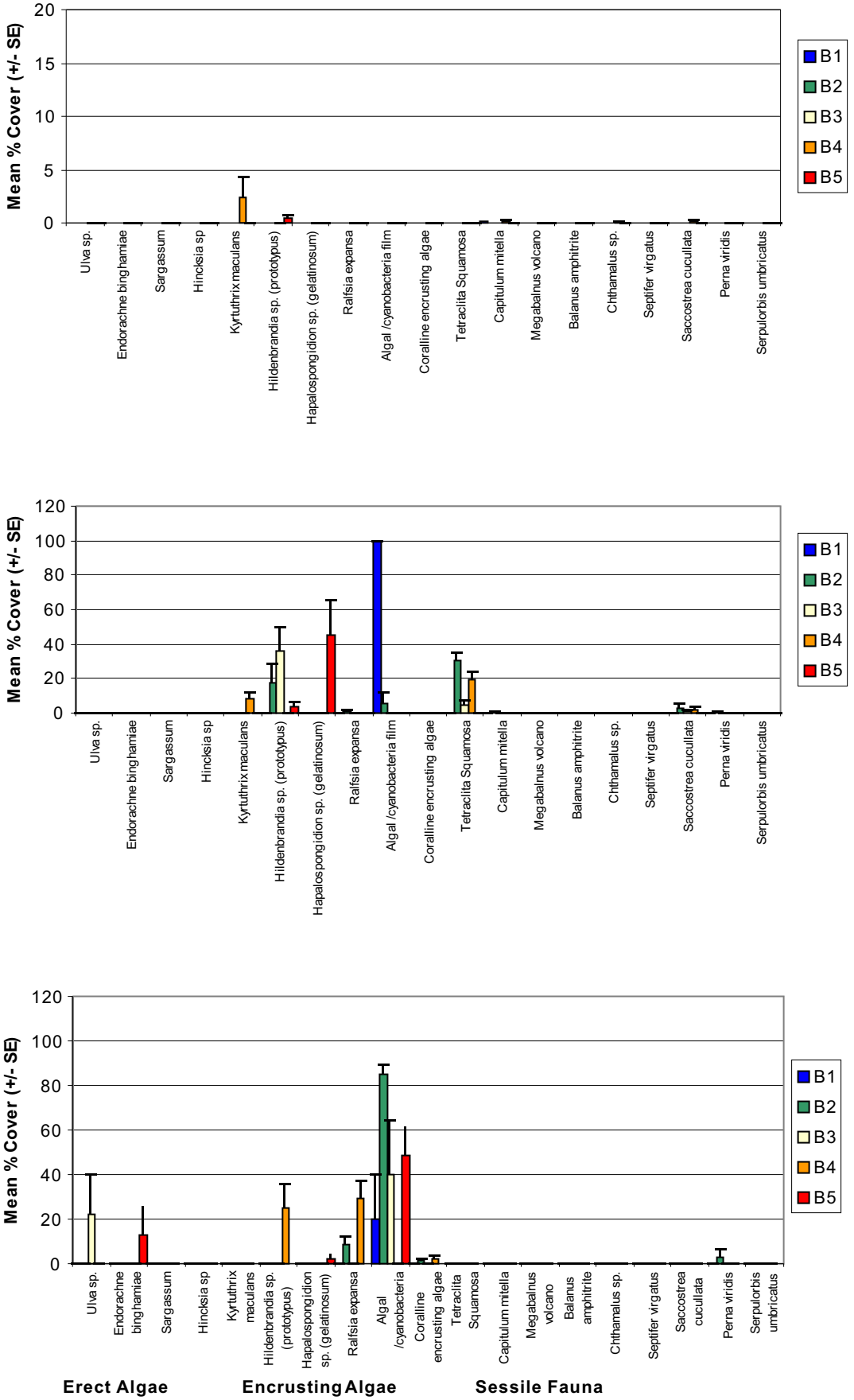

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Figure 8-11
Sessile Intertidal Communities in the High (Top), Mid (Middle) and Low (Bottom) Tidal Zones (Wet Season)

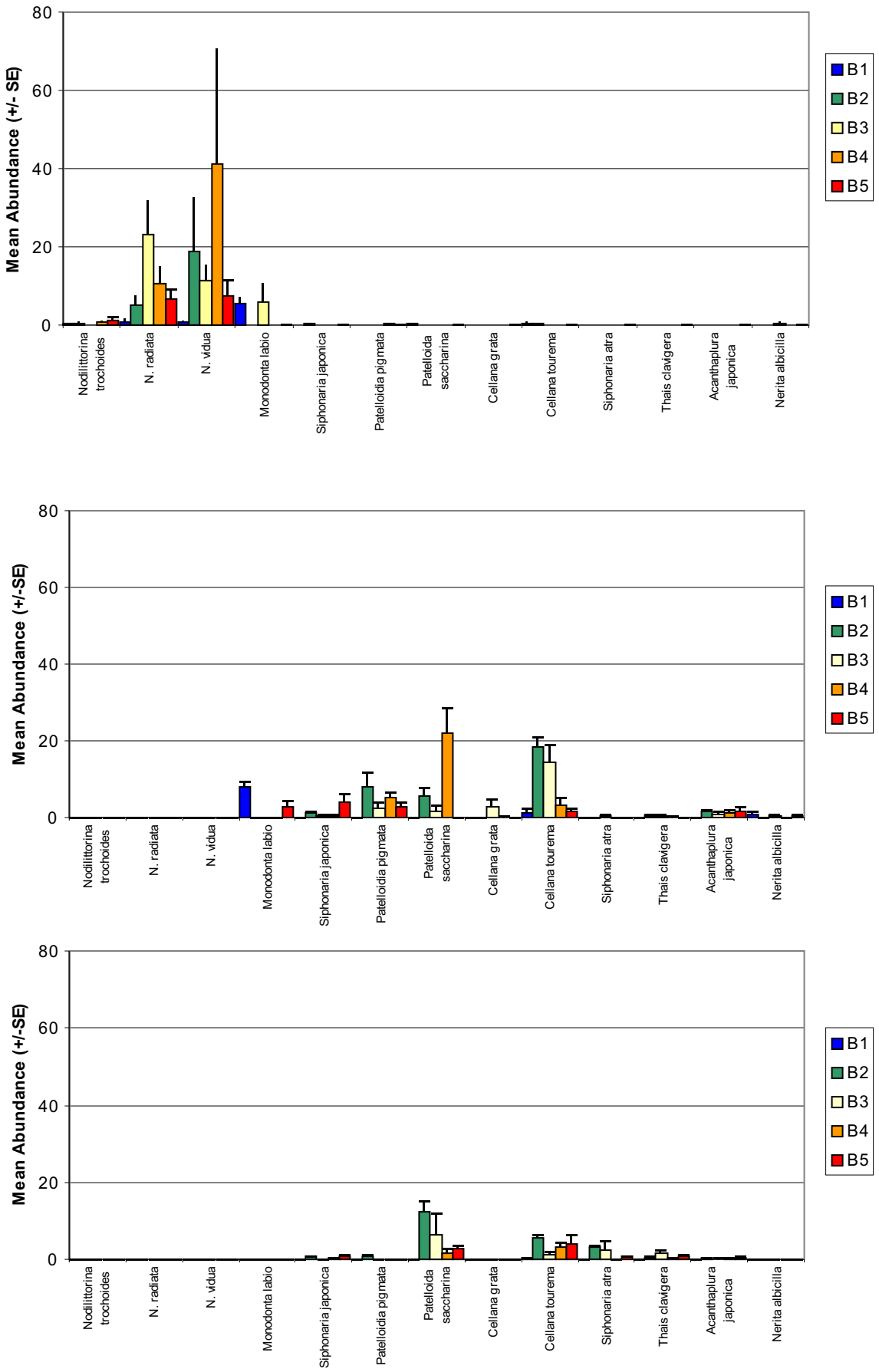

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Figure 8-12
Mobile Intertidal Communities in the High (Top), Mid (Middle) and Low (Bottom) Tidal Zones (Dry Season)

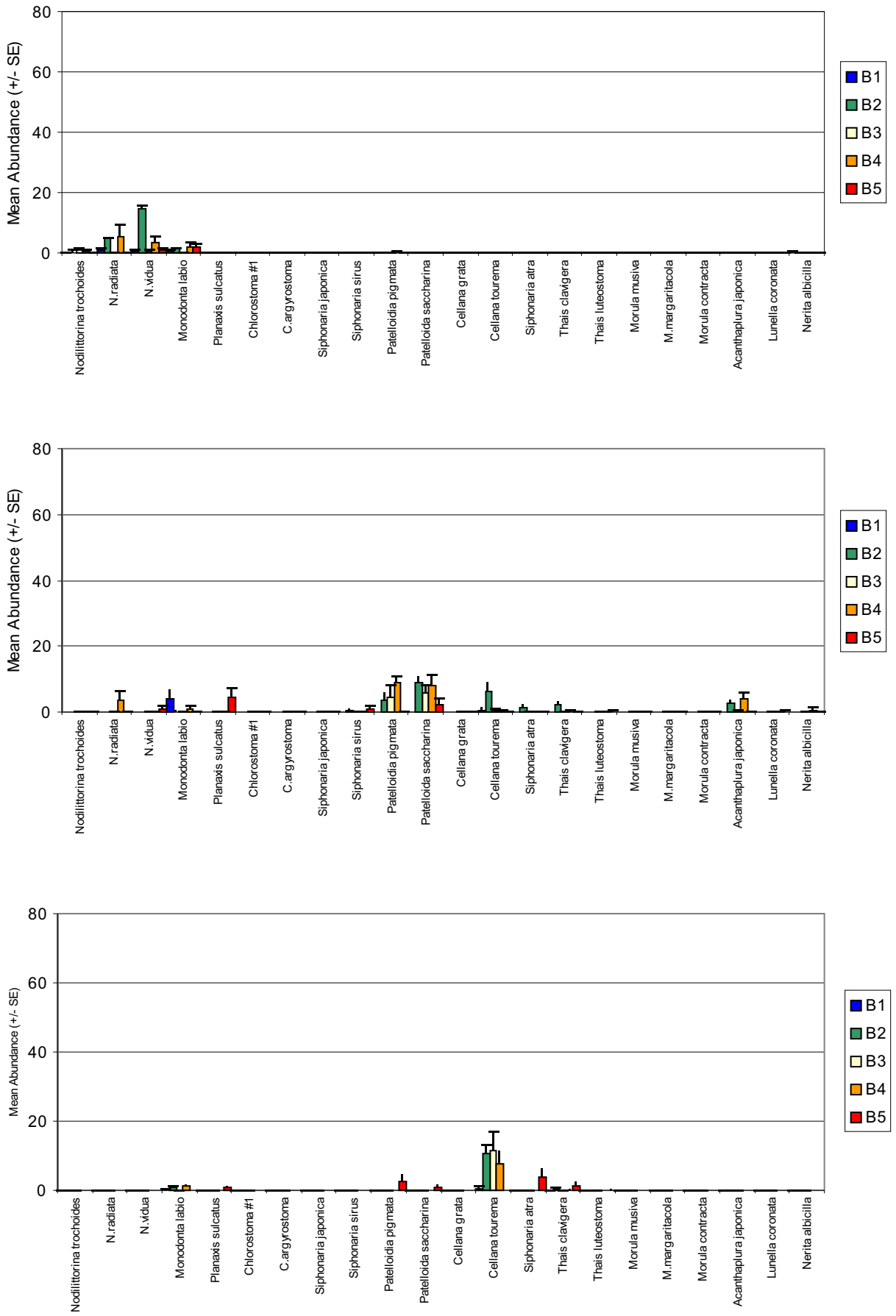

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Figure 8-13
Mobile Intertidal Communities in the High (Top), Mid (Middle) and Low (Bottom) Tidal Zones (Wet Season)

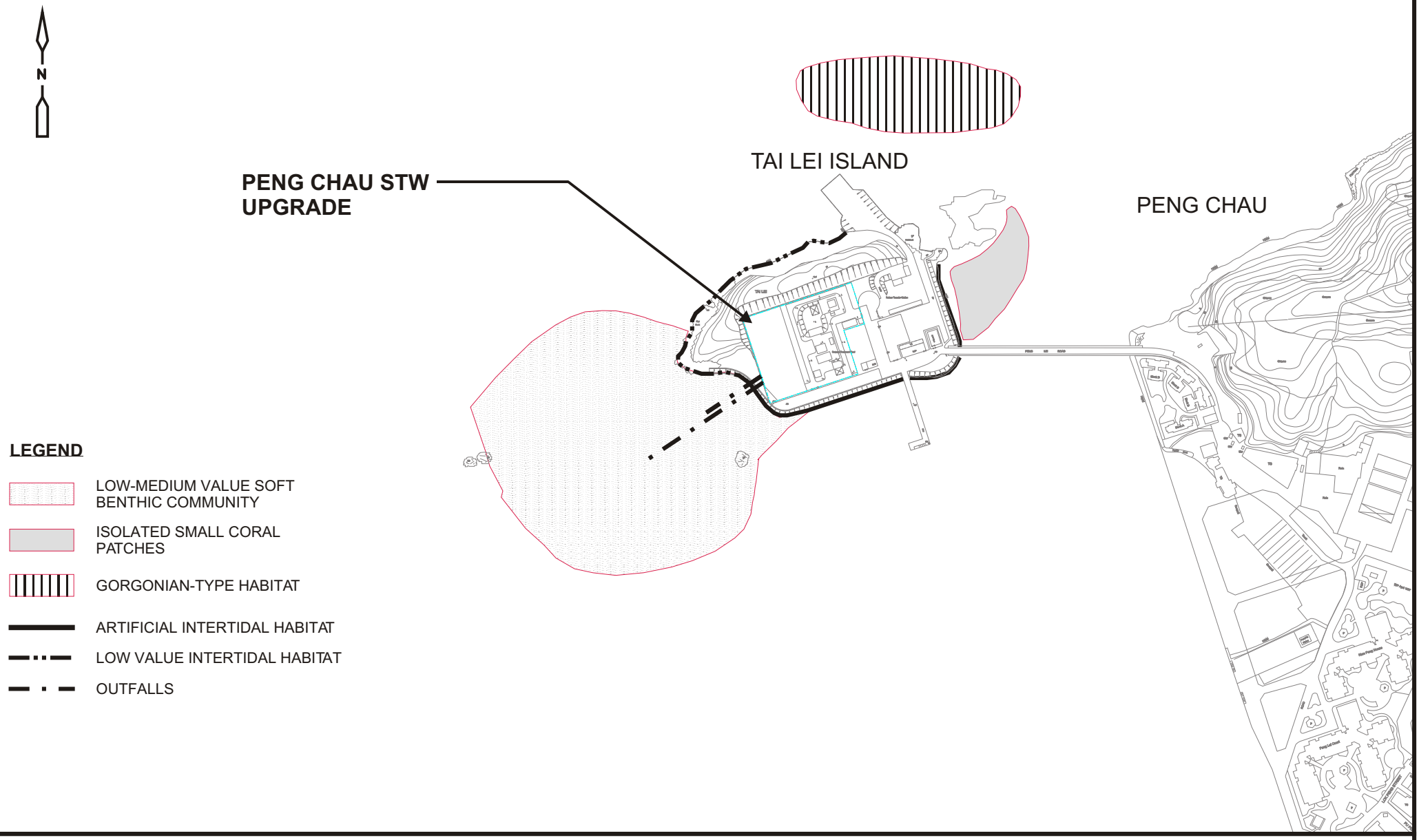

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Figure 8-14

Habitat Map

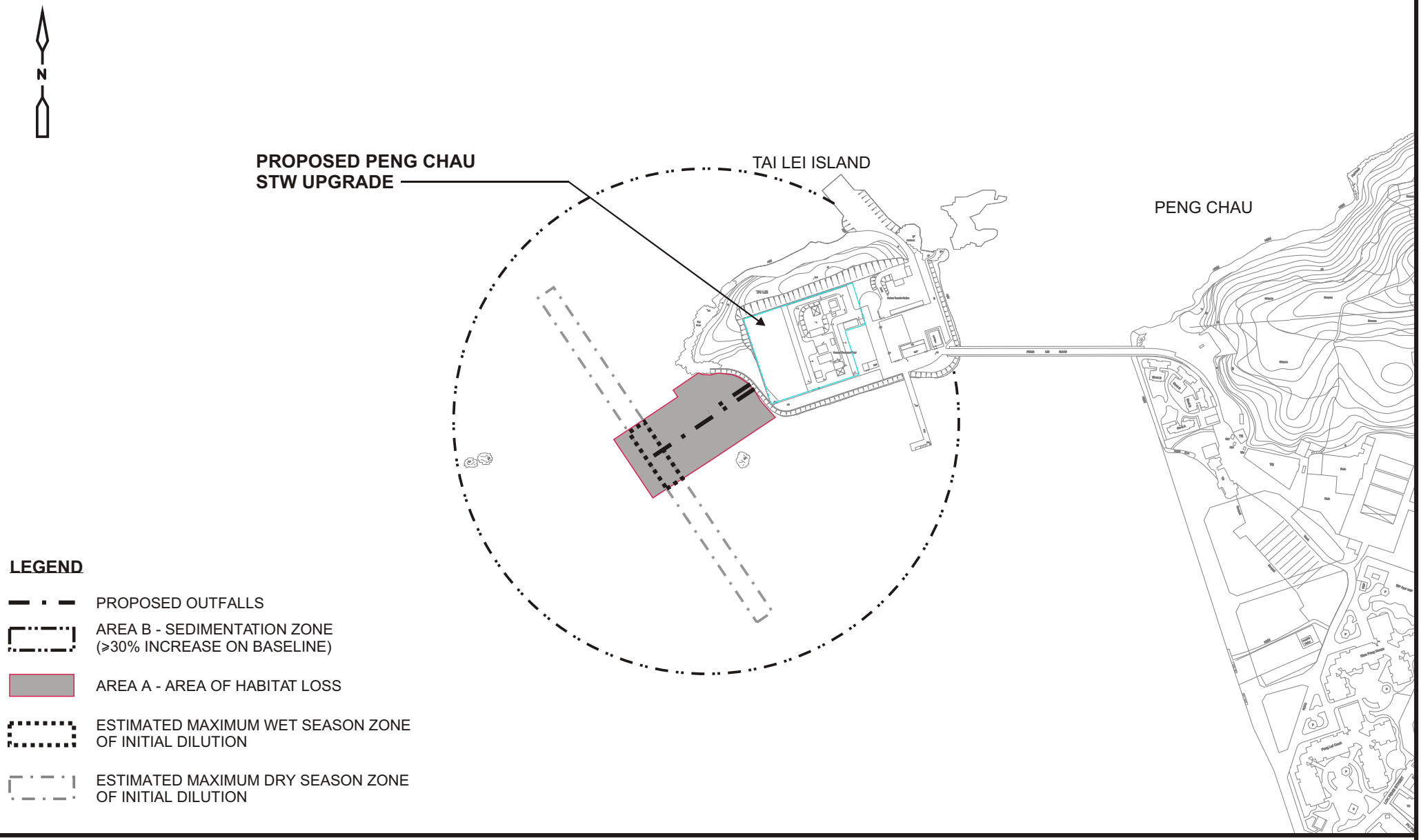

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Figure 8-15

Construction and Operational Impact Areas

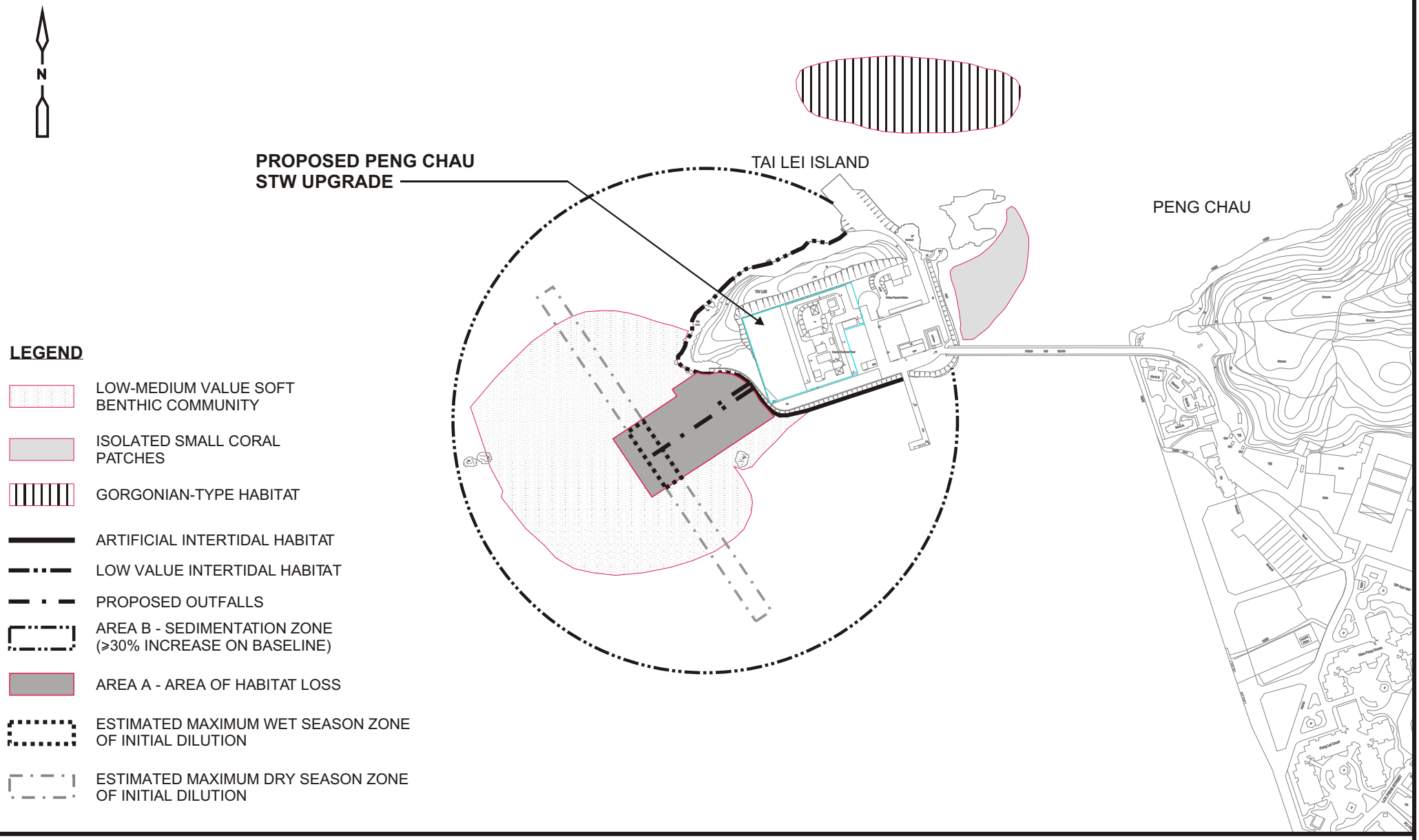

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Figure 8-16

Habitat Map Overlaid with Construction and Operational Impact Areas