Mott MacDonald

Appendix D2

Marine Ecological Dive Survey Report

Installation of Submarine Gas Pipelines
and Associated Facilities from
To Kwa Wan to North Point for Former Kai Tak Airport
Development

Consultancy Services for Feasibility Study and Detailed Design

Marine Ecological Dive Survey Report

December 2009

The Hong Kong and China Gas Company Limited

Mott MacDonald Hong Kong Limited

in association with

The Oceanway Corporation Limited

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Executive Summary

- Carrying out a marine benthic survey is part of the environmental requirements of Governmental approval for any works involving the Hong Kong sea shore. This survey should identify any sensitive communities within the area likely to be impacted by the works.

- On the 28th July 2009, the Oceanway Corporation Limited carried out Spot Diving Surveys in all areas shown on the map in Appendix I.

- Following up from the Spot Dive Data collected, four REA Surveys were carried out in areas that contained stony corals.

- From all of the data collected, a total of one hard coral species was identified in the survey areas; *Oulastrea crispata*. One single colony of the gorgonian species *Euplexaura* sp. was also recorded. Two colonies of the soft coral *Dendronephthya gigantea* were also recorded along a single transect. Corals were recorded on both of the breakwater seawalls at the To Kwa Wan end of the survey. Two small colonies of *Oulastrea crispata* were recorded under the pier at the North Point end of the survey. Both were on small rocks and these could be easily relocated if required. This area was searched thoroughly for other colonies and none were recorded.

- The status of the species recorded is shown in the table below:

Species	Status	Reference
Oulastrea crispata	Common	Field Guide to Hard Corals of Hong Kong. Agriculture, Fisheries & Conservation Department.
Euplexaura sp.	Widespread	Soft Corals and Sea Fans. K. Fabricius & P. Alderslade
Dendronephthya gigantea	Common	Soft Corals and Sea Fans. K. Fabricius & P. Alderslade

- All of the *Oulastrea crispata* recorded was in very good health. Appendix III contains the CoralWatch graphs for all transects with more than two colonies recorded.

- From the Spot Dive results, a total of four numbers of REA were carried out at selective locations along the breakwater structures near the To Kwa Wan Landing Point. The positions of these surveys are shown in Appendix IV. From this data, areas of 1% coral cover were identified.

- Recommended mitigation measures include strategically located and properly maintained sediment curtains to be used during the seabed dredging period.

- Selected photographs are in Appendix VI.

1. Introduction

The coral communities of Hong Kong are known as incipient reefs and are not typical of other high-latitude, non-reefal locations such as eastern and western Australia. Incipient reef coral areas have no calcium carbonate framework as a foundation for the corals, instead corals attach directly onto boulders and bedrock, forming simple pseudo fringing coral communities. Local coral communities are dominated by faviid species with massive, encrusting and foliaceous growth forms and 84 species from 28 genera having been recorded. These corals tolerate wide annual fluctuations in water temperature (12-30℃) and salinity (20-35‰) (Cope 1982) and periodic typhoons.

Most of the shallow (2~5m depth) marine areas in Hong Kong with reasonable amounts hard substratum have a veneer of corals attached. Species makeup varies and depends upon the environmental parameters of the area. For the area surveyed, similar surveys carried out in nearby areas have already identified the pioneering coral *Oulastrea crispata* in this area, particularly around the old runway at Kai Tak.

All areas surveyed had a very low coral cover. This was confirmed in the REA survey, with less than 1% cover in 100m^2 of surveyed area. Most of these were on large boulders forming the breakwaters. Whilst it may be possible to relocate the few colonies on small boulders (<5%) but this work may impact the integrity of the breakwaters.

2. Methodology

2.1 Introduction

The Three Tier Coral Survey Methodology was first adapted for use in Hong Kong by the Oceanway in the late 1990's. Basically the concept is for a series of surveys to be carried out, each providing more detail than the previous. The interesting feature of the methodology is that certain conditions in a low tier survey may trigger a more thorough investigation by a survey that is basically a higher tier. The higher tier survey designed to collect a more detailed information data set than a lower tier survey.

2.2 Spot Dive Survey

The Spot Dive Survey methodology has suitably trained and qualified SCUBA divers swimming at random depths along predetermined transects noting several characteristics of any coral communities encountered. Surface parameters like temperature, time and date information are recorded before the dive begins. Parameters like estimated number of species, coral cover, partial mortality and the presence of any rare corals are recorded during the actual dive.

Divers also note anything significantly different about the coral areas encountered. Features like non-typical reef structures, unusual coral species associations, unique or peculiar assemblages of the local Incipient Reef formations, and reefs that are almost completely dominated by one particular species.

Dives were conducted in and around as per the map in Appendix I. Data was recorded on water proof paper during the dive in preparation for a later consolidation in a Preliminary Survey Report (this document). Once all of the Spot Dive Survey data was collected on an area, then this information is summarized and a decision is made as to whether or not an REA dive is also required for that area.

2.3 Coral Watch Survey

The CoralWatch (South China Sea Version) is also carried out to determine the current health of the coral communities encountered. This survey technique provides a simple method of monitoring the condition of hard corals by the use of simple graded colour charts underwater. The University of Queensland, Australia, was responsible for developing this survey methodology. The colour charts are a standard and are based upon the actual colours of bleached and healthy corals. Each colour square corresponds to a concentration of symbionts (zooxanthellae) contained in the coral tissue and this is directly related to the coral's condition. The process is simple, accurate and non-invasive. Individual coral colony stress may then be identified rapidly.

All recorded corals were surveyed using the standard Chinese CoralWatch Chart. A total of ten coral colonies were examined in situ and the lightest and darkest colour match was determined. Data was recorded on prepared underwater sheets for later analysis. Care was taken to avoid the colour of the tips of the corals since there can be a delay in the colouration due to the required up-take time for zooxanthellae to enter the coral tissue.

CoralWatch data was collected for each transect. The numerical difference, the colour score, was calculated for each colony. These data are presented for each colony, and then grouped into the corresponding blanching categories with the percentage of corals in each category determined. This data was then averaged so that the figure for Cumulative Average calculated.

2.4 Rapid Ecological Assessment (REA) Survey

The Rapid Ecological Assessment (REA) methodology was first detailed in DeVantier et al. 1998. The survey is a two tier approach for underwater survey to assess the sub-littoral substrata and benthic organisms in an area. This methodology has been modified to suit Hong Kong conditions (Oceanway 2002b) and has become a standardized and widely adopted way to establish ecological baseline conditions. Two levels of information are recorded in a ~2m wide swath, 1m either side of a 100m long tape.

- Tier 1 assesses the relative cover of major benthic groups and substrata.
- Tier II provides an inventory of sedentary / sessile benthic taxa, which are also ranked in terms of their abundance in the community at the survey site.

Data is recorded by experts who are experienced in the field identification of sedentary / sessile benthic taxa, particularly corals.

2.4.1 Tier I : Categorisation of benthic cover

For each transect, ecological and substratum attributes should be categorised and ranked. The required attributes are detailed as follows:

Table 2.1: Tier I Benthic Attribute Categories

Ecological Attributes	Substratum Attributes
Hard Corals	**Hard substrata**
Dead coral	Bedrock / continuous pavement
Octocorals (Soft corals black and gorgonians)	Boulder blocks (diam. >50cm)
Anemone beds	Boulder blocks (diam. <50cm)
Dead standing corals	Rubble
Other benthos (sponges, zoanthids, ascidians and bryozoans)	Other
Macro-algae	**Soft substrata**
	Sand
	Mud / Silt
	Mud

Table 2.2: Tier I Ordinal Ranks of Percentage Cover of Benthic Attributes

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

Note: For substratum attributes, it is preferable to record actual estimates of cover. The percentage of hard substrata vs soft substrata can be provided (e.g. 80% and 20% respectively). The percentage cover of the types of hard or soft substrata could also then be presented (e.g. bedrock pavement 60%, rubble 20%, sand 15%, mud/silt 5%). Similarly, recording and presenting actual estimates of, for instance, hard and soft coral cover may be more informative (e.g. <1%) and is also approach adopted by similar recent survey reports.

Table 2.3: Taxonomic inventory Identification

Taxon Abundance Rank	Abundance
0	Absent
1	Rare
2	Uncommon
3	Common
4	Abundant
5	Dominant

The taxon categories were ranked in terms of relative abundance of individuals, rather than the contribution to benthic cover along each transect. The ranks are visual assessments of abundance, rather then quantitative counts of each taxon. Representative photos of organisms were also taken.

2.4.2 Results Presentation

The results of the REA Survey are presented in table form to allow an easy comparison between the different sites investigated.

3. Results

3.1 Introduction

The survey was carried out on the 28th July 2009. The weather was overcast with periods of heavy showers. The air temperature was 31°C. Water temperatures varied between 28°C in water shallower than 3m and 26°C down to 8m depth. The sea was calm (<10cm wavelets) with only boat wash causing anything bigger. Surface salinity was only 27ppt. At 2m depth it was measured to be 30ppt. It is likely that the rainfall had contributed to this situation.

The Spot dive recorded three different species of coral; one hard, one soft and one gorgonian. The pioneering hard coral, *Oulastrea crispata* had been recorded at nearby locations in the past, especially on the seawall along the old Kai Tak runway.

3.2 Spot Dive Results

The location of the Spot dives carried out for this survey is shown in Appendix I. Below is a summary of the results followed by a detailed description of each transect. The raw data for the spot dives is in Appendix II.

3.2.1 Summary of Spot Dive Data Recorded

A summary of the Spot Dive Survey Results is shown in the table below; **Table 3.1**. The corresponding dive numbers is shown on the map in Appendix I. The rows highlighted with yellow are those transects that an REA Survey was also carried out. The raw data is in Appendix II.

Table 3.1: The Summary Results for the Corals recorded in the Spot Dive Survey

Dive No.	No. Hard Species	% Cover	No. Gorg. Species	% Cover	No. Soft Species	% Cover	Remarks
T1	0	0	0	0	0	0	Along and nearby boulders and seawall
T2	0	0	0	0	0	0	Out from To Kwa Wan Landing point
T3	0	0	0	0	0	0	Along and nearby seawall.
T4	1	<1%	0	0	0	0	Along and nearby breakwater
T5	1	<1%	0	0	0	0	Along and nearby breakwater
T6	1	<1%	0	0	0	0	Along and nearby breakwater
T7	1	<1%	1	<1%	1	<1%	Along and nearby breakwater
T8	0	0	0	0	0	0	Along and nearby seawall.
T9	1	<1%	0	0	0	0	Out from To Kwa Wan Landing point
T10	0	0	0	0	0	0	Along and nearby seawall.

The hard coral recorded on T9 consisted of two small (<10cm^2 area) coral colonies of *Oulastrea crispata.*

3.2.2 Transect T1

The location of this transect is shown in Appendix I. The area surveyed was along the seawall and out from this structure for 25 metres. A compass bearing zigzag search pattern was followed. The northern most section of this transect consisted of large boulders beneath a pagoda. This was the only natural section of

shoreline that was investigated in this entire survey. All areas along this transect had tissue paper on the seabed indicating the close proximity of a sewage outflow pipe.

Depths around the section of natural shoreline area were very shallow at less than 1m. The seabed at this location consisted of very coarse sand and rubbish. Further out the seabed gradually changed to sand and mud, then to just mud. Most of the latter areas were covered in a thick layer of cyanobacteria. There were scattered piles of rubbish and discarded material over the entire area. The seabed gently sloped down to 4m.

Scattered clumps of *Perna viridis* and some small oysters were the main bivalves recorded in this area. This included on some of the natural rock and seawall sections of this transect. There were small areas of small barnacles also recorded on the rocks as well. Tunicates were also recorded. Further out from the seawall there were sponges with the very occasional stinging hydroid *Lytocarpus philippinus* also attached to any hard substratum including rubbish. There was no coral recorded along this transect.

3.2.3 Transect T2

The location of this transect is shown in Appendix I. The area surveyed was 75m out from the seawall at the To Kwa Wan Landing Point along the proposed alignment of the pipeline. A compass bearing zigzag search pattern was followed out from the seawall.

Depths started at 2.1m at the seawall gently sloping down to 5.5m at the end of the transect. The seabed consisted of sand and mud at the seawall end of the dive and became mud at the other end. Most of the latter areas were covered in a thick layer of cyanobacteria. There were scattered piles of rubbish and discarded material over the entire area.

The benthos recorded was the same as that recorded out from the first transect. Scattered clumps of *Perna viridis* and some small oysters were the main bivalves recorded in this area. Tunicates were also recorded as were sponges with the very occasional stinging hydroid *Lytocarpus philippinus* also attached to any hard substratum including rubbish. There was no coral recorded along this transect. The anemone *Cerianthus* cf. *filiformis* was observed on this dive. The long spine sea urchin, *Diadema setosum,* was recorded at the far end of this transect.

3.2.4 Transect T3

The location of this transect is shown in Appendix I. The area surveyed was along the seawall and out from this structure for 25 metres. A compass bearing zigzag search pattern was followed. All areas along this transect had tissue paper on the seabed indicating the close proximity of a sewage outflow pipe.

Depths along the seawall went down to 3m. This slowly changed to 5.5m further out. The seabed along the seawall consisted of very coarse sand and rubbish. Further out the seabed gradually changed to sand and mud, then to just mud. Most of the latter areas were covered in a thick layer of cyanobacteria. There were scattered piles of rubbish and discarded material over the entire area.

Scattered clumps of *Perna viridis* and some small oysters were the main bivalves recorded in this area. Tunicates were also recorded. Further out from the seawall there were sponges with the very occasional

stinging hydroid *Lytocarpus philippinus* also attached to any hard substratum including rubbish. There was no coral recorded along this transect.

3.2.5 Transect T4

The location of this transect is shown in Appendix I. The area surveyed is along the proposed pipeline side of the northern breakwater near the To Kwa Wan Landing Point. The breakwaters consist of mostly large boulders sloping at about 45 degrees down to 8~10m at a gently sloping muddy seabed. A zigzag search pattern was followed along the submerged section of the breakwater.

There was quite a lot of discarded items along the transect, mostly large pieces of metal. Areas with patches of the pioneering hard coral *Oulastrea crispata* were recorded all along this transect. The coral was in the depth band of between 1.5m to 5m depth. There was a thin layer of silt over most of the rocks.

There were a few patches of *Perna viridis* and some small oysters recorded as well as *Schizoporella* sp. Scattered tunicates as well as the very occasional stinging hydroid *Lytocarpus philippinus* also attached to hard substratum including rubbish. Ghost nets were recorded along this transect.

3.2.6 Transect T5

The location of this transect is shown in Appendix I. The area surveyed is along the inside section of the northern breakwater near the To Kwa Wan Landing Point. The breakwaters consist of mostly large boulders sloping at about 45 degrees down to 7~9m at a gently sloping muddy seabed. A zigzag search pattern was followed along the submerged section of the breakwater.

There was quite a lot of discarded items along the transect, mostly large pieces of metal. Areas with patches of the pioneering hard coral *Oulastrea crispata* were recorded all along this transect. The coral was in the depth band of between 2m to 5m depth. There was a thin layer of silt over most of the rocks.

There were a few patches of *Perna viridis* and some small oysters recorded as well as *Schizoporella* sp. Scattered tunicates as well as the very occasional stinging hydroid *Lytocarpus philippinus* also attached to hard substratum including rubbish. Ghost nets were recorded along this transect.

3.2.7 Transect T6

The location of this transect is shown in Appendix I. The area surveyed is along the inside section of the southern breakwater near the To Kwa Wan Landing Point. The breakwaters consist of mostly large boulders sloping at about 45 degrees down to 8~12m at a gently sloping muddy seabed. A zigzag search pattern was followed along the submerged section of the breakwater.

There was quite a lot of discarded items along the transect, mostly large pieces of metal. Areas with patches of the pioneering hard coral *Oulastrea crispata* were recorded all along this transect. The coral was in the depth band of between 1.5m to 5m depth. There was a thin layer of silt over most of the rocks.

There were a few patches of *Perna viridis* and some small oysters recorded as well as *Schizoporella* sp. Scattered tunicates as well as the very occasional stinging hydroid *Lytocarpus philippinus* also attached to hard substratum including rubbish. Ghost nets were recorded along this transect.

3.2.8 Transect T7

The location of this transect is shown in Appendix I. The area surveyed is along the outside exposed section of the southern breakwater near the To Kwa Wan Landing Point. The breakwaters consist of mostly large boulders sloping at about 45 degrees down to 8~13m at a gently sloping muddy seabed. A zigzag search pattern was followed along the submerged section of the breakwater.

There was quite a lot of discarded items along the transect, mostly large pieces of metal. Areas with patches of the pioneering hard coral *Oulastrea crispata* were recorded all along this transect. The coral was in the depth band of between 1.5m to 5.5m depth. One colony of the gorgonian *Euplexaura* sp. was recorded near the middle of this transect. Two colonies of the soft coral *Dendronephthya gigantea* were observed near the far end of this transect. There was a thin layer of silt over most of the rocks.

There were a few patches of *Perna viridis* and some small oysters recorded as well as *Schizoporella* sp. Scattered tunicates as well as the very occasional stinging hydroid *Lytocarpus philippinus* also attached to hard substratum including rubbish. Ghost nets were recorded along this transect.

3.2.9 Transect T8

The location of this transect is shown in Appendix I. The area surveyed was the western section of the North Point Landing Point. This area consists of a seawall, an area under the Eastern Corridor and a small section out from the Eastern Corridor. The seawall goes down 3m to a coarse sand seabed. There was a large amount of tissue paper along this transect. The seabed changes to sand and mud and then to soft mud at a depth of 6m, about 25m out from the seawall. There was scattered rubbish all along this transect as well as a lot of discarded fishing gear. The long spine sea urchin *Diadema setosum* was recorded on the seawall and on the cement foundation structures of the corridor.

The anemone *Cerianthus* cf. *filiformis* was observed on this dive. There were a few individuals of *Perna viridis* and some small oysters recorded as well as *Schizoporella* sp.and some tunicates. A thin layer of silt and tissue covered most of the substratum.

3.2.10 Transect T9

The location of this transect is shown in Appendix I. The area surveyed was directly out from the North Point Landing Point. This area consists of a small section of seawall, an area under the Eastern Corridor and a large section out from the Eastern Corridor. The seawall goes down 3.5m to a coarse sand seabed. There was a large amount of tissue paper along this transect. The seabed changes to sand and mud and then to soft mud at a depth of 12m, about 75m out from the seawall. There was scattered rubbish all along this transect as well as a lot of discarded fishing gear. The long spine sea urchin *Diadema setosum* was recorded on the seawall and on the cement foundation structures of the corridor. There were two small colonies of the hard coral *Oulastrea crispata* on small pieces of hard substratum (rocks) recorded along this transect. The whole area was then thoroughly searched for more colonies and none were recorded. The location of the two colonies was noted so that they could be relocated. Both colonies were in good condition. Due to the fact that there were only two colonies, it was not possible to CoralWatch these colonies.

The anemone *Cerianthus* cf. *filiformis* was observed on this dive. There were a few individuals of *Perna viridis* and some small oysters recorded as well as *Schizoporella* sp. and some tunicates. A thin layer of silt and tissue covered most of the substratum.

3.2.11 Transect T10

The location of this transect is shown in Appendix I. The area surveyed was the eastern section of the North Point Landing Point. This area consists of a seawall, an area under the Eastern Corridor and a small section out from the Eastern Corridor. The seawall goes down 3.5m to a coarse sand seabed. There was a large amount of tissue paper along this transect. The seabed changes to sand and mud and then to soft mud at a depth of 6m, about 25m out from the seawall. There was scattered rubbish all along this transect as well as a lot of discarded fishing gear. The long spine sea urchin *Diadema setosum* was recorded on the seawall and on the cement foundation structures of the corridor.

The anemone *Cerianthus* cf. *filiformis* was observed on this dive. There were a few individuals of *Perna viridis* and some small oysters recorded as well as *Schizoporella* sp.and some tunicates. A thin layer of silt and tissue covered most of the substratum.

3.2.12 Summary of CoralWatch Data Recorded

The CoralWatch results for all of the transects with more than 2 colonies are in **Table 3.2** below. CoralWatch gives the general coral health.

Table 3.2: The Summary Results of the CoralWatch Survey

Dive No.	Cumulative Average	Remarks
T1	~	No hard coral
T2	~	No hard coral
T3	~	No hard coral
T4	5.00	1 species
T5	5.09	1 species
T6	4.82	1 species
T7	5.14	1 species
T8	~	No hard coral
T9	~	Only 2 colonies
T10	~	No hard coral

The value of Cumulative Average is a measure of the health of the coral. It is an ordinate based value that varies between 1 (very poor health) to a maximum value of 6 (maximum health). For Hong Kong values above 3.50 are normal. Values below that normally indicate the area has some stress. The CoralWatch Graphs for all transects with hard corals are in Appendix III.

3.2.13 Summary of the REA Data Recorded

A total of four REA transects were carried out along the breakwaters that were near the To Kwa Wan landing point. The location of these transects is shown in Appendix IV. From the preliminary REA data indicate that there are ~1 colony per 1m2 of the hard coral species Oulastrea crispata on the rocks of the breakwater. The depth of the coral area varies but is mostly between the 1.8m to 3.5m depth. There were no other significant coral areas located during this survey.

Table 3.3 compares the results of the REA surveys at each location. As expected there is not that much difference with these results.

Table 3.3: Summary of the Tier 1 results. Recorded ranks of percentage cover from Table 2.1 & 2.2

Parameter / Station	REA 1	REA 2	REA 3	REA 4
Average Depth (m)	2.35	2.15	2.25	2.3
Exposure (1~4)	2	2	2	2
Sediment (0~3)	1	1	1	1
% cover soft corals (live)	0	0	0	0
% cover hard corals (live)	<1	<1	<1	<1
Hard Substrate (% of total)	100	100	100	100
Bed rock (% of HS)	0	0	0	0
Large boulders (% of HS)	100	100	100	100
Soft Substrate (% of total)	0	0	0	0
Sand (% of SS)	0	0	0	0
Silt/mud (% of SS)	0	0	0	0
Mud (% of SS)	0	0	0	0
Slope (flat = 0, vertical = 4)	2	2	2	2
Visibility (m)	3	3	3	2
Salinity (ppt)	33	33	31	31
Temp (ºC)	26	26	26	25

Table 3.4: Summary of the Tier 2 results. Recorded Ordinal ranks of percentage cover from Table 2.1 & 2.3

Taxa / Station	REA 1	REA 2	REA 3	REA 4
Bryazoa				
Brown/orange encrusting	1	0	1	0
Red encrusting	0	0	0	0
Bugula sp.	1	1	1	1
Actiniaria (sea anemonies)				
Anthopleura dixoniana	1	1	1	1
Anemone	0	0	0	0
Sand anemone	0	0	0	0
Gorgonacea				
Guaiagorgia sp.	0	0	0	0
Scleractinia				
Oulastrea crispata	1	1	1	1
Molusca				
Phenacovolva brevitostris	0	0	0	0
Perna viridis	2	2	2	2
Oysters small	1	1	1	1
Oysters large	0	0	0	0
Porifere (sponge)				
Orange encrusting	0	0	0	0
Encrusting	1	1	1	1
Golf ball	0	0	0	0
Crustacea				
Cirripedea	0	0	0	0
Echinodermata				
Diadema setosum	1	1	1	1
Parasalenia gratiosa	0	0	1	0
Echinothrix calamaris	0	0	0	0
Holothuria leucospilota	1	1	1	1
Misc.				
Coralline algae	1	1	1	1
Cyanobacteria l mats	0	0	0	0
Tunicate	1	1	1	1

3.2.13.1 REA 1 – Proposed Pipeline Side of Northern Breakwater

See Appendix IV for the location of this station. The raw survey data is in Appendix V. The survey depths were between 1.7m and 3.0m with an average depth of 2.35m. All 100m of this survey was carried out along the artificial boulder breakwater. Visibility was ~3m. Salinity was measured at 1m to be 33ppt.

There was only one species of hard coral recorded and that was the pioneering coral *Oulastrea crispata*. Coral cover was < 1% on the hard substratum between the depths of this survey. Colony sizes varied considerably and ranged from a few polyps (<1cm^2) to colonies covering areas over 100cm^2. The density of the colonies was ~1 per m^2 over the survey area. All of the coral colonies along this transect were in good condition.

Other associated organisms included the coralline algae *Schizoporella errata, Bugula* sp., the bivalve *Perna viridis*, some small oysters, the long spine sea urchin, *Diadema setosum* and the black sea cucumber *Holothuria leucospilota*. The transect also had scattered sponges and the occasional fan worm amongst the corals.

3.2.13.2 REA 2 – Inside of Northern Breakwater

See Appendix IV for the location of this station. The raw survey data is in Appendix V. The survey depths were between 1.8m and 2.5m with an average depth of 2.15m. All 100m of this survey was carried out along the artificial boulder breakwater. Visibility was ~3m. Salinity was measured at 1m to be 33ppt.

The REA results of this transect were the same as with REA 1. There was only one species of hard coral recorded and that was the pioneering coral *Oulastrea crispata*. Coral cover was < 1% on the hard substratum between the depths of this survey. Colony sizes varied considerably and ranged from a few polyps (<1cm^2) to colonies covering areas over 100cm^2. The density of the colonies was ~1 per m^2 over the survey area. All of the coral colonies along this transect were in good condition.

Other associated organisms included the coralline algae *Schizoporella errata, Bugula* sp., the bivalve *Perna viridis*, some small oysters, the long spine sea urchin, *Diadema setosum* and the black sea cucumber *Holothuria leucospilota*. The transect also had scattered sponges and the occasional fan worm amongst the corals.

3.2.13.3 REA 3 – Inside of Southern Breakwater

See Appendix IV for the location of this station. The raw survey data is in Appendix V. The survey depths were between 1.9m and 2.6m with an average depth of 2.25m. All 100m of this survey was carried out along the artificial boulder breakwater. Visibility was ~3m. Salinity was measured at 1m to be 31ppt.

The REA results of this transect were the same as with REA 1 and REA 2. There was only one species of hard coral recorded and that was the pioneering coral *Oulastrea crispata*. Coral cover was < 1% on the hard substratum between the depths of this survey. Colony sizes varied considerably and ranged from a few polyps (<1cm^2) to colonies covering areas over 150cm^2. The density of the colonies was ~1 per m^2 over the survey area. All of the coral colonies along this transect were in good condition.

Other associated organisms included the coralline algae *Schizoporella errata, Bugula* sp., the bivalve *Perna viridis*, some small oysters, the long spine sea urchin, *Diadema setosum* and the black sea cucumber *Holothuria leucospilota*. The transect also had scattered sponges and the occasional fan worm amongst the corals.

3.2.13.4 REA 4 – Outside of Southern Breakwater

See Appendix IV for the location of this station. The raw survey data is in Appendix V. The survey depths were between 1.5m and 3.1m with an average depth of 2.3m. All 100m of this survey was carried out along the artificial boulder breakwater. Visibility was ~2m. Salinity was measured at 1m to be 31ppt.

The REA results of this transect were almost the same as with REA 1, REA 2 and REA 3. There was only one species of hard coral recorded and that was the pioneering coral *Oulastrea crispata*. Coral cover was < 1% on the hard substratum between the depths of this survey. Colony sizes varied considerably and ranged from a few polyps (<1cm^2) to colonies covering areas over 150cm^2. The density of the colonies was ~1 per m^2 over the survey area. All of the coral colonies along this transect were in good condition.

Other associated organisms included the coralline algae *Schizoporella errata, Bugula* sp*.,* the bivalve *Perna viridis*, some small oysters, the long spine sea urchin, *Diadema setosum* and the black sea cucumber *Holothuria leucospilota*. The transect also had scattered sponges and the occasional fan worm amongst the corals.

This transect contained more rubbish than the other areas and a current was present during the REA survey. Of all of the areas investigated in this survey, this was the most exposed in terms of current, but not in terms of wave action and boat wash.

4. Discussion

4.1 Overview

Four REA Surveys were carried out in the survey area to describe the major coral communities recorded in the Spot Dive Survey. All of these areas contained one species of hard coral, *Oulastrea crispata*. This pioneering species of coral has been reported in and around the Hong Kong Harbour in surveys carried out in the past.

With regards to rare species, both confirmed and unconfirmed past records suggest that there were no rare corals recorded in this survey. The classification for the hard corals has been determined from the Field Guide to Hard Corals of Hong Kong by AFCD. The classification of the gorgonian and soft corals has been determined from the Soft Corals and Sea Fans by K. Fabricius & P. Alderslade (published by the Australian Institute of Marine Science). The table below (**Table 4.1**) lists the status of the coral species recorded in this survey:

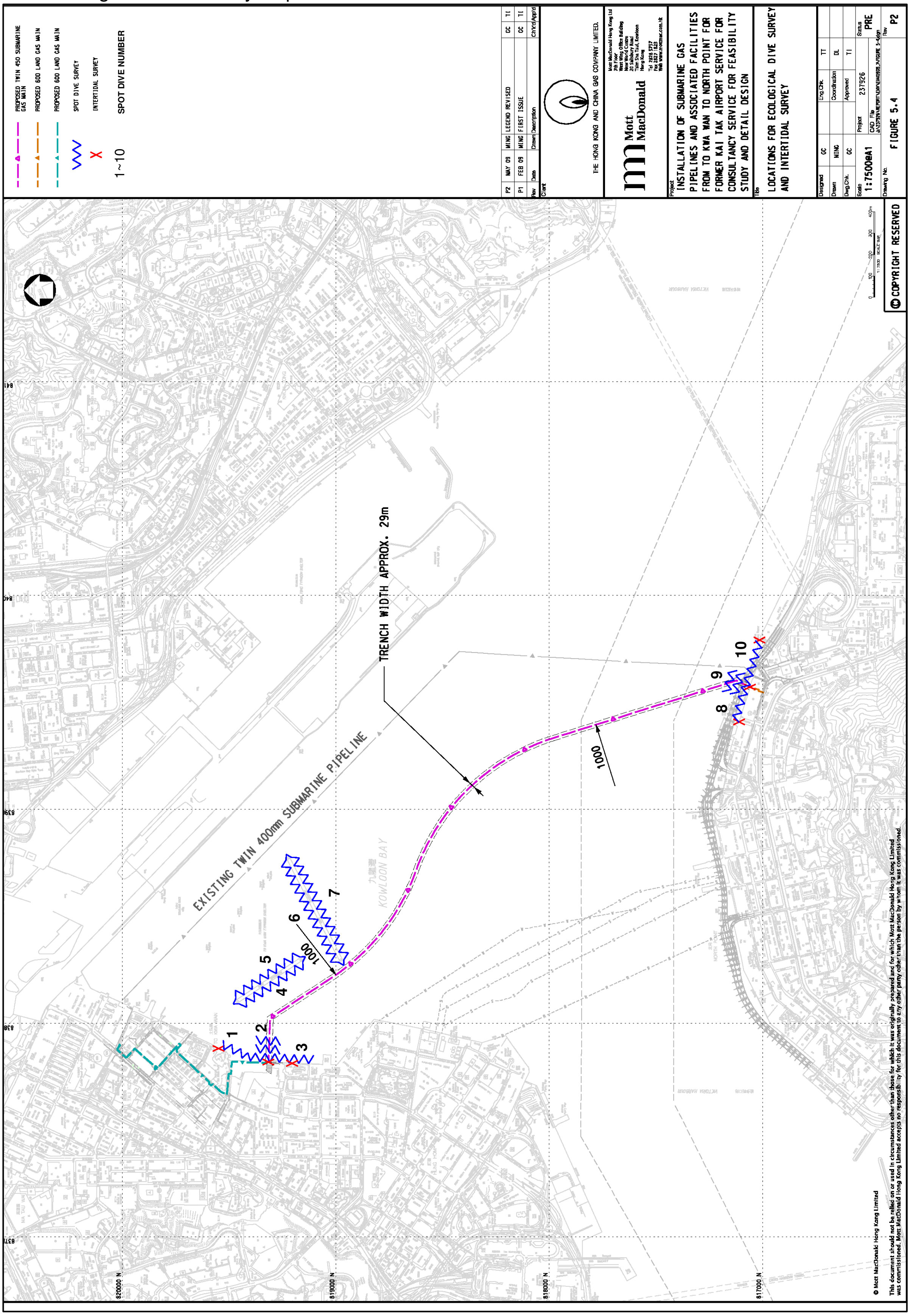
Table 4.1: The Status of the Coral Species Recorded in the Spot Dive Survey

Species	Status	Reference
Oulastrea crispata	Common	Field Guide to Hard Corals of Hong Kong. Agriculture, Fisheries & Conservation Department.
Euplexaura sp.	Widespread	Soft Corals and Sea Fans. K. Fabricius & P. Alderslade
Dendronephthya gigantea	Common	Soft Corals and Sea Fans. K. Fabricius & P. Alderslade

Whilst this species is common, it is prudent to propose some mitigation measures before and during the works period to minimize adverse impact on coral community. In order to protect the colonies on the breakwater, we recommend that a series of sediment curtains be deployed and moved as the grab dredge is operating. A setup similar to the double curtain that was installed at Pak Ah in Sai Kung during the pier renovations in 2001 should be sufficient. With the installation and strategic placement of the sediment curtain, the potential impact on the coral communities on the breakwaters due to the increase suspended solid concentration would be mitigated.

Appendices

Appendix I. Transect Site Map


PROPOSED TWIN 450 SUBMARINE GAS MAIN
PROPOSED 600 LAND GAS MAIN
PROPOSED 600 LAND GAS MAIN
SPOT DIVE SURVEY
INTERTIDAL SURVEY
1~10 SPOT DIVE NUMBER
THE HONG KONG AND CHINA GAS COMPANY LIMITED
INSTALLATION OF SUBMARINE GAS PIPELINES AND ASSOCIATED FACILITIES FROM TO KWA WAN TO NORTH POINT FOR FORMER KAI TAK AIRPORT SERVICE FOR CONSULTANCY SERVICE FOR FEASIBILITY STUDY AND DETAIL DESIGN
LOCATIONS FOR ECOLOGICAL DIVE SURVEY AND INTERTIDAL SURVEY
1:7500@A1
237926
PRE
FIGURE 5.4
P2
© COPYRIGHT RESERVED
TRENCH WIDTH APPROX. 29m
EXISTING TWIN 400mm SUBMARINE PIPELINE
KOWLOON BAY
1000
1
2
3
4
5
6
7
8
9
10

Appendix II. Spot Dive Raw Data

Transect T3

Parameter	Result	Remarks
Details:		Transect T3
Time:	11:35	
Date:	28.7.09	
Depth:	<5.5m	
Visibility:	2m	
Corals:		
Hermatypic Hard Coral Cover:	0	
CoralWatch Health (CA):	~	
Ahermatypic Hard Coral Cover:	0%	
Soft Coral Cover:	0%	
Rare Coral Species:	0	
Other Key Species:		
Perna viridis	Yes	
Oysters	Yes	
Sponges	Yes	
Anemones	Yes	
Tunicates	Yes	
Schizoporella sp.	No	
Zoanthid spp.	No	

Parameter	Result	Remarks
Substratum:		
Mud / Silt:	0%	
Sand:	40%	
Sand & Mud:	10%	
Rubble:	0%	
Rocks:	0%	
Boulders:	0%	
Large boulders(>50cm):	10%	
Pavement:	40%	
Angle of seabed:	90%	Mostly vertical
	10%	
Silt Cover thickness:	0	

Comments:

Scattered rubbish recorded in this area.
Small oysters on the seawall and on the scattered rubbish.
The seawall had a more diverse community including sponges.
Sponges on the scattered rubbish
Lytocarpus philippinus on some of the rocks and rubbish.
No corals were recorded in this area.
Evidence of sewage discharge into this area.

Transect T4

Parameter	Result	Remarks
Details:		Transect T4
Time:	12:20	
Date:	28.7.09	
Depth:	<10.0m	
Visibility:	2m	
Corals:		
Hermatypic Hard Coral Cover:	<1%	1 Species
		< 1% mortality
CoralWatch Health (CA):		
Ahermatypic Hard Coral Cover:	0%	
Soft Coral Cover:	0%	
Rare Coral Species:	0	
Other Key Species:		
Perna viridis	Yes	
Oysters	Yes	
Sponges	Yes	
Anemones	Yes	
Tunicates	Yes	
Schizoporella sp.	Yes	
Zoanthid spp.	No	

Parameter	Result	Remarks
Substratum:		
Mud / Silt:	5%	
Sand:	0%	
Sand & Mud:	0%	
Rubble:	0%	
Rocks:	5%	
Boulders:	5%	
Large boulders(>50cm):	85%	
Pavement:	0%	
Angle of seabed:	~45º	Sloping wall
Silt Cover thickness:	<1mm	

Comments:

Scattered colonies of *Oulastrea crispata* recorded in this area.
Ghost nets recorded in this area.
The boulders had *Perna viridis* and dead barnicles.
Some rubbish and discarded ropes recorded in this area.
Lytocarpus philippinus on some of the rocks and rubbish.
Diadema setosum amongst scattered rocks and rubbish.
Occasional *Holothuria leucospilota* recorded.

Transect T5

Parameter	Result	Remarks
Details:		Transect T5
Time:	13:15	
Date:	28.7.09	
Depth:	<9.0m	
Visibility:	2m	
Corals:		
Hermatypic Hard Coral Cover:	<1%	1 Species
		< 1% mortality
CoralWatch Health (CA):		
Ahermatypic Hard Coral Cover:	0%	
Soft Coral Cover:	0%	
Rare Coral Species:	0	
Other Key Species:		
Perna viridis	Yes	
Oysters	Yes	
Sponges	Yes	
Anemones	Yes	
Tunicates	Yes	
Schizoporella sp.	Yes	
Zoanthid spp.	No	

Parameter	Result	Remarks
Substratum:		
Mud / Silt:	5%	
Sand:	0%	
Sand & Mud:	0%	
Rubble:	0%	
Rocks:	10%	
Boulders:	5%	
Large boulders(>50cm):	80%	
Pavement:	0%	
Angle of seabed:	~45º	Sloping wall
Silt Cover thickness:	<1mm	

Comments:

Scattered colonies of *Oulastrea crispata* recorded in this area.
Ghost nets recorded in this area.
The boulders had *Perna viridis* and dead barnicles.
Some rubbish and discarded ropes recorded in this area.
Lytocarpus philippinus on some of the rocks and rubbish.
Diadema setosum amongst scattered rocks and rubbish.
Occasional *Holothuria leucospilota* recorded.

Transect T6

Parameter	Result	Remarks
Details:		Transect T6
Time:	13:45	
Date:	28.7.09	
Depth:	<12.0m	
Visibility:	2m	
Corals:		
Hermatypic Hard Coral Cover:	<1%	1 Species
		< 1% mortality
CoralWatch Health (CA):		
Ahermatypic Hard Coral Cover:	0%	
Soft Coral Cover:	0%	
Rare Coral Species:	0	
Other Key Species:		
Perna viridis	Yes	
Oysters	Yes	
Sponges	Yes	
Anemones	Yes	
Tunicates	Yes	
Schizoporella sp.	Yes	
Zoanthid spp.	No	

Parameter	Result	Remarks
Substratum:		
Mud / Silt:	5%	
Sand:	0%	
Sand & Mud:	0%	
Rubble:	0%	
Rocks:	15%	
Boulders:	5%	
Large boulders(>50cm):	75%	
Pavement:	0%	
Angle of seabed:	~45º	Sloping wall
Silt Cover thickness:	<1mm	

Comments:

Scattered colonies of *Oulastrea crispata* recorded in this area.
Ghost nets recorded in this area.
Perna viridis recorded in this area.
Some rubbish and discarded ropes recorded in this area.
Diadema setosum amongst scattered rocks and rubbish.
Occasional *Holothuria leucospilota* recorded.

Transect T7

Parameter	Result	Remarks
Details:		Transect T7
Time:	14:15	
Date:	28.7.09	
Depth:	<13.0m	
Visibility:	2m	
Corals:		
Hermatypic Hard Coral Cover:	<1%	1 Species
		< 1% mortality
CoralWatch Health (CA):		
Ahermatypic Hard Coral Cover:	<1%	
Soft Coral Cover:	<1%	
Rare Coral Species:	0	
Other Key Species:		
Perna viridis	Yes	
Oysters	Yes	
Sponges	Yes	
Anemones	Yes	
Tunicates	Yes	
Schizoporella sp.	Yes	
Zoanthid spp.	No	

Parameter	Result	Remarks
Substratum:		
Mud / Silt:	5%	
Sand:	0%	
Sand & Mud:	0%	
Rubble:	0%	
Rocks:	10%	
Boulders:	5%	
Large boulders(>50cm):	80%	
Pavement:	0%	
Angle of seabed:	~45º	Sloping wall
Silt Cover thickness:	<1mm	

Comments:

Scattered colonies of *Oulastrea crispata* recorded in this area.
One colony of *Euplexaura* sp. recorded.
Two colonies of *Dendronephthya gigantea were recorded.*
Ghost nets recorded in this area.
Perna viridis recorded in this area.
Some rubbish and discarded ropes recorded in this area.
Diadema setosum amongst scattered rocks and rubbish.
Occasional *Holothuria leucospilota* recorded.

Transect T8

Parameter	Result	Remarks
Details:		Transect T8
Time:	15:00	
Date:	28.7.09	
Depth:	<6m	
Visibility:	1m	
Corals:		
Hermatypic Hard Coral Cover:	0	
CoralWatch Health (CA):	~	
Ahermatypic Hard Coral Cover:	0%	
Soft Coral Cover:	0%	
Rare Coral Species:	0	
Other Key Species:		
Perna viridis	Yes	
Oysters	Yes	
Sponges	Yes	
Anemones	Yes	
Tunicates	Yes	
Schizoporella sp.	Yes	
Zoanthid spp.	No	

Parameter	Result	Remarks
Substratum:		
Mud / Silt:	30%	
Sand:	15%	
Sand & Mud:	25%	
Rubble:	10%	
Rocks:	10%	
Boulders:	0%	
Large boulders(>50cm):	0%	
Pavement:	10%	
Angle of seabed:	~90 deg	On seawall
	~10 deg	At seabed
Silt Cover thickness:	~1mm	

Comments:

Scattered sponges on the seawall.
Tunicates on most hard substratum.
Individuals of *Diadema setosum* on the seawall.
Evidence of sewage discharge nearby.
Anemone *Cerianthus cf. filiformis* recorded.

Transect T9

Parameter	Result	Remarks
Details:		Transect T9
Time:	15:30	
Date:	28.7.09	
Depth:	<12.0m	
Visibility:	2m	
Corals:		
Hermatypic Hard Coral Cover:	<1%	I species, 2 colonies
CoralWatch Health (CA):	~	
Ahermatypic Hard Coral Cover:	0%	
Soft Coral Cover:	0%	
Rare Coral Species:	0	
Other Key Species:		
Perna viridis	Yes	
Oysters	Yes	
Sponges	Yes	
Anemones	Yes	
Tunicates	Yes	
Schizoporella sp.	Yes	
Zoanthid spp.	No.	

Parameter	Result	Remarks
Substratum:		
Mud / Silt:	0%	
Sand:	30%	
Sand & Mud:	10%	
Rubble:	10%	
Rocks:	30%	
Boulders:	5%	
Large boulders(>50cm):	5%	
Pavement:	10%	
Angle of seabed:	~90 deg	On seawall
	~10 deg	At seabed
Silt Cover thickness:	~1mm	

Comments:

Evidence of sewage discharge nearby.
A lot of rubbish in this area.
Anemone *Cerianthus cf. filiformis* recorded.
Two colonies of *Oulastrea crispata* were recorded.

Transect T10

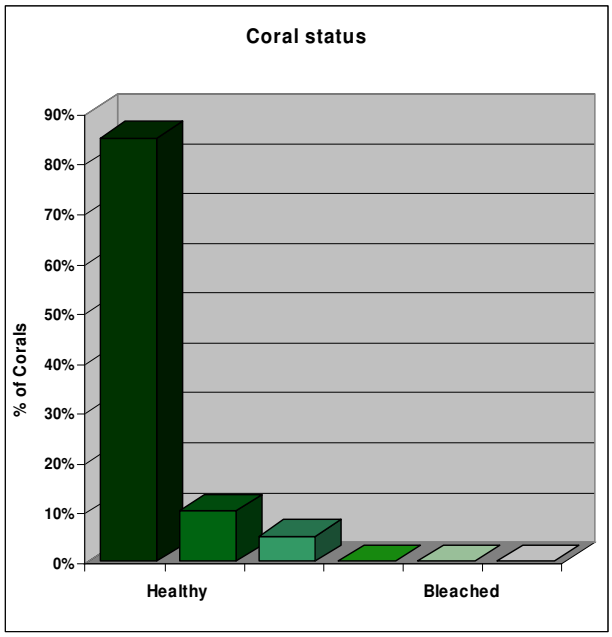
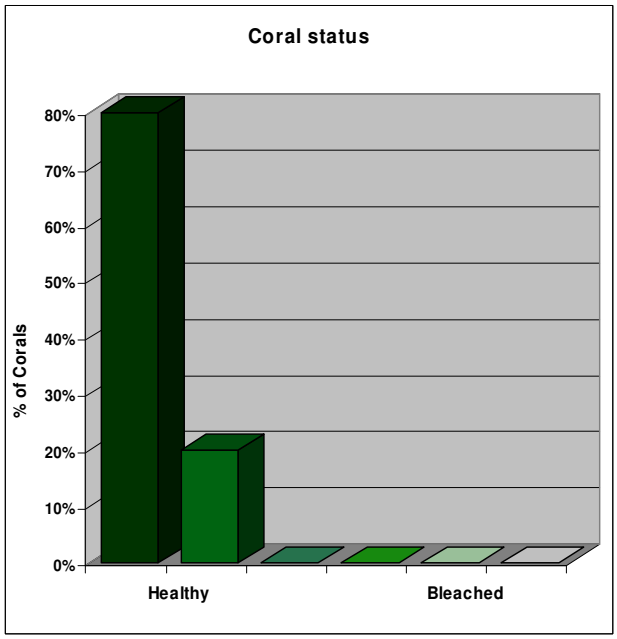
Parameter	Result	Remarks
Details:		Transect T10
Time:	16:05	
Date:	28.7.09	
Depth:	<6m	
Visibility:	2m	
Corals:		
Hermatypic Hard Coral Cover:	0	
CoralWatch Health (CA):	~	
Ahermatypic Hard Coral Cover:	0%	
Soft Coral Cover:	0%	
Rare Coral Species:	0	
Other Key Species:		
Perna viridis	Yes	
Oysters	Yes	
Sponges	Yes	
Anemones	Yes	
Tunicates	Yes	
Schizoporella sp.	Yes	
Zoanthid spp.	No	

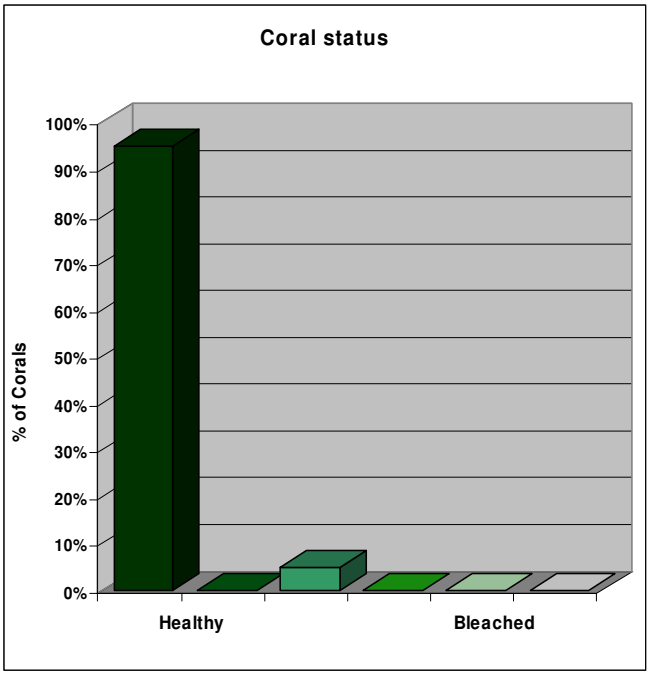
Parameter	Result	Remarks
Substratum:		
Mud / Silt:	30%	
Sand:	15%	
Sand & Mud:	25%	
Rubble:	10%	
Rocks:	10%	
Boulders:	0%	
Large boulders(>50cm):	0%	
Pavement:	10%	
Angle of seabed:	~90 deg	On seawall
	~10 deg	At seabed
Silt Cover thickness:	~1mm	

Comments:

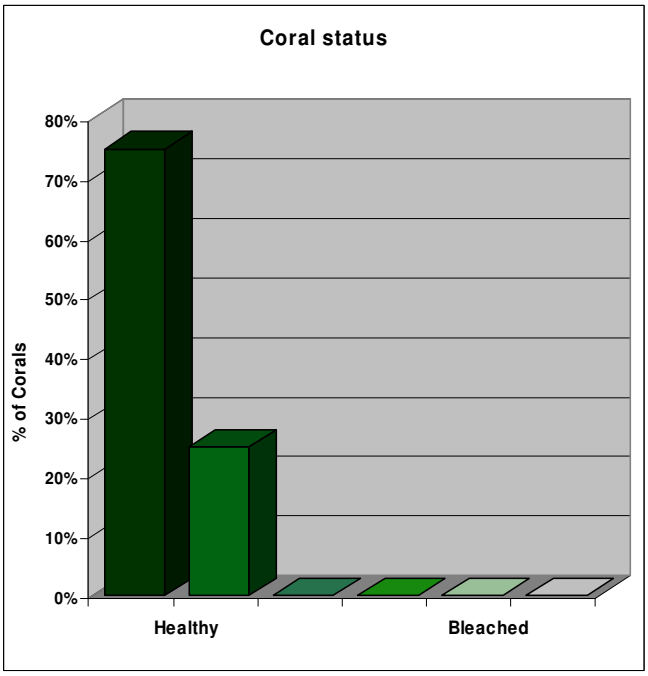
Scattered sponges on the seawall.
Tunicates on most hard substratum.
Individuals of *Diadema setosum* on the seawall.
Evidence of sewage discharge nearby.
Anemone *Cerianthus cf. filiformis* recorded.

Appendix III. Coralwatch Graphs

	Graph 1. Transect T4. CA = 5.00
	Graph 2. Transect T5. CA = 5.09

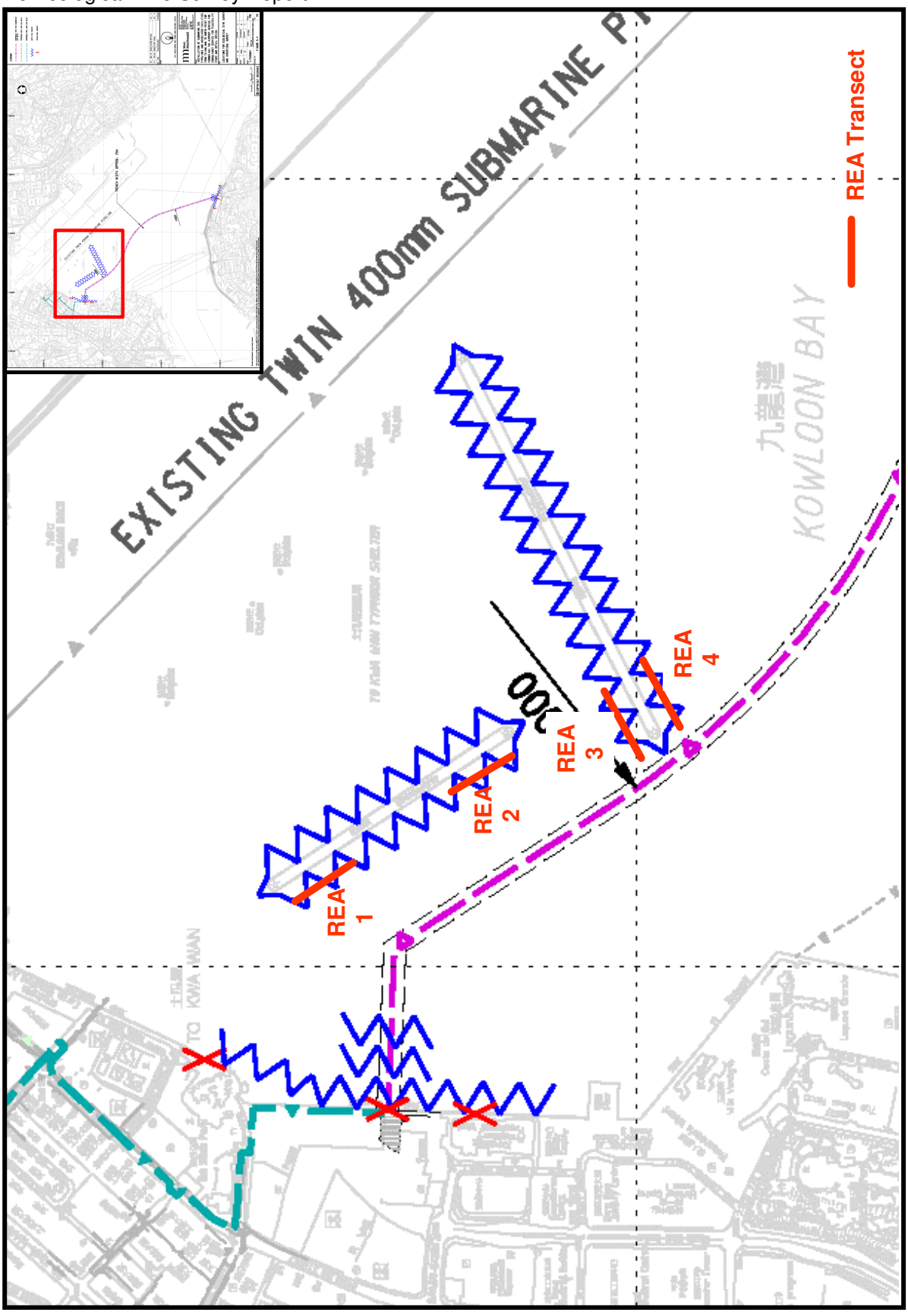


Graph 3. Transect T6. CA = 4.82



Graph 4. Transect T7. CA = 5.14

Appendix IV. REA Transect Locations


EXISTING TWIN 400mm SUBMARINE P
REA Transect
KOWLOON BAY
九龍灣
100
REA 1
REA 2
REA 3
REA 4
TO KWA WAN

Appendix V. REA Raw Data

Transect	REA 1	REA 2	REA 3	REA 4
General Data				
Depth min (m)	1.7	1.8	1.9	1.5
Depth max (m)	3.0	2.5	2.6	3.1
Average (m):	2.35	2.15	2.25	2.3
Exposure (1~4)	2	2	2	2
Sediment (0~3)	1	1	1	1
Slope (0=Flat, 4=vertical)	2	2	2	2
Hard substratum (% of total)	100	100	100	100
Bed Rock (% of HS)	0	0	0	0
Large Boulders (% of HS)	100	100	100	100
Soft Substratum (% of total)	0	0	0	0
Sand (% of SS)	0	0	0	0
Silt/Mud (% of SS)	0	0	0	0
Mud (% of SS)	0	0	0	0
Visibility (m)	3	3	3	2
Salinity (ppt)	33	33	31	31
Temp ºC (1m)	26	26	26	25
Taxa				
Bryazoa				
Brown/orange encrusting	1	0	1	0
Red encrusting	0	0	0	0
Bugula sp.	1	1	1	1
Actiniaria (sea anemonies)				
Anthopleura dixoniana	1	1	1	1
Anemone	0	0	0	0
Sand anemone	0	0	0	0
Gorgonacea				
Guaiagorgia sp.	0	0	0	0
Scleractinia				
Oulastrea crispata	1	1	1	1
Molusca				
Phenacovolva brevitostris	0	0	0	0
Perna viridis	2	2	2	2
Oysters small	1	1	1	1
Oysters large	0	0	0	0
Porifere (sponge)				
Orange encrusting	0	0	0	0
Encrusting	1	1	1	1
Golf ball	0	0	0	0
Crustacea				
Cirripedea	0	0	0	0
Echinodermata				
Diadema setosum	1	1	1	1
Parasalenia gratiosa	0	0	1	0
Echinothrix calamaris	0	0	0	0
Holothuria leucospilota	1	1	1	1
Misc.				
Coralline algae	1	1	1	1
Cyanobacteria l mats	0	0	0	0
Tunicate	1	1	1	1

Appendix VI. Photographs

	Plate 1. The To Kwa Wan Landing Point.
	Plate 2. The sea surface was quite filthy at the To Kwa Wan Landing Point.
	Plate 3. Several clumps of *Perna viridis.*

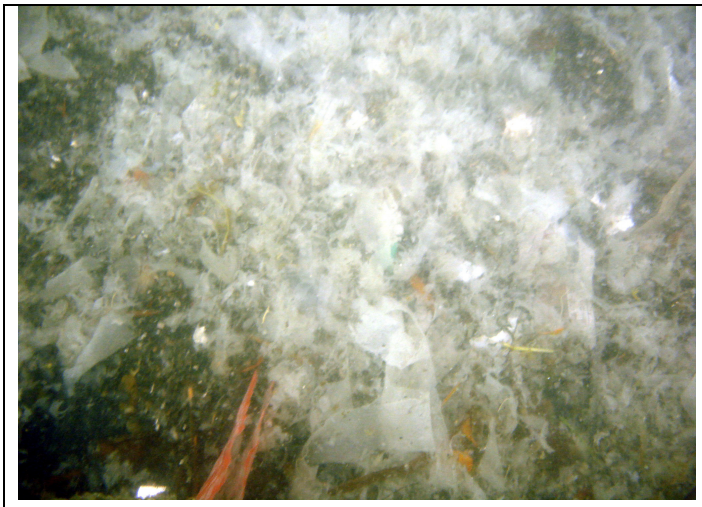
	Plate 4. This is part of the discharge from a sewage outflow – tissue.
	Plate 5. The cyanobacteria mat that covered most of the seabed directly out from the To Kwa Wan Landing Point.
	Plate 6. The anemone *Cerianthus* cf. *filiformis* recorded out from the To Kwa Wan Landing Point..

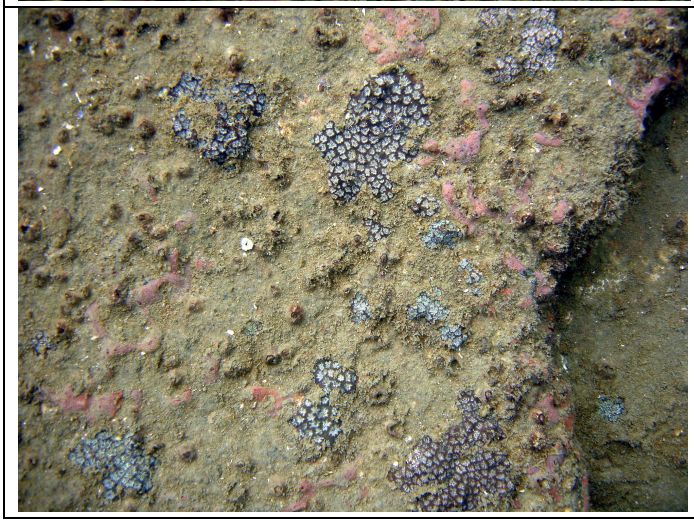
	Plate 7. The start of the first breakwater surveyed for corals.
	Plate 8. A single colony of *Oulastrea crispata*.
	Plate 9. Some areas had many colonies of *Oulastrea crispata* clustered together.

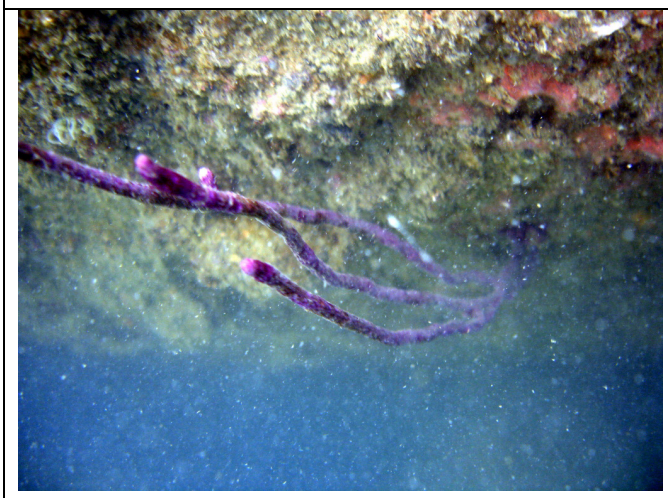
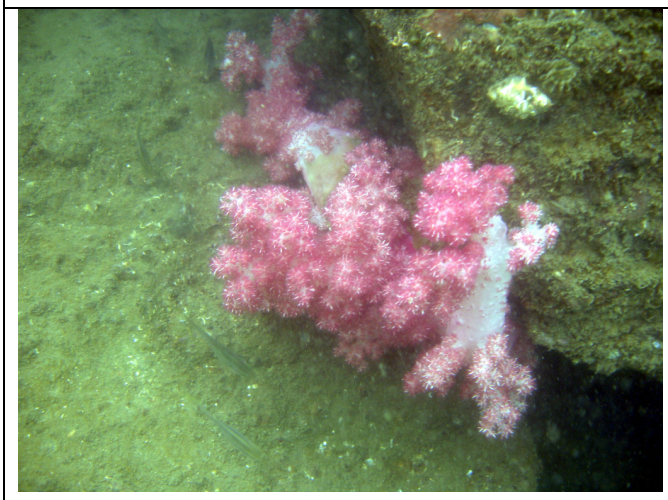
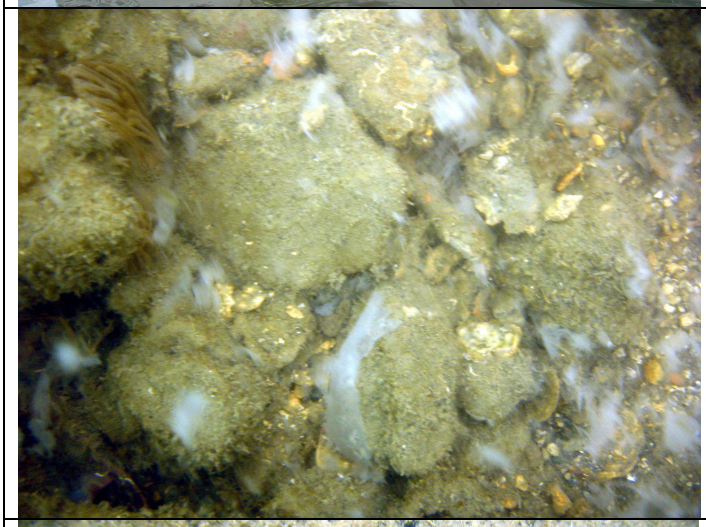
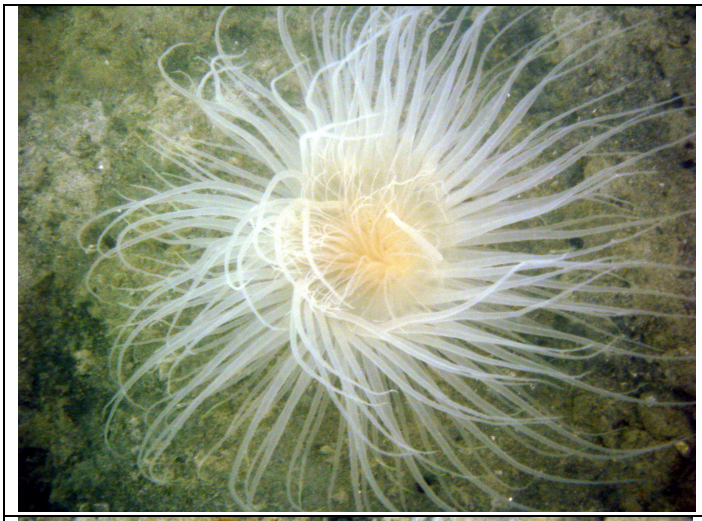
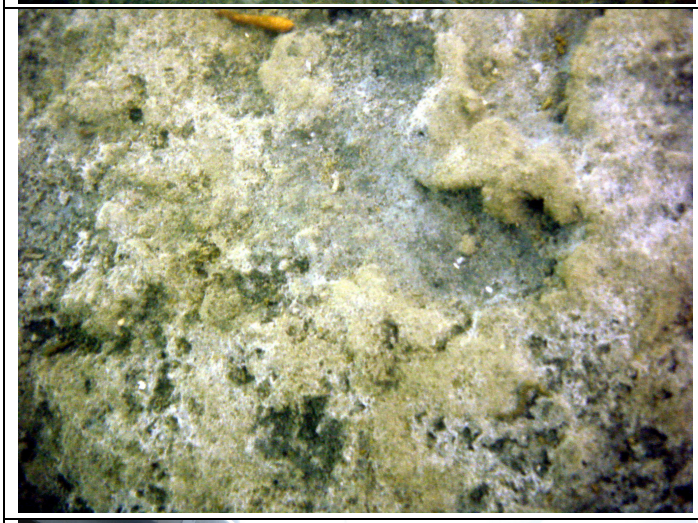
	Plate 10. There were quite a few ghosted fishing nets recorded in the area.
	Plate 11. The single colony of the gorgonian *Euplexaura* sp. recorded in this survey.
	Plate 12. One of the two colonies of the soft coral *Dendronephthya gigantean* recorded during this survey.

	Plate 13. The seawall at the North Point Landing Point.
	Plate 14. This is part of the discharge from a sewage outflow – tissue.
	Plate 15. This is one of the two colonies of the hard coral *Oulastrea crispata* recorded during the survey carried out at the North Point Landing Point.

	Plate 16. The anemone *Cerianthus* cf. *filiformis* recorded out from the North Point Landing Point.
	Plate 17. There was a thick cyanobacteria mat on the seabed at the North Point Landing Point.
	Plate 18. The eastern Corridor structure.