

**Agreement No. CE 18/2002 (EP)**  
**Construction of Helipads at Peng Chau and Yung Shue Wan,**  
**Lamma Island**



**Report for**  
**Coral Mapping, Ecological Assessment and Tagging Exercise**  
**at Yung Shue Wan, Lamma Island**

(Version 3.0)

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**miniprojects co. Ltd.**

**CINOTECH** 漢臻  
consultants limited

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# 1 INTRODUCTION

## 1.3 Project Background

- 1.1.1 Construction of Yung Shue Wan Helipad (the Project) involves the construction and operation of a permanent helipad at Yung Shue Wan, Lamma Island. The Project has been planned and managed in-house by the Land Works Division of Civil Engineering and Development Department (CEDD) on behalf of the Home Affairs Department (HAD). Construction works are to be completed by contractors under CEDD's supervision.
- 1.1.2 The helipad is solely required for transporting residents in areas of North Lamma to urban areas for medical treatment in emergency situations, and is not for commercial use. The previous Yung Shue Wan helipad – located on a soccer pitch outside the North Lamma Clinic – ceased operation in May 1998 when the Government Flying Service (GFS) classified the Site to a Category 1 Landing Site
- 1.1.3 Since there has been no permanent, dedicated helipad serving the local community. The community was until recently using the helipad at The Hongkong Electric Co. (HEC) Ltd's Lamma Power Station – a distance of 2.75 km and a typical trip time of around 20 minutes by mini-ambulance from the North Lamma Clinic. As a more acceptable interim measure, HAD commissioned the development of a temporary helipad that has been in operation at Yung Shue Wan since October 2003 pending the construction of a permanent helipad to serve the local community
- 1.1.4 Cinotech Consultants Limited has been appointed to formulate a Coral Survey Team to conduct the Marine Ecology Survey for Construction of Helipads at Yung Shue Wan, Lamma Island, Agreement No. CE 18/2002 (EP).
- 1.1.5 miniprojects Company Limited (miniprojects co. Ltd.) have been commissioned by Cinotech Consultants Limited to undertake coral mapping at the Impact Monitoring Site (IMS) at Yung Shue Wan; and ecological assessment and coral tagging exercise at both the IMS and Control Monitoring Site (CMS) at Shum Wan, Lamma Island.
- 1.1.6 This report presents the results of
- Coral mapping of the boulder seawall at the IMS.
  - Ecological assessment of the coral community at the IMS and CMS
  - Coral tagging exercise at the IMS and CMS
- 1.1.7 As background to this study, a brief review of previous subtidal survey findings has been included and is presented in Section 2 of this report. The report then describes the survey methodology (Section 3) and results (Section 4) of coral mapping at the IMS, the ecological assessment and tagging exercise at the IMS and CMS.

## 2 PREVIOUS SURVEY FINDINGS

- 2.1.1 Environmental Impact Assessment Study for Construction of Helipads at Peng Chau and Lamma Island – Investigation – EIA Study for Helipad at Yung Shue Wan, Lamma Island – Final EIA Study Report – BMT Asia Pacific Limited.
- 2.1.2 The only available previous information on coral community around the construction area is from the dive survey conducted in 2005 for the EIA Study of the Helipad construction.
- 2.1.3 Spot-check reconnaissance dives and qualitative transect survey were conducted at the seawall around the helipad construction location. The area was comprised of three major habitat types, namely granite boulder habitat, granite rocky shore and silty marine muds. Benthic flora and fauna, including corals, bryozoans, encrusting sponges, mussels and barnacles were confined to the hard substratum.
- 2.1.4 A total of 15 species (4 families) of hard coral was recorded around the seawall, with the dominant family being the Faviidae.

**Table 2.1 Hard coral species recorded around the seawall at Yung Shue Wan (April 2003, BMT)**

Family	Scientific Name
Faviidae	<i>Favites pentagona</i>
	<i>Favites chinensis</i>
	<i>Favites flexuosa</i>
	<i>Favites abdita</i>
	<i>Goniastrea aspera</i>
	<i>Favia rotumana</i>
	<i>Oulastrea crispata</i>
	<i>Cyphastrea serailia</i>
	<i>Platygyra carnosus</i>
	<i>Plesiastrea versipora</i>
Siderastreidae	<i>Psammocora haimeana</i>
	<i>Psammocora profundacella</i>
	<i>Psammocora superficialis</i>
Dendrophylliidae	<i>Turbinaria peltata</i>
Poritidae	<i>Porites cf lutea/lobata</i>

- 2.1.5 The coral cover was estimated to be 6 to 10% of the surveyed area. The granite boulder seawall was regarded moderate ecological value due to relatively high coral richness and good potential value.

### 3 METHODOLOGY

The coral survey was divided into 3 parts,

- Coral mapping of the boulder seawall at the IMS
- Ecological assessment of the coral community at the IMS and CMS
- Coral tagging exercise at the IMS and CMS

#### 3.3 Coral Mapping of the Boulder Seawall at the IMS

3.1.1 The coral mapping area at the IMS is shown in Fig. 3.1. A map of working area at IMS is shown in Fig 3.2.

3.1.2 At the IMS, coral mapping was conducted along three 160m transects (which covered the whole length of the sea wall) at three depths, D1 (1.5m below C.D.), D2 (2.5m below C.D.) and D3 (3.5m below C.D.). The belt transect area, accordingly, was divided into 4 zones (Figs. 4.1 and 4.2). Except shallow zone above D1, area of each zone was 320 m<sup>2</sup> (2 x 160m, wide x length). The area of the shallow zone above D1 was 640 m<sup>2</sup> (4 x 160m). A total area of 1600m<sup>2</sup> (10 x 160m) was, therefore, surveyed. By using the readings on the line and belt transects, coordinates (x, y) of each coral colony were recorded and mapped. Locations of the line transects were recorded by GPS (GPSmap 60CS, Garmin).

3.1.3 The size and species of the corals, health conditions and associated substratum of individual coral colonies were recorded. Size of associated substratum was measured by its maximum diameter and was classified into rubble (diameter <0.5m), boulder (diameter >0.5m) or bedrock. Percentage area of sedimentation, bleaching and partial mortality was also measured.

#### 3.3 Ecological Assessment of the Coral Community at the IMS and CMS

##### Rapid Ecological Assessment (REA)

3.2.1 Assessment of coral community using the semi-quantitative REA method was conducted at the Impact Monitoring Site (IMS) and Control Monitoring Site (CMS) (Fig. 3.2)

3.2.2 Rapid Ecological Assessment methods have been adopted in many regions to examine baseline information on coral reefs, such as the Great Barrier Reef (DeVantier et al. 1998). The methods can be applied to a wide range of coral reef and community types and were also used in a coral community study in Hong Kong with some modification (OCL 2003).

3.2.3 For each site selected for REA study, three 50m-long transect tape (T1 to T3) was laid. Each transect was positioned within a single ecological zone/habitat at an approximately constant depth range. Survey was performed along the transect tape. On each transect, a belt area of 100m<sup>2</sup> (2m wide x 50m long) was surveyed.

3.2.4 Two types of information were recorded:

- a. cover of the major benthic groups;
- b. inventory of sessile benthic taxa.

These were performed according to Tier I and Tier II levels of information.

3.2.5 Tier I: Categorization of ecological (benthic cover) and environmental variables.

To describe the benthic cover, six ecological and seven substratum attributes (Table 3.1a) were assigned. Each attribute was given a rank, from 0 to 6 (Table 3.1b) based on the overall cover along the survey area.

3.2.6 Tier II: Taxonomic inventories to define types of benthic communities.

An inventory of benthic taxa was compiled during each swim. Taxa were identified either *in situ* or with the aid of photographs to confirm identification afterward.

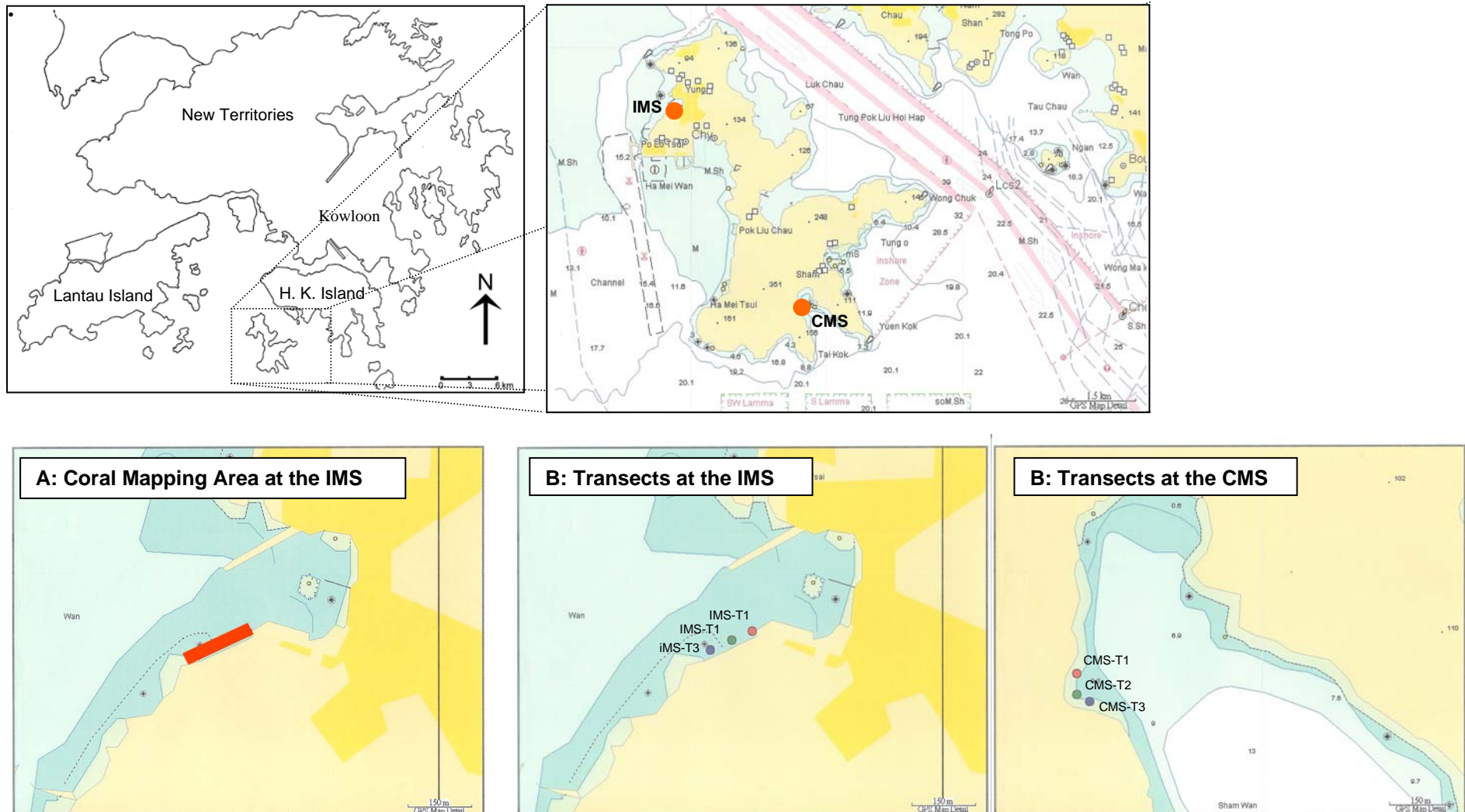
- a. Hard corals (Order Scleractinia) – to genus and species level whenever possible.
- b. Soft corals (Subclass Octocorallia) – genus level
- c. Other benthos (such as sponges zoanthids, bryozoans, macroalgae etc) – high taxonomic level (usually phylum plus growth form)

3.2.7 Each taxon in the inventory was given a rank (0 to 5) on the basis of its abundance in the community at the site (Table 3.1c). These broad categories rank taxa in terms of the relative abundance of individuals, rather than the contribution to benthic cover, at each site.

**Table 3.1 Categories of a) benthic attributes, b) ordinal ranks of percentage cover and c) ordinal ranks of taxon abundance.**

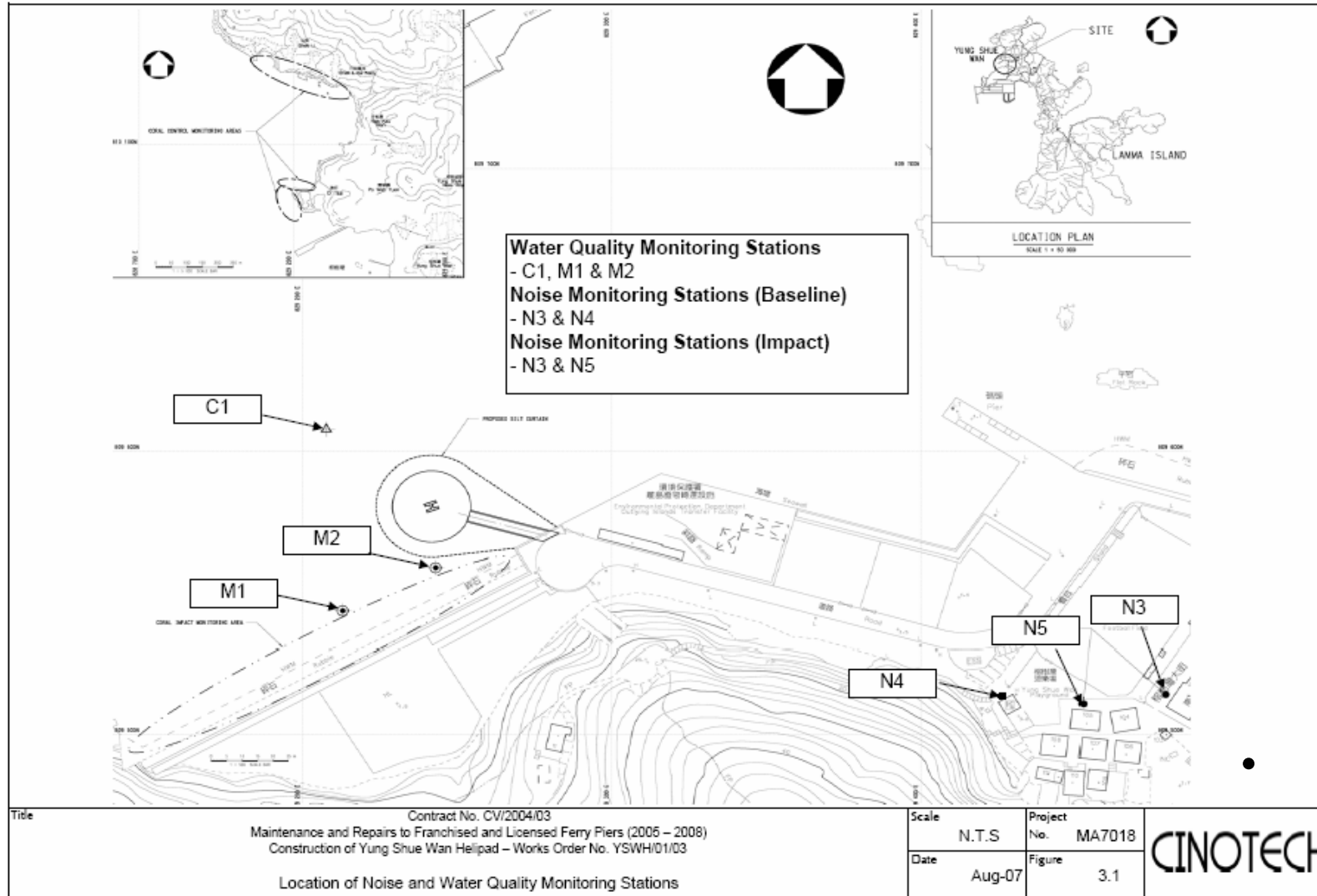
a) Attributes		b) Cover		c) Taxon Abundance	
Ecological	Substratum	Rank	Percentage	Rank	Abundance
Hard coral	Bedrock	0	Not recorded	0	Absent
Dead standing coral	Boulders (diam. >50cm)	1	1-5%	1	Rare
Soft coral	Rubble (diam. <50cm)	2	6-10%	2	uncommon
Encrusting algae	Sand & Shell debris	3	11-30%	3	Common
Coralline algae	Mud & Silt	4	31-50%	4	Abundant
Macro-algae		5	51-75%	5	Dominant
Sea anemone		6	76-100%		

**Fig. 3.1 Map Showing the Locations of the Impact Monitoring Site (IMS) and Control Monitoring Site (CMS). A: The Mapping Area at the IMS. B: The Positions of the Transects (Only Starting Points are Shown) for Ecological Assessment at the IMS and CMS.**





**Fig. 3.2 Map showing the working area at the Impact Monitoring Station**



### **3.3 Coral Tagging Exercise at the IMS and CMS**

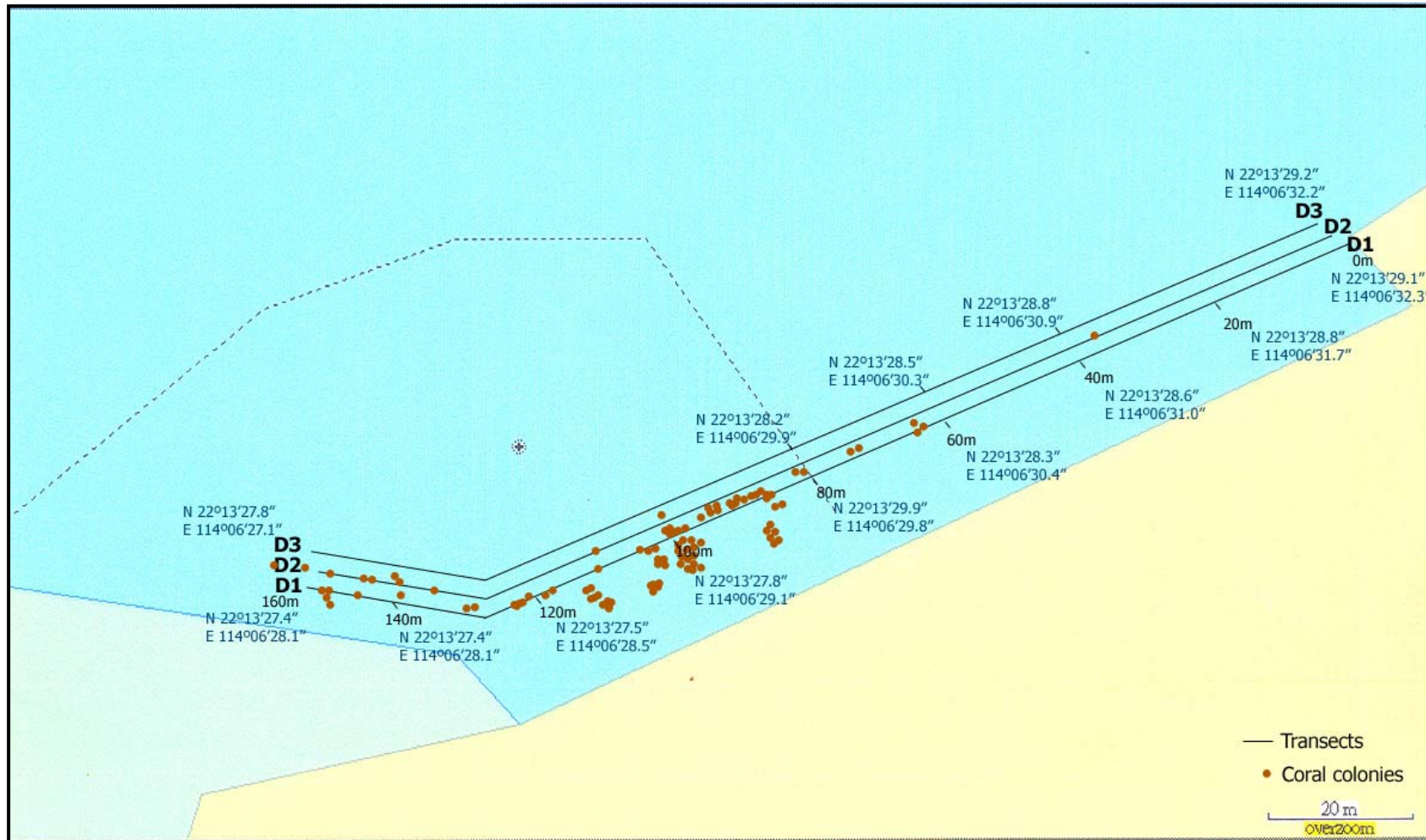
- 3.3.1 At each site, at least 10 hard coral colonies were identified to species level (if possible) and tagged for impact monitoring during the construction works. Corals were tagged giving priority to the large, undamaged colonies since damage to these colonies would be more evident compared to smaller colonies or corals with existing damage. Corals were also selected for tagging based on the most suitable coral species and growth forms. As far as possible, tagging of hard coral species with tall polyps were avoided due to their higher tolerance of sedimentation.
- 3.3.2 The selected colonies were tagged using two-level marking,
- A numbered stone, painted in bright yellow, was placed next to each tagged colony,
  - A numbered plastic tag was nailed into an adjacent piece of hard substrate.
- 3.3.3 For each tagged coral, specific detailed information was collected including species identification, size, growth form and depth. The health status of each tagged coral colony was carefully recorded, including information on existing surface area with partial mortality, bleached area, as well as percentage cover of sedimentation. The condition of each tagged coral colony was recorded by taking a photograph from an angle and distance that best represents the entire colony.

## 4 RESULTS

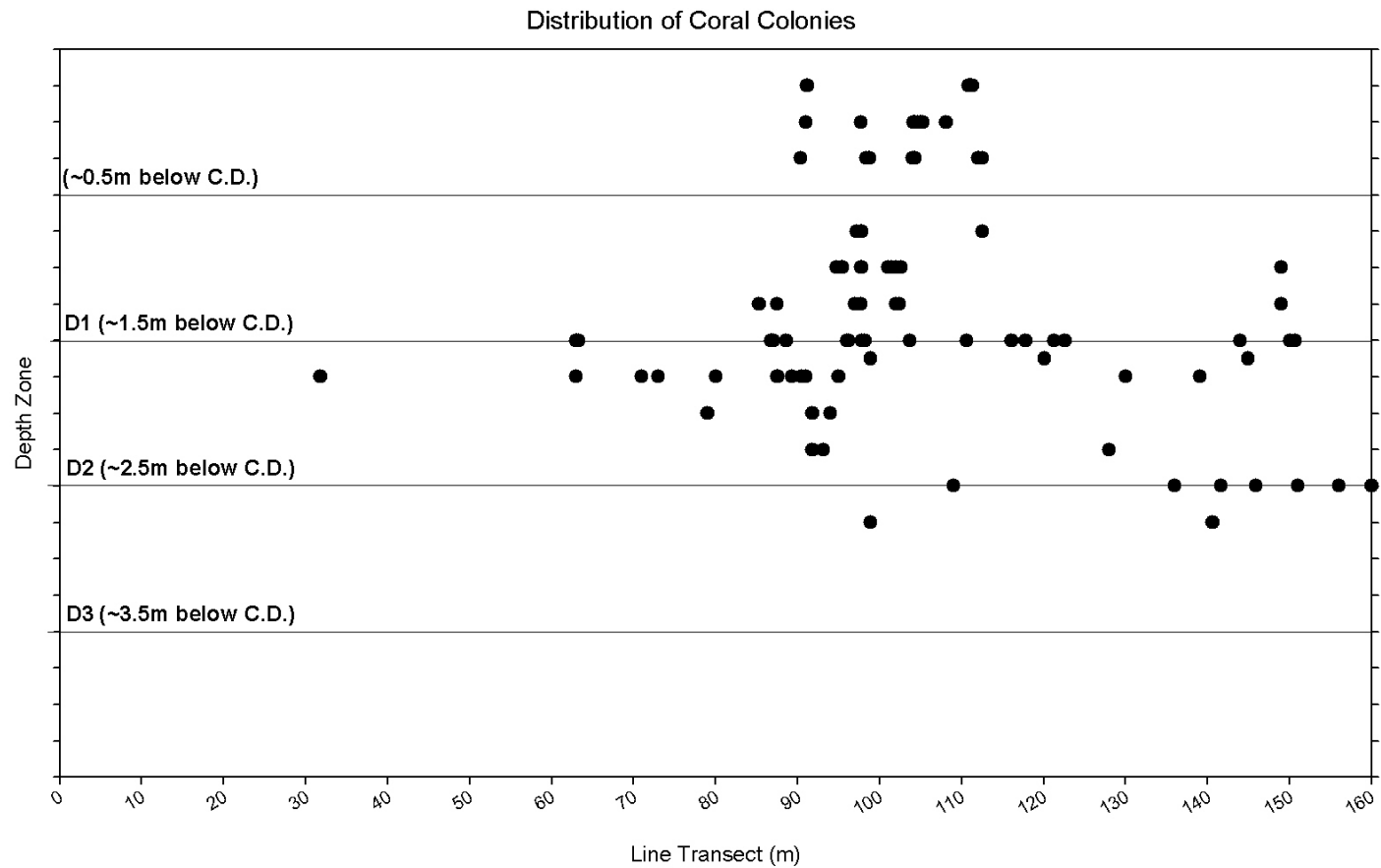
### 4.3 Coral Mapping of the Boulder Seawall at the IMS

- 4.1.1 The coral mapping was conducted on 24<sup>th</sup> June 2007.
- 4.1.2 Along the artificial seawall at the IMS, the substratum is mainly composed of artificial boulders at the shallow depth (-0.5 to -3.5m below C.D.). Most coral colonies were attached to these big boulders.
- 4.1.3 A total of 122 hard coral colonies were recorded and mapped within the surveyed area. The distribution of each colony in the surveyed area (10m wide x 160m long) is shown in Figs. 4.1, 4.2 and 4.3.
- 4.1.4 Species identity of each coral colony, the colony size, percentage sediment cover, health conditions in terms of percentage area of bleaching and partial mortality and the associated substratum of colonies were recorded and presented in Appendix I.
- 4.1.5 The 122 colonies belong to 15 species, 11 genus and 4 families. A summary of number of colonies from each genus is presented in Table 4.1. *Favites pentagona* was the most abundant species recorded in the survey area. The 5 most common species were namely, *Favites pentagona*, *Porites sp.*, *Plesiastrea versipora*, *Oulastrea crispata* and *Cyphastrea serailia*. These species are all common local shallow species. Representative pictures are presented in Appendix II.
- 4.1.6 The size of the coral colonies ranged from 1 to 1,600 cm<sup>2</sup>, over 80 of the 122 colonies were between 100 to 500 cm<sup>2</sup> (Table 4.2). Sedimentation cover ranged from 0 to 40% of the colony area, bleaching (0 to 1%) and partial mortality (0 to 8%) were low (Table 4.3). Most of the colonies were attached on boulders of over 0.5m diameter (Table 4.4).

**Fig. 4.1 Map Showing the Distribution of Coral Colonies at the Impact Monitoring Site (IMS). Orange dots represent coral colonies. GPS coordinates of the transects are shown.**



**Fig. 4.2. Coral Mapping - Distribution of Coral Colonies at the IMS (line transect scale = 1:500).**



**Fig. 4.3. Coral Mapping - Distribution of Coral Colonies at the IMS (line transect scale = 1:100).**

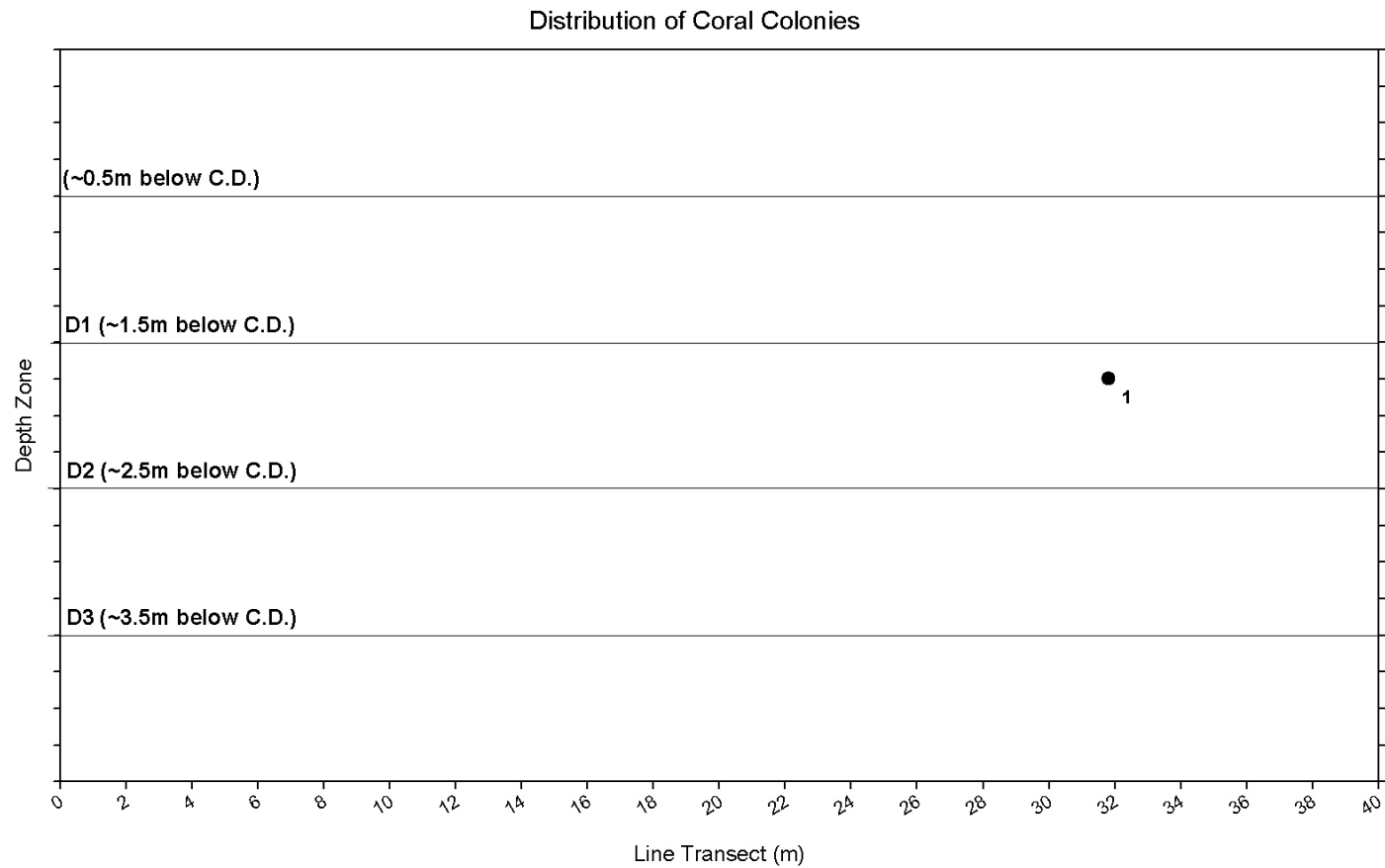


Fig. 4.3.....continued.

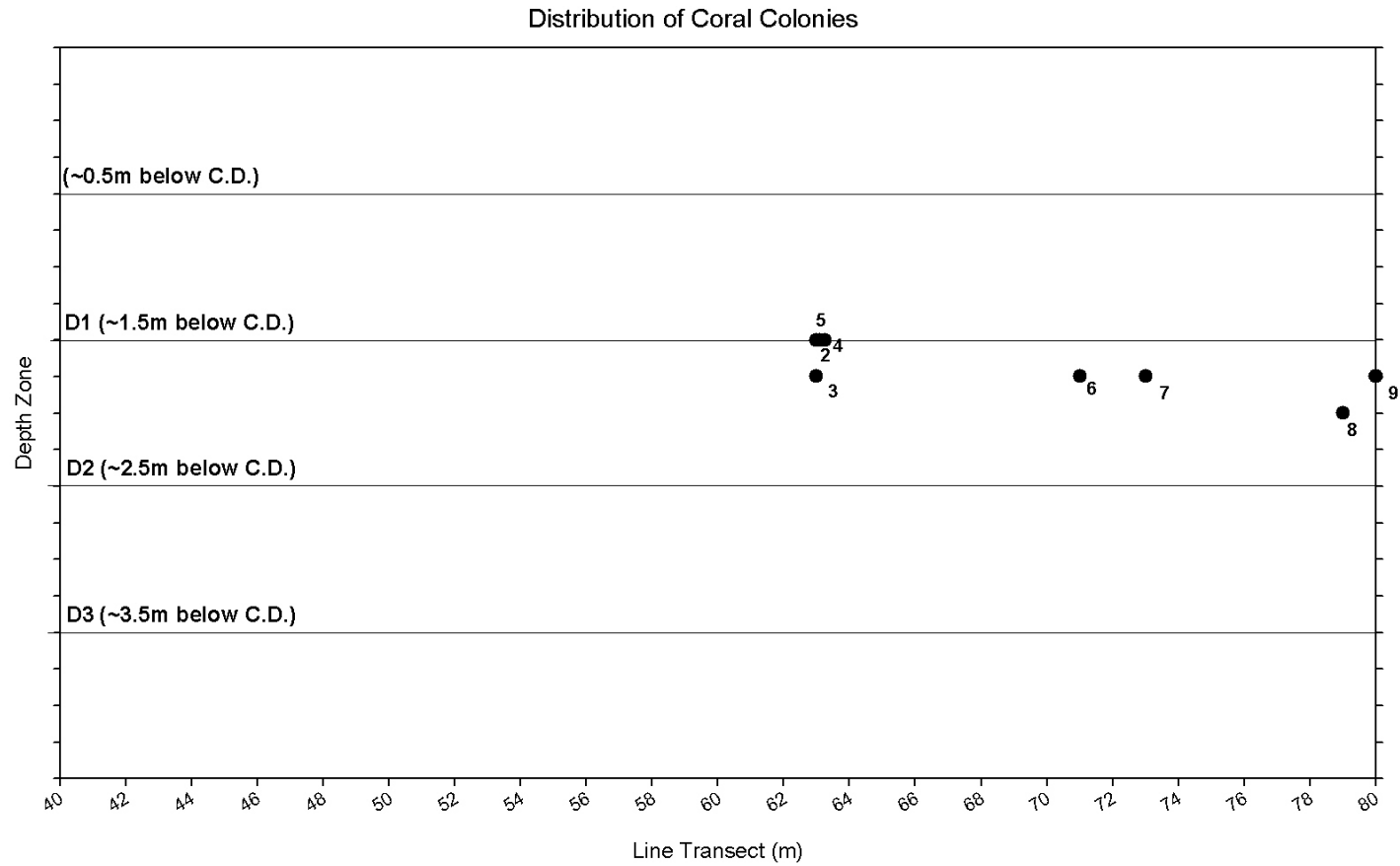


Fig. 4.3.....continued.

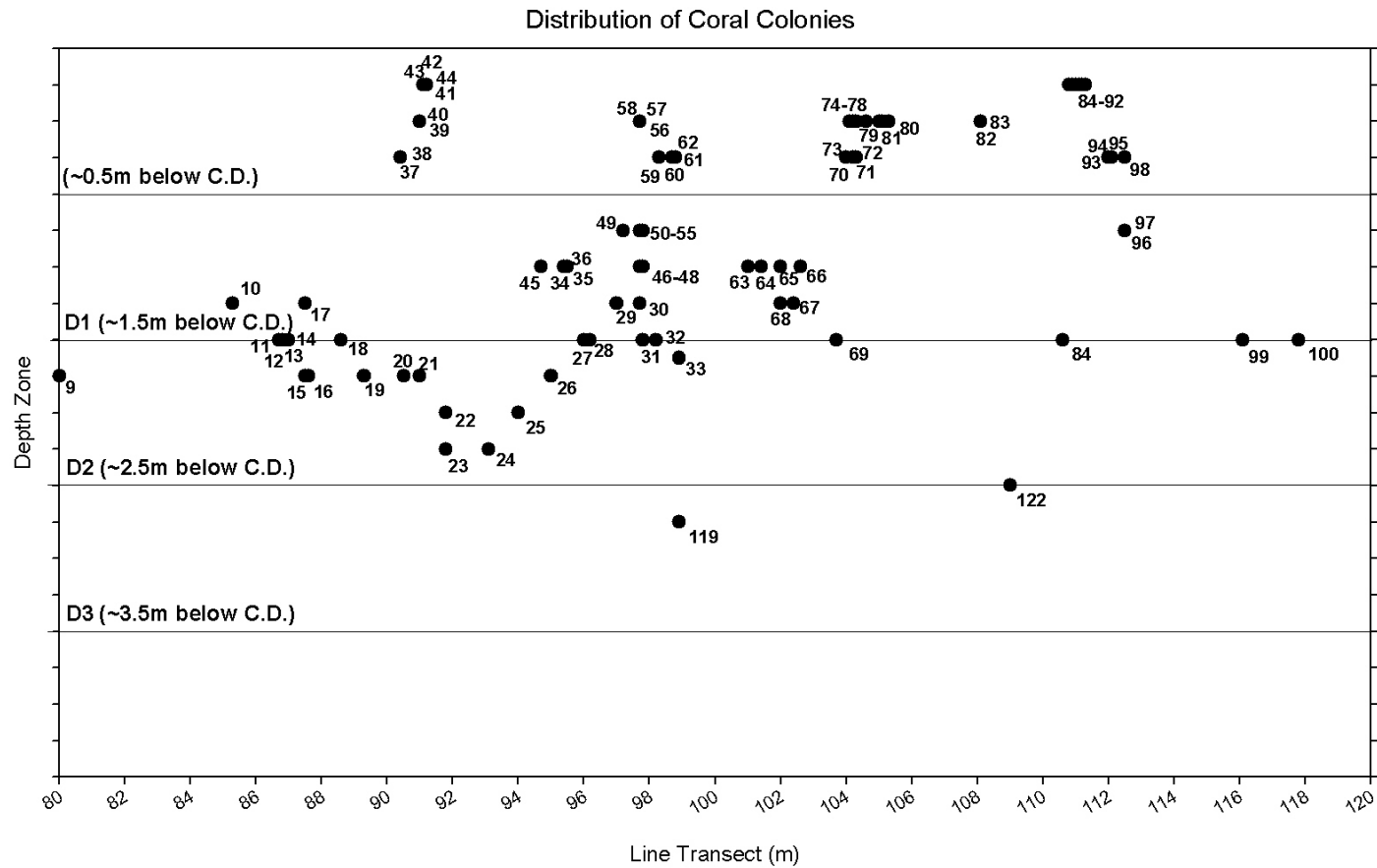
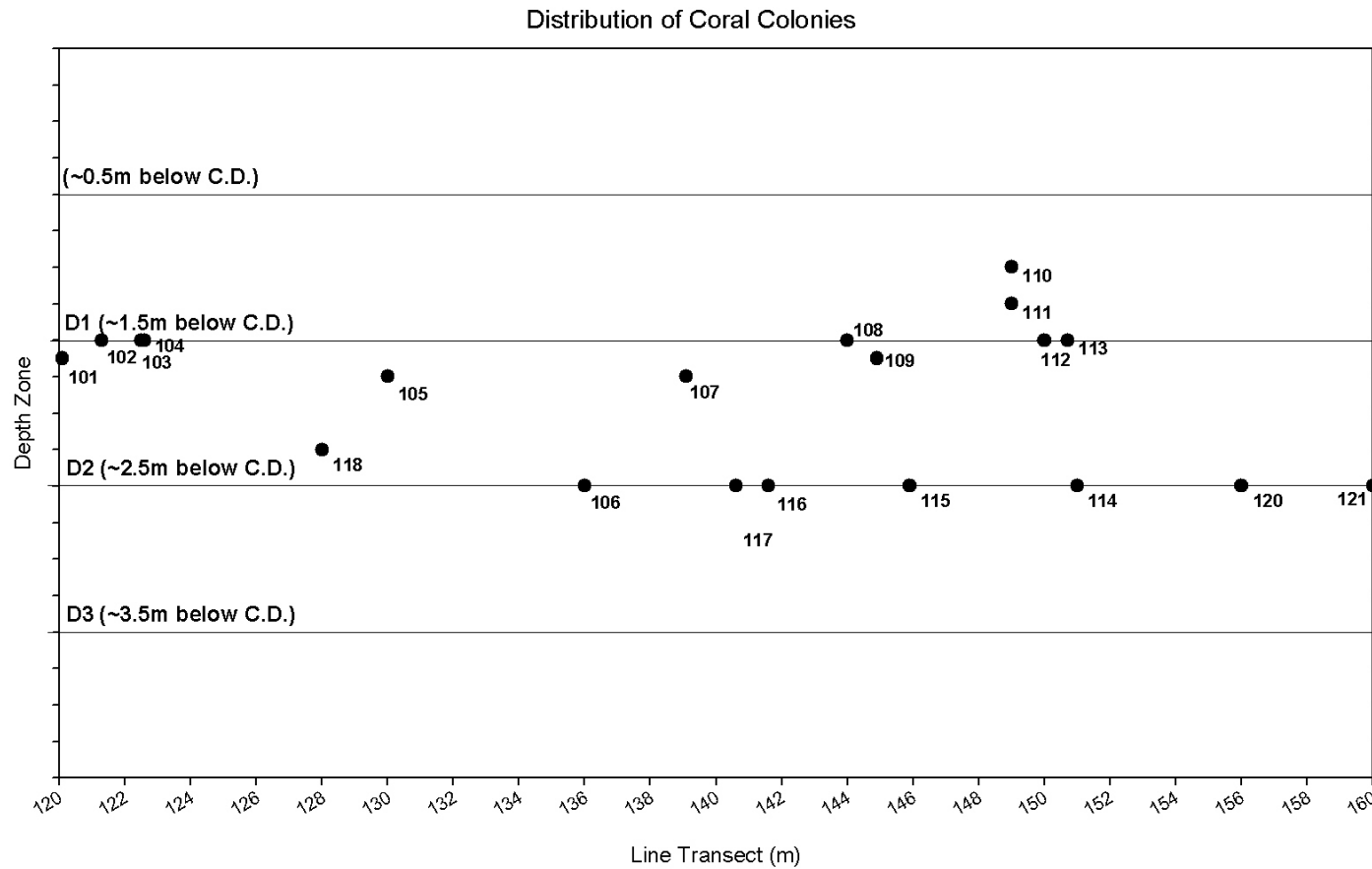




Fig. 4.3.....continued.



**Table 4.1 Summary of the Number of Coral Colonies from each Species within the Coral Mapping Area.**

Family	Species	Number of colony recorded
Siderastreidae	<i>Psammocora profundacella</i>	5
	<i>Psammocora superficialis</i>	2
Dendrophylliidae	<i>Turbinaria peltata</i>	5
Faviidae	<i>Cyphastrea serailia</i>	8
	<i>Favia rotumana</i>	5
	<i>Favia speciosa</i>	2
	<i>Favites abdita</i>	1
	<i>Favites chinensis</i>	6
	<i>Favites pentagona</i>	34
	<i>Goniastrea aspera</i>	6
	<i>Oulastrea crispata</i>	11
	<i>Platygyra carnosus</i>	1
	<i>Plesiastrea versipora</i>	12
	<i>Goniopora stutchburyi</i>	5
Poritidae	<i>Porites sp.</i>	19
<b>Total</b>		<b>122</b>

**Table 4.2 Colony Size Range and Classes of the Coral Colonies within the Coral Mapping Area.**

Colony Size		Size of colony (cm <sup>2</sup> )			
Maximum	Minimum	< 10	10 – 100	100 – 500	> 500
1 cm <sup>2</sup>	1,600 cm <sup>2</sup>				
<b>Number of Colonies</b>		11	10	84	17

**Table 4.3 Range of Sedimentation, Bleaching and Partial Mortality of the Coral Colonies within the Coral Mapping Area.**

	Minimum (%)	Maximum (%)
<b>Sedimentation Cover</b>	0	40
<b>Bleaching</b>	0	1
<b>Partial Mortality</b>	0	8

**Table 4.4 Type of Associated Substratum of the Coral Colonies within the Coral Mapping Area.**

	Associated Substratum		
	Bedrock	Rubble (diameter <0.5 m)	Boulder (diameter > 0.5 m)
<b>Number of Colonies</b>	5	16	101

### 4.3 Ecological Assessment of the Coral Community at the IMS and CMS

4.2.1 The coral surveys at the IMS and CMS were conducted on 21<sup>st</sup> and 22<sup>nd</sup> July 2007.

4.2.2 At each survey site, three transects (T1 to T3) were deployed for the REA survey. The location of the transects and the survey condition are shown in Fig. 3.1 and Table 4.5. Records of ecological and substratum attributes, as well as the taxonomic inventories are presented in Table 4.6

**Table 4.5 Location and Condition of Ecological Assessment at the IMS and CMS.**

Site	Transact Replicate	GPS Coordinates	Depth (m)	Sedimentation on Rocks Surface (mm)	Visibility (m)	Weather	Tide	Current (knot)	
IMS (Yung Shue Wan)	T1	Start	N 22°13'29.1 E 114°06'32.3	2.8-4.2	0-1	1-1.5	calm, sunny	ebb	0-0.5
		End	N 22°13'28.5 E 114°06'30.3						
	T2	Start	N 22°13'28.4 E 114°06'30.6	2.8-4.5	0-1				
		End	N 22°13'27.7 E 114°06'28.9						
	T3	Start	N 22°13'27.7 E 114°06'28.8	3.1-4.5	0-2				
		End	N 22°13'27.6 E 114°06'27.0						
CMS (Shum Wan)	T1	Start	N 22°11'15.0 E 114°08'04.0	2.7-4.0	0-3	1-2	calm, sunny	flood	0
		End	N 22°11'13.4 E 114°08'04.0						
	T2	Start	N 22°11'13.4 E 114°08'04.0	2.7— 4.6	0-3				
		End	N 22°11'12.9 E 114°08'05.4						
	T3	Start	N 22°11'12.9 E 114°08'05.4	3.5-4.5	0-3				
		End	N 22°11'12.4 E 114°08'07.0						

4.2.3 In the IMS, the 3 transects were mainly composed of boulders with low abundance of corals (Table 4.6). T1 at the NE end of the seawall was mainly occupied by artificial boulders, the rock surface was bare and sparsely covered by coralline algae. Hard corals were rarely recorded in T1, with only 1 small colony (<5 cm<sup>2</sup>) of *Oulastrea crispata*. T2 mainly comprised boulders of artificial and natural sources, as well as rubbles, mud and silt. Abundance of hard corals was higher than T1, but the cover is still low. Seven species of hard corals were observed, with *Favites pentagona* being the most common. T3 was mainly covered by boulders and sand and shell debris. Hard coral abundance was similar to T2, 7 species were observed in which *Favites pentagona* was most common. In site total, 10 species of hard coral and no soft coral were recorded in the IMS.

4.2.4 In the CMS, the 3 transects were mainly composed of boulders with different abundance of corals (Table 4.6). T1 at the N end was mainly boulders with scattered rubbles, bedrock and sand. The hard surface was covered by hard corals and encrusting algae. Ten species of hard corals were observed at T1, in which *Leptastrea pruinosa*, *Leptastrea purpurea* and *Porites sp.* were the

common taxa. Recently mortality was observed in few colonies, mainly *Porites sp.*. Substratum of T2 was mainly boulders with sand and shell debris. Abundance of hard corals were similar to T1, but only 6 species were observed in which *Leptastrea pruinosa*, *Leptastrea purpurea* and *Pavona decussata* were the common residents. T3 was a slope completely covered by boulders, the rock surface was mainly covered by encrusting algae and barnacles. Hard corals were scarce on the transect and only 2 species were recorded. In site total, 11 species of hard coral and no soft coral were observed in the CMS.

**Table 4.6 Ecological, Substratum Attributes and Taxonomic Inventories at the IMS and CMS**

Substratum attributes (0 – 6)	IMS			CMS		
	T1	T2	T3	T1	T2	T3
Bedrock	0	1	0	2	0	0
Boulders	6	5	6	6	6	6
Rubble	2	3	2	2	2	0
Sand & Shell debris	0	2	3	2	3	0
Mud & Silt	0	3	0	0	0	0
Ecological attributes (0-6)	IMS			CMS		
	T1	T2	T3	T1	T2	T3
Hard coral	1	2	2	3	3	1
Dead standing coral	0	0	0	1	0	0
Soft coral	0	0	0	0	0	0
Encrusting algae	0	0	0	2	1	3
Coralline algae	1	2	1	0	0	0
Macro algae	0	0	0	0	0	0
Sea anemone	0	0	0	0	1	0
Taxonomic inventories (0 – 5)	IMS			CMS		
	T1	T2	T3	T1	T2	T3
Hard Coral						
<i>Oulastrea crispata</i>	1	3	0	0	0	0
<i>Cyphastrea serailia</i>	0	1	0	1	1	0
<i>Favia rotumana</i>	0	1	1	0	1	0
<i>Favia lizardensis</i>	0	0	0	1	0	0
<i>Favites pentagona</i>	0	3	3	1	0	0
<i>Favites abdita</i>	0	0	0	1	0	0
<i>Goniopora stutchburyi</i>	0	2	0	0	0	0
<i>Plesiastrea versipora</i>	0	2	1	0	0	0
<i>Porites sp.</i>	0	2	2	3	3	1
<i>Goniastrea aspera</i>	0	0	1	0	0	0
<i>Psammocora profundacella</i>	0	0	1	1	0	0
<i>Turbinaria peltata</i>	0	0	1	0	0	0
<i>Leptastrea pruinosa</i>	0	0	0	3	3	0
<i>Leptastrea purpurea</i>	0	0	0	3	3	1
<i>Pavona decussata</i>	0	0	0	1	3	0
<i>Platygyra acuta</i>	0	0	0	1	0	0
<b>No. Hard Coral Species (by transect)</b>	1	7	7	10	6	2
<b>No. Hard Coral Species (by site)</b>	10			11		

4.2.5 In the CMS, the 3 transects were mainly composed of boulders with different abundance of corals (Table 4.6). T1 at the N end was mainly boulders with scattered rubbles, bedrock and sand. The hard surface was covered by hard corals and encrusting algae. Ten species of hard corals were observed at T1, in which *Leptastrea pruinosa*, *Leptastrea purpurea* and *Porites sp.* were the common taxa. Recently mortality was observed in few colonies, mainly *Porites sp.*. Substratum of T2 was mainly boulders with sand and shell debris. Abundance of hard corals were similar to T1, but only 6 species were observed in which *Leptastrea pruinosa*, *Leptastrea purpurea* and *Pavona decussata* were the common residents. T3 was a slope completely covered by boulders, the rock surface was mainly covered by encrusting algae and barnacles. Hard corals were scarce on the transect and only 2 species were recorded. In site total, 11 species of hard coral and no soft coral were observed in the CMS.

### **4.3 Coral Tagging Exercise at the IMS and CMS**

4.3.1 The coral tagging exercises were conducted on 21<sup>st</sup> and 22<sup>nd</sup> July 2007.

4.3.2 The code, species name, area, sedimentation level, and percentage of bleaching and mortality of the tagged coral colonies at each site were summarized in Tables 4.7a-b. Photographs of the colonies were shown in Appendices IIa-b. The survey team had tried to take photographs of the corals from an angle and distance that best represented the colonies but difficulties sometimes occurred as a result of low water visibility during the surveys.

4.3.3 In general, the healthy status of the tagged coral colonies was normal, with low levels of sedimentation, bleaching and mortality.

**Table 4.7a Code, Species Name, Percentage of Sedimentation, Bleaching and Mortality of the Tagged Coral Colonies at IMS.**

Code	Coral Species	Area (cm <sup>2</sup> )	Depth (m)	Sedimentation (%)	Bleaching (%)	Mortality (%)	Code No. in Coral Mapping Area
A01	<i>Favites pentagona</i>	110	3.3	1	0	0	19
A02	<i>Favia rotumana</i>	220	2.5	0	0	0	57
A03	<i>Platygyra carnosus</i>	430	2.5	0	0	0	56
A04	<i>Favia rotumana</i>	570	2.5	0	0	0	50
A05	<i>Cyphastrea serailia</i>	330	2.5	3	0	0	43
A06	<i>Cyphastrea serailia</i>	190	2.5	0	0	0	44
A07	<i>Favites pentagona</i>	200	2.5	0	0	0	61
A08	<i>Porites sp</i>	440	2.5	3	0	0	59
A09	<i>Favites pentagona</i>	300	2.5	0	0	0	66
A10	<i>Porites sp.</i>	300	2.5	3	0	0	77

**Table 4.7b Code, Species Name, Percentage of Sedimentation, Bleaching and Mortality of the Tagged Coral Colonies at CMS.**

Code	Coral Species	Area (cm <sup>2</sup> )	Depth (m)	Sedimentation (%)	Bleaching (%)	Mortality (%)
B01	<i>Favia lizardensis</i>	360	3.6	1	0	0
B02	<i>Porites sp.</i>	370	3.6	1	0	0
B03	<i>Psammocora profundacella</i>	440	3.6	2	0	0
B04	<i>Cyphastrea serailia</i>	220	3.6	0	0	0
B05	<i>Favites abdita</i>	650	3.6	2	0	0
B06	<i>Leptastrea pruinosa</i>	450	3.6	1	0	0
B07	<i>Platygyra acuta</i>	350	3.6	1	0	0
B08	<i>Leptastres purpurea</i>	470	3.5	2	0	0
B09	<i>Leptastrea pruinosa</i>	400	3.5	2	0	0
B10	<i>Favites pentagona</i>	130	3.4	0	0	0

### 4.3 Measures to Minimize Ecological Impacts

4.4.1 A silt curtain shall be properly installed, checked and maintained throughout the construction period to minimise water quality impacts. The silt curtain should be secured to the *vertical* seawall at both points of contact.

- 4.4.2 Divers with knowledge about corals should be present underwater during installation of the silt curtain to ensure no corals would be hit or enclosed.
- 4.4.3 Decommissioning of silt curtain shall be properly controlled to avoid sudden dispersion of large quantity of muddy waters.

### **4.3 Coral Monitoring Frequency and Requirements**

- 4.5.1 Monitoring on the tagged corals for degree of sedimentation and area of bleaching shall be conducted at the frequencies indicated below during works affecting the seabed.
- During the first two weeks of works affecting seabed: twice a week.
  - If no exceedance detected for the first 2 weeks of monitoring: once a week for the following 2 weeks.
  - If no exceedance detected for the first 4 weeks of monitoring: once every two weeks for the 2nd and 3rd months (5th to 12th weeks).
  - If no exceedance in the 3rd month of monitoring, coral monitoring shall be conducted once per month until completion of the construction works.

### **4.3 Actions on Exceedance of Action & Limit Levels**

- 4.6.1 Where the coral survey indicates the health conditions of the corals exceed the AL levels, the Engineer may direct more frequent monitoring to be carried out until exceedance stops. The action and limit level of coral monitoring is shown in Table 4.8.
- 4.6.2 The Contractor shall take all necessary steps to ensure that the actions of the Contractor are not contributing to the deterioration. These steps shall include, but not be limited to the following:
- Checking of water quality monitoring data;
  - Checking of all marine plant and equipment; maintenance or replacement of any marine plant or equipment contributing to the deterioration;
  - Checking and maintenance of silt curtains;
  - Review of all working methods; and
  - Reduced construction rate.
- 4.6.3 Upon action level being exceeded and after agreement from the Environmental Specialist and AFCD has been obtained regarding the most appropriate method for reducing the adverse impacts during works affecting the seabed, this mitigated method should then be enacted on the next working day.
- 4.6.4 Upon limit level being exceeded, the Contractor shall suspend all works affecting the seabed until an effective solution is identified. Once the solution has been identified and agreed with the Environmental Specialist and AFCD, construction works affecting seabed may recommence.
- 4.6.5 The Engineer and AFCD shall be kept informed of all steps taken; and written reports and proposals for action shall be passed to the Engineer and AFCD by

the Contractor whenever the coral survey shows any adverse impact upon the corals.

- 4.6.6 After the Contractor have implemented the agreed mitigating measures, if the coral surveys indicate the coral condition is unacceptable, additional mitigation measures should be recommended by the Contractor after consulting the Environmental Specialist for the approval of the Engineer and AFCD to rectify the situation. The Engineer can temporarily suspend the site activities until the problem is under control and an acceptable coral condition is restored.
- 4.6.7 In case the Contractor fails to implement the agreed mitigation measures, the Engineer can direct the Contractor to slow down or suspend his work until the Engineer and AFCD is convinced that the mitigation measures have restored the corals to an acceptable condition.
- 4.6.8 The Environmental Specialist shall assess the effectiveness and efficiency of the proposed mitigation measures and/or remedial actions for construction activities affecting the seabed. The performance of the Environmental Monitoring and Audit Programme shall be reviewed and audited by the Environmental Specialist on a quarterly basis. The findings of this review shall be included in the quarterly EM&A summary reports, together with any recommendations to improve the performance of the Environmental Monitoring and Audit Programme.

**Table 4.8. Action and Limit Level for Coral Monitoring**

<b>Parameter</b>	<b>Action Level Definition</b>	<b>Limit Level Definition</b>
Sedimentation	If during Coral Monitoring a 15% increase in the percentage of sediment cover on hard corals occurs at more than 20% of the tagged coral at any one Coral Monitoring Site that is not recorded at the Control Site, then the Action Level is exceeded.	If during Coral Monitoring a 25% increase in the percentage of sediment cover on hard corals occurs at more than 20% of the tagged coral at any one Coral Monitoring Site that is not recorded at the Control Site, then the Limit Level is exceeded.
Bleaching	If during Coral Monitoring a 15% increase in the percentage of bleaching (bleached white) on hard corals occurs at more than 20% of the tagged coral at any one Coral Monitoring Site that is not recorded at the Control Site, then the Action Level is exceeded.	If during Coral Monitoring a 25% increase in the percentage of bleaching (bleached white) on hard corals occurs at more than 20% of the tagged coral at any one Coral Monitoring Site that is not recorded at the Control Site, then the Limit Level is exceeded.



## 5 CONCLUSION

- 5.1.1 In the 2 survey sites of the present study, the abundance of hard coral is not high. In the IMS, hard coral cover was below 10%, number of hard coral species sampled in the REA transects was 10. The record comprised of common shallow species which are widely distributed at Eastern and Southern HK waters. The standing colonies were generally in health condition, with low level of sedimentation, bleaching and mortality.
- 5.1.2 In the CMS, hard coral cover was higher (10% to 15%). Similar to the IMS, number of species recorded in the REA transects was 11, although there was variation in species composition between the two sites. The existing corals were composed of common shallow species of local waters. Level of sedimentation and bleaching was low, indicating the colonies were generally healthy. It was observed, however, mortality in a few hard coral colonies, particular for *Porites sp.* The reason for the phenomenon is unknown, but is believed not related to sedimentation as it was observed in small portion of the standing colonies.
- 5.1.3 Detail mapping of hard corals at the IMS showed that a total of 122 colonies was located around the seawall at the IMS. The majority of the colonies was situating at the SW part of the subtidal seawall. Most of the corals were attached to the boulders of >0.5m diameter. Coral size ranged from 1 to 1,600 cm<sup>2</sup>, with over 70% of the colonies between 100 and 500 cm<sup>2</sup>.
- 5.1.4 No direct impact will be exerted to the existing coral community by the proposed construction.
- 5.1.5 In overall, although abundance and species richness was not high, the coral communities in both sites were generally in good conditions with low level of sedimentation, bleaching and mortality. Monitoring of the communities during the course of construction is necessary in order to avoid adverse impact to the standing corals.

## **6 REFERENCES**

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## **APPENDIX**

**Appendix I List of Hard and Soft Coral Colonies, Percentage Sedimentation, Bleaching, Mortality and Associated Substratum in Coral Mapping Area.**

Coral no.	Species	Species code	Area (cm <sup>2</sup> )	Sed %	Bleach %	Mort %	Growth form	Associated Substratum	Substrate size (diameter, m)
1	<i>Oulastrea crispata</i>	OC	2	0	0	0	Encrusting	Boulder	1.5
2	<i>Oulastrea crispata</i>	OC	1	0	0	0	Encrusting	Boulder	1.5
3	<i>Oulastrea crispata</i>	OC	1	0	0	0	Encrusting	Boulder	1.5
4	<i>Oulastrea crispata</i>	OC	2	0	0	0	Encrusting	Boulder	1.5
5	<i>Oulastrea crispata</i>	OC	3	0	0	0	Encrusting	Boulder	1.5
6	<i>Oulastrea crispata</i>	OC	2	0	0	0	Encrusting	Boulder	2.5
7	<i>Oulastrea crispata</i>	OC	1	0	0	0	Encrusting	Boulder	2.5
8	<i>Oulastrea crispata</i>	OC	1	0	0	0	Encrusting	Boulder	2.5
9	<i>Oulastrea crispata</i>	OC	1	0	0	0	Encrusting	Boulder	2.5
10	<i>Plesiastrea versipora</i>	PLV	220	40	0	0	Encrusting	Rubble	0.3
11	<i>Plesiastrea versipora</i>	PLV	300	7	0	0	Submassive	Boulder	0.9
12	<i>Goniopora stutchburyi</i>	GS	180	5	0	3	Encrusting	Rubble	0.3
13	<i>Cyphastrea serailia</i>	CS	120	1	0	3	Encrusting	Boulder	0.7
14	<i>Favites pentagona</i>	FP	210	5	0	0	Encrusting	Boulder	0.9
15	<i>Favites pentagona</i>	FP	30	0	0	0	Encrusting	Rubble	0.5
16	<i>Favites pentagona</i>	FP	50	0	0	0	Encrusting	Rubble	0.5
17	<i>Porites sp.</i>	POR	250	4	1	0	Encrusting	Boulder	1.1
18	<i>Goniopora stutchburyi</i>	GS	190	8	0	5	Encrusting	Boulder	1.5
19	<i>Favites pentagona</i>	FP	110	1	0	0	Submassive	Rubble	0.3
20	<i>Goniopora stutchburyi</i>	GS	150	5	0	8	Encrusting	Boulder	0.7
21	<i>Goniopora stutchburyi</i>	GS	100	2	0	0	Submassive	Rubble	0.3
22	<i>Favites pentagona</i>	FP	100	0	0	0	Encrusting	Boulder	1.5
23	<i>Psammocora superficialis</i>	PS	350	0	0	0	Encrusting	Boulder	1.2

Coral no.	Species	Species code	Area (cm <sup>2</sup> )	Sed %	Bleach %	Mort %	Growth form	Associated Substratum	Substrate size (diameter, m)
24	<i>Psammocora profundacella</i>	PP	300	2	0	0	Encrusting	Boulder	1.2
25	<i>Favites pentagona</i>	FP	200	3	0	0	Encrusting	Rubble	0.4
26	<i>Porites sp.</i>	POR	120	2	0	0	Encrusting	Rubble	0.3
27	<i>Favites pentagona</i>	FP	330	1	0	0	Encrusting	Boulder	1.5
28	<i>Favia rotumana</i>	FR	340	0	0	0	Submassive	Boulder	0.8
29	<i>Favites pentagona</i>	FP	360	2	0	0	Encrusting	Boulder	1
30	<i>Porites sp.</i>	POR	300	0	0	0	Submassive	Boulder	1.2
31	<i>Favites pentagona</i>	FP	190	3	0	5	Encrusting	Bed Rock	NA
32	<i>Favites pentagona</i>	FP	40	0	0	0	Encrusting	Bed Rock	NA
33	<i>Plesiastrea versipora</i>	PLV	450	3	0	0	Submassive	Bed Rock	NA
34	<i>Favites pentagona</i>	FP	130	2	0	0	Encrusting	Boulder	0.6
35	<i>Porites sp.</i>	POR	380	2	0	0	Submassive	Boulder	1.5
36	<i>Psammocora profundacella</i>	PP	160	0	0	0	Submassive	Boulder	1.2
37	<i>Plesiastrea versipora</i>	PLV	420	3	0	0	Submassive	Boulder	3
38	<i>Favites pentagona</i>	FP	70	0	0	0	Encrusting	Boulder	1.2
39	<i>Cyphastrea serailia</i>	CS	130	3	0	0	Encrusting	Boulder	0.8
40	<i>Porites sp.</i>	POR	290	0	0	0	Submassive	Rubble	0.5
41	<i>Goniastrea aspera</i>	GS	40	0	0	0	Encrusting	Boulder	0.6
42	<i>Porites sp.</i>	POR	60	0	0	0	Encrusting	Rubble	0.3
43	<i>Cyphastrea serailia</i>	CS	330	0	0	0	Encrusting	Boulder	0.8
44	<i>Cyphastrea serailia</i>	CS	190	2	0	0	Encrusting	Boulder	2.5
45	<i>Cyphastrea serailia</i>	CS	410	5	0	0	Submassive	Boulder	1
46	<i>Porites sp.</i>	POR	660	5	0	0	Submassive	Boulder	1.3
47	<i>Favites pentagona</i>	FP	110	1	0	0	Encrusting	Boulder	0.8
48	<i>Turbinaria peltata</i>	TP	1600	1	0	0	Laminae	Boulder	1.5
49	<i>Favites chinensis</i>	FC	280	3	0	0	Encrusting	Boulder	0.9
50	<i>Favia rotumana</i>	FR	570	2	0	0	Submassive	Boulder	1.5
51	<i>Favites chinensis</i>	FC	230	2	0	0	Encrusting	Boulder	0.7

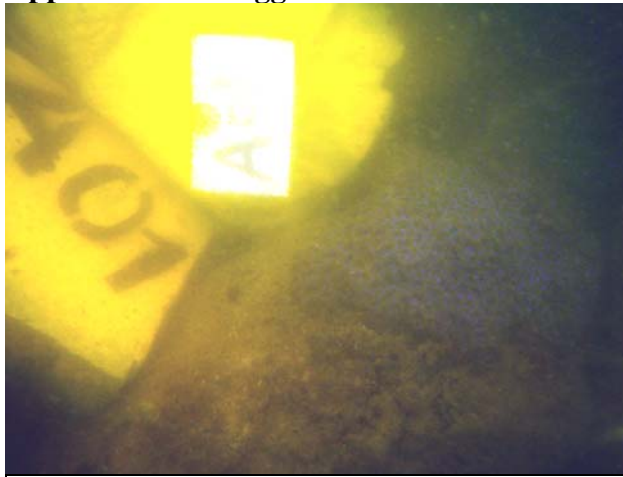
Coral no.	Species	Species code	Area (cm <sup>2</sup> )	Sed %	Bleach %	Mort %	Growth form	Associated Substratum	Substrate size (diameter, m)
52	<i>Porites sp.</i>	POR	360	5	0	0	Encrusting	Boulder	1.2
53	<i>Goniastrea aspera</i>	FA	200	0	0	0	Encrusting	Boulder	1.5
54	<i>Favites chinensis</i>	FC	380	0	0	0	Encrusting	Boulder	1.5
55	<i>Cyphastrea serailia</i>	CS	380	0	0	0	Submassive	Boulder	1
56	<i>Platygyra carnosus</i>	PCA	430	0	0	0	Submassive	Boulder	1.3
57	<i>Favia rotumana</i>	FR	220	0	0	0	Submassive	Boulder	1.3
58	<i>Favites chinensis</i>	FC	200	0	0	0	Encrusting	Rubble	0.4
59	<i>Porites sp.</i>	POR	440	0	0	0	Submassive	Boulder	1
60	<i>Plesiastrea versipora</i>	PLV	270	4	0	0	Submassive	Bed Rock	NA
61	<i>Favites pentagona</i>	FP	200	0	0	0	Encrusting	Rubble	0.3
62	<i>Plesiastrea versipora</i>	PLV	680	0	0	0	Encrusting	Boulder	1
63	<i>Porites sp.</i>	POR	550	0	0	0	Encrusting	Boulder	1.5
64	<i>Porites sp.</i>	POR	290	0	0	0	Encrusting	Boulder	2
65	<i>Porites sp.</i>	POR	500	3	0	2	Encrusting	Boulder	1.3
66	<i>Favites pentagona</i>	FP	300	0	0	0	Encrusting	Boulder	1.2
67	<i>Goniastrea aspera</i>	FA	110	0	0	0	Encrusting	Rubble	0.3
68	<i>Favia rotumana</i>	FR	210	0	0	0	Submassive	Boulder	1.4
69	<i>Favites pentagona</i>	FP	190	0	0	0	Encrusting	Boulder	2
70	<i>Favites pentagona</i>	FP	180	0	0	0	Encrusting	Boulder	1.5
71	<i>Psammocora profundacella</i>	PP	100	0	0	0	Encrusting	Boulder	1.5
72	<i>Cyphastrea serailia</i>	CS	700	0	0	0	Encrusting	Boulder	1.5
73	<i>Plesiastrea versipora</i>	PLV	620	8	0	0	Encrusting	Boulder	1
74	<i>Turbinaria peltata</i>	TP	500	3	0	0	Encrusting	Boulder	1
75	<i>Cyphastrea serailia</i>	CS	400	0	0	0	Encrusting	Boulder	2.1
76	<i>Favia rotumana</i>	FR	210	0	0	0	Encrusting	Boulder	1.1
77	<i>Porites sp.</i>	POR	300	4	0	0	Encrusting	Boulder	2.1
78	<i>Psammocora profundacella</i>	PP	280	6	0	0	Encrusting	Boulder	0.9
79	<i>Favites pentagona</i>	FP	610	0	0	0	Encrusting	Boulder	1

Coral no.	Species	Species code	Area (cm <sup>2</sup> )	Sed %	Bleach %	Mort %	Growth form	Associated Substratum	Substrate size (diameter, m)
80	<i>Goniastrea aspera</i>	FA	300	1	0	0	Encrusting	Boulder	0.9
81	<i>Favites abdita</i>	FA	270	3	0	0	Encrusting	Boulder	2.5
82	<i>Favia speciosa</i>	FS	230	2	0	0	Submassive	Boulder	1.2
83	<i>Favites pentagona</i>	FP	230	2	0	0	Encrusting	Boulder	1.2
84	<i>Favites pentagona</i>	FP	390	0	0	0	Encrusting	Boulder	1
85	<i>Porites sp.</i>	POR	730	3	0	0	Encrusting	Boulder	1.8
86	<i>Favites pentagona</i>	FP	300	0	0	0	Encrusting	Boulder	1.8
87	<i>Favites pentagona</i>	FP	250	2	0	0	Encrusting	Boulder	4
88	<i>Favites pentagona</i>	FP	380	2	0	0	Encrusting	Boulder	4
89	<i>Favites pentagona</i>	FP	390	2	0	0	Encrusting	Boulder	2.5
90	<i>Favites pentagona</i>	FP	270	2	0	0	Encrusting	Boulder	1.1
91	<i>Favites pentagona</i>	FP	280	2	0	0	Encrusting	Boulder	1.5
92	<i>Goniastrea aspera</i>	GA	40	0	0	0	Encrusting	Boulder	1.1
93	<i>Turbinaria peltata</i>	TP	510	0	0	0	Laminae	Boulder	1.5
94	<i>Goniopora stutchburyi</i>	GS	280	3	0	0	Encrusting	Boulder	2.5
95	<i>Favites pentagona</i>	FP	80	1	0	0	Encrusting	Boulder	2.5
96	<i>Favites pentagona</i>	FP	320	3	0	0	Encrusting	Rubble	0.4
97	<i>Favites chinensis</i>	FC	280	2	0	0	Submassive	Rubble	0.3
98	<i>Favites chinensis</i>	FC	100	0	0	0	Encrusting	Boulder	1.5
99	<i>Porites sp.</i>	POR	290	4	0	0	Submassive	Boulder	3
100	<i>Turbinaria peltata</i>	TP	180	0	0	0	Laminae	Rubble	0.3
101	<i>Porites sp.</i>	POR	580	0	0	0	Encrusting	Boulder	1
102	<i>Porites sp.</i>	POR	480	3	0	0	Encrusting	Boulder	1
103	<i>Plesiastrea versipora</i>	PLV	400	8	0	0	Encrusting	Boulder	2.5
104	<i>Porites sp.</i>	POR	380	3	0	0	Submassive	Boulder	2.5
105	<i>Favites pentagona</i>	FP	830	2	0	0	Encrusting	Boulder	3.2
106	<i>Oulastrea crispata</i>	OC	5	0	0	0	Encrusting	Boulder	2
107	<i>Psammocora profundacella</i>	PP	380	3	0	0	Encrusting	Boulder	2

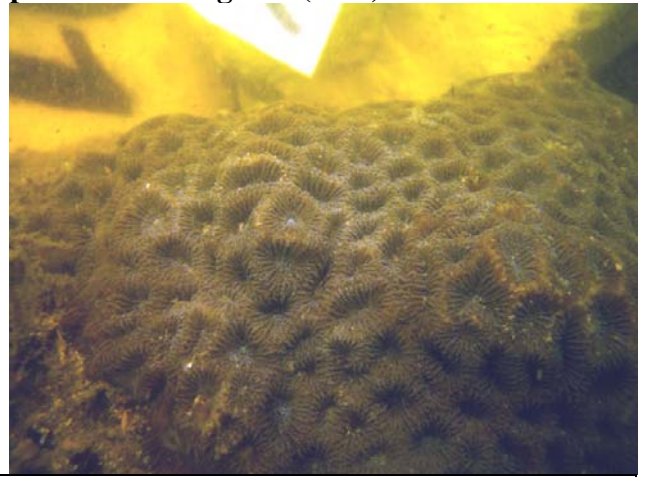
<b>Coral no.</b>	<b>Species</b>	<b>Species code</b>	<b>Area (cm<sup>2</sup>)</b>	<b>Sed %</b>	<b>Bleach %</b>	<b>Mort %</b>	<b>Growth form</b>	<b>Associated Substratum</b>	<b>Substrate size (diameter, m)</b>
108	<i>Favites pentagona</i>	FP	90	1	0	0	Encrusting	Boulder	0.8
109	<i>Goniastrea aspera</i>	GA	230	0	0	0	Encrusting	Boulder	1.1
110	<i>Favites pentagona</i>	FP	750	0	0	0	Encrusting	Boulder	1.5
111	<i>Favites pentagona</i>	FP	310	0	0	0	Encrusting	Boulder	1.3
112	<i>Plesiastrea versipora</i>	PLV	1300	1	0	0	Encrusting	Boulder	1.5
113	<i>Favites pentagona</i>	FP	290	1	0	0	Encrusting	Boulder	0.8
114	<i>Psammocora superficialis</i>	PS	480	3	0	0	Encrusting	Boulder	1.5
115	<i>Favia speciosa</i>	FS	260	3	0	0	Submassive	Boulder	1.8
116	<i>Oulastrea crispata</i>	OC	2	0	0		Encrusting	Boulder	1.5
117	<i>Plesiastrea versipora</i>	PLV	150	0	0	0	Encrusting	Boulder	0.7
118	<i>Porites sp.</i>	POR	128	2	0	0	Encrusting	Boulder	2
119	<i>Turbinaria peltata</i>	TP	80	0	0	0	Laminae	Bed Rock	NA
120	<i>Plesiastrea versipora</i>	PLV	300	3	0	0	Encrusting	Boulder	1.3
121	<i>Favites pentagona</i>	FP	580	0	0	0	Encrusting	Boulder	1.9
122	<i>Plesiastrea versipora</i>	PLV	440	5	0	0	Encrusting	Boulder	2.4



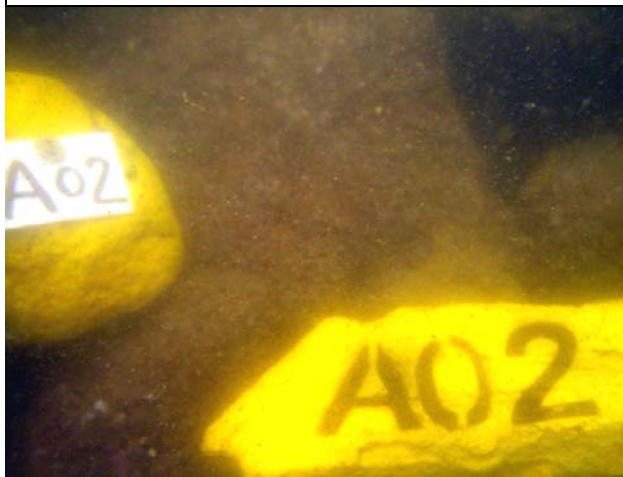
Appendix IIa Tagged coral colonies at the Impact Monitoring Site (IMS).



A01



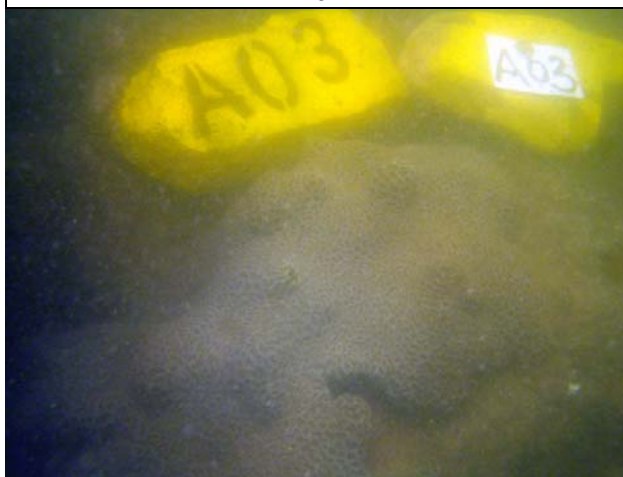
*Favites pentagona*



A02



*Favia rotumana*



A03



*Platygyra carnosus*

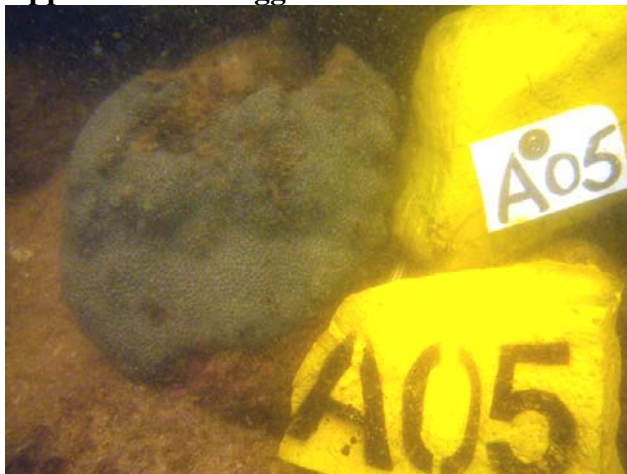


A04



*Favia rotumana*

Appendix IIa Tagged coral colonies at the Impact Monitoring Site (IMS).....continued.



A05



*Cyphastrea serailia*



A06



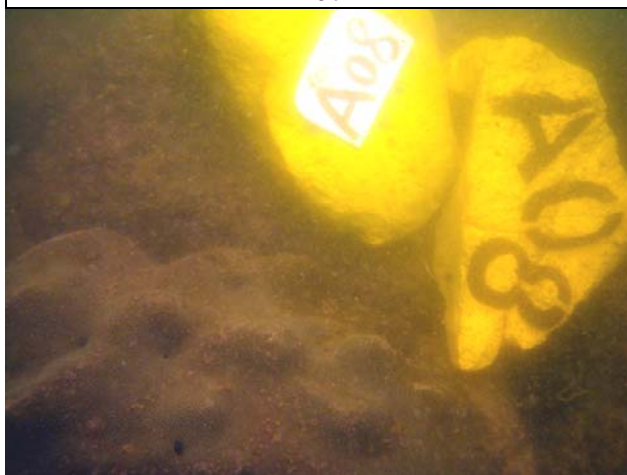
*Cyphastrea serailia*



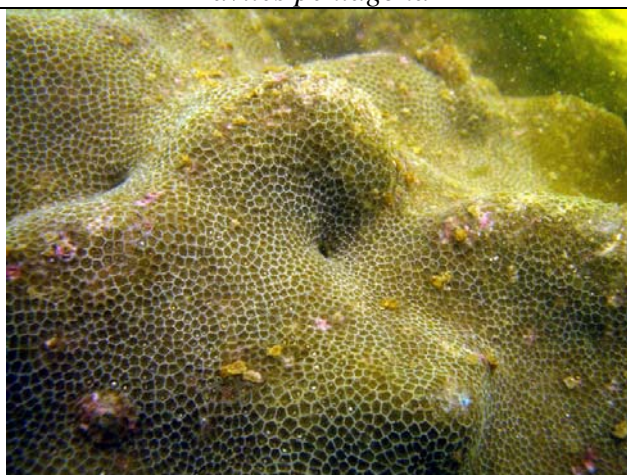
A07



*Favites pentagona*

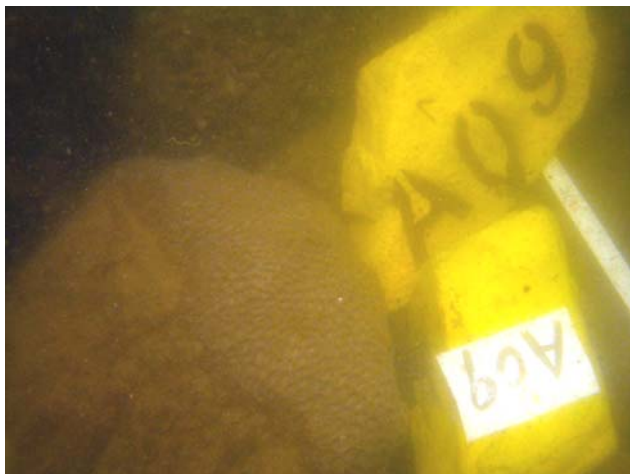


A08



*Porites* sp.

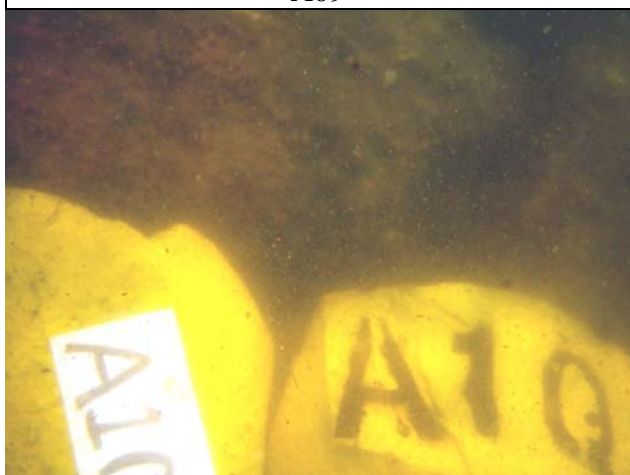
Appendix IIa Tagged coral colonies at the Impact Monitoring Site (IMS).....continued.



A09



*Favites pentagona*



A10



*Porites* sp.

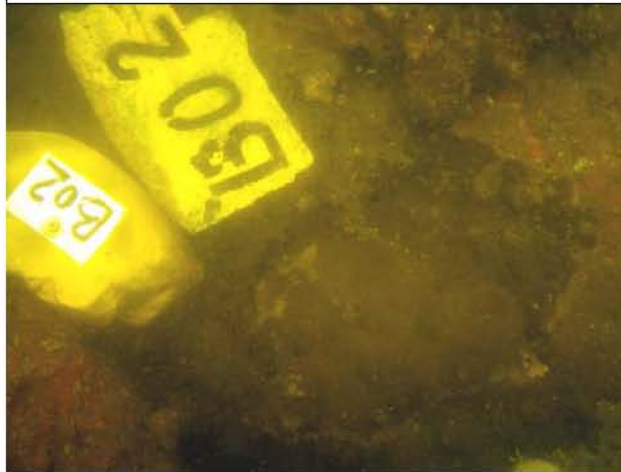
Appendix IIb Tagged coral colonies at the Control Monitoring Site (CMS).



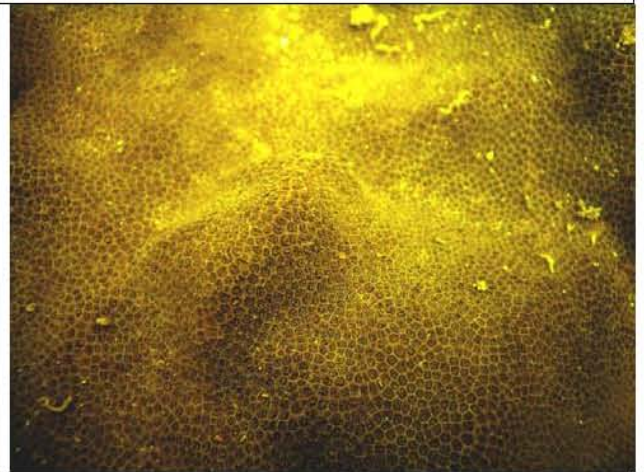
B01



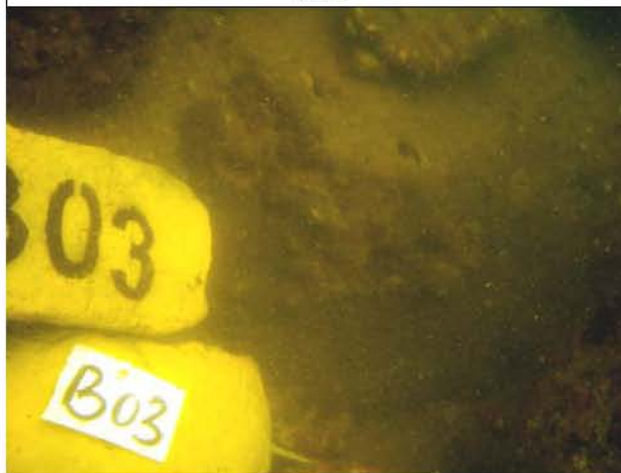
*Favia lizardensis*



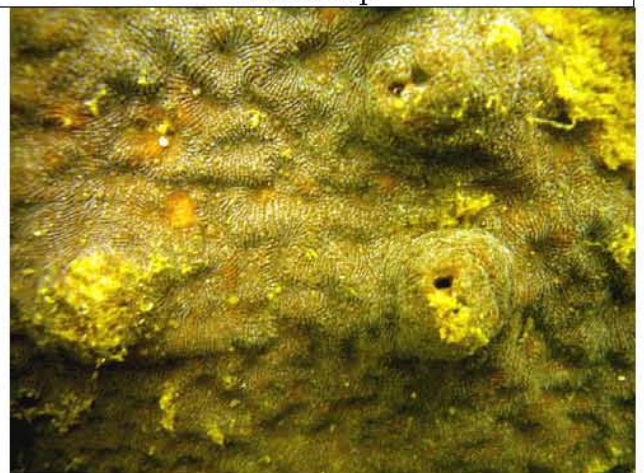
B02



*Porites* sp.



B03



*Psammocora profundacella*



B04



*Cyphastrea serailia*

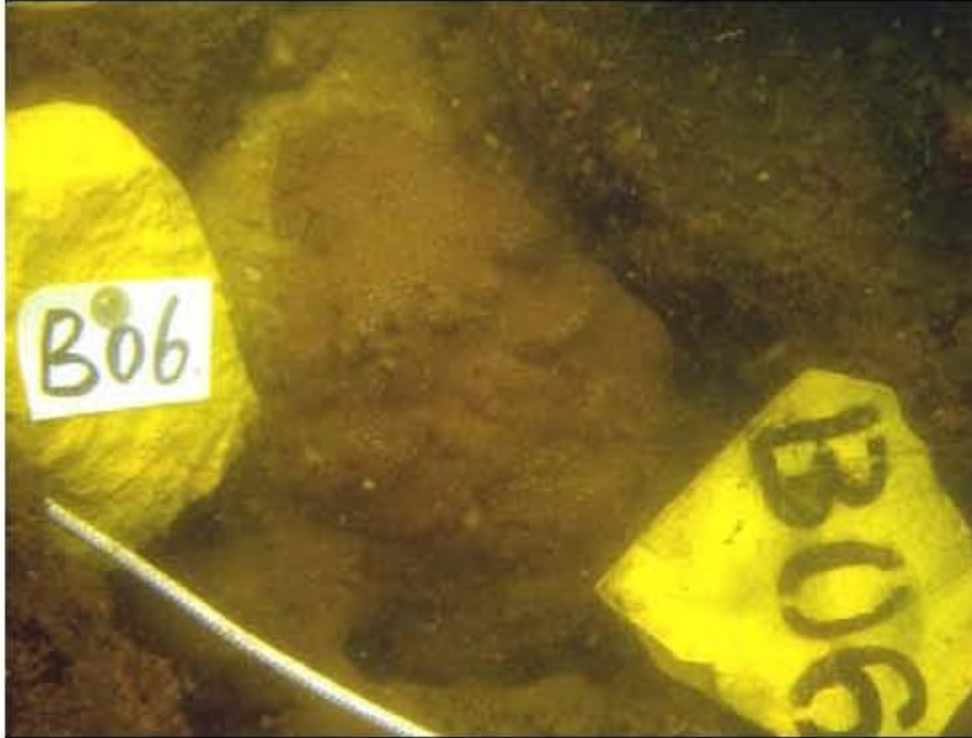
Appendix IIb Tagged coral colonies at the Control Monitoring Site (CMS).....continued.



B05



*Favites abdita*



B06



*Leptastrea pruinosa*



B07



*Platygyra acuta*



B08



*Leptastrea purpurea*

Appendix IIb Tagged coral colonies at the Control Monitoring Site (CMS).....continued.



B09



*Leptastrea pruinosa*



B10



*Favites pentagona*