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FINAL REPORT

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Civil Engineering Department

Backfilling of Marine Borrow Areas  
at East Tung Lung Chau :  
*Environmental Monitoring and Audit  
Manual*

11 February 1998

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11 February 1998

Reference C1412

For and on behalf of ERM-Hong Kong, Ltd

Approved by: S.M. LAISTER

Signed: [Signature]

Position: Executive Director

Date: 11<sup>th</sup> February 1998

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## CONTENTS:

1	INTRODUCTION	1
1.1	BACKGROUND TO STUDY	1
1.2	OBJECTIVES OF ENVIRONMENTAL MONITORING AND AUDIT	1
1.3	THE ENVIRONMENTAL MONITORING & AUDIT MANUAL	2
2	EIA, OPERATIONS PLAN AND MITIGATION MEASURES	5
2.1	INTRODUCTION	5
2.2	POTENTIAL IMPACTS IDENTIFIED IN THE EIA	5
2.3	COMPONENTS OF THE EM&A PROGRAMME	7
3	OPERATIONS PLAN	9
3.1	INTRODUCTION	9
3.2	CONTROL AND ADMINISTRATION OF BACKFILLING	9
3.3	PLACEMENT OF DREDGED MATERIAL	10
3.4	MITIGATION MEASURES	13
3.5	INDICATIVE PROGRAMME	14
3.6	MARINE TRAFFIC ISSUES	14
4	ORGANIZATION AND MANAGEMENT OF EM&A	17
4.1	INTRODUCTION	17
4.2	THE SITE MANAGER	17
4.3	EPD MONITORING AND AUDIT SECTION	17
4.4	ENVIRONMENTAL TEAM	17
5	ENVIRONMENTAL MONITORING REQUIREMENTS	19
5.1	INTRODUCTION	19
5.2	WATER QUALITY MONITORING	19
5.3	ECOLOGICAL MONITORING	26
6	ENVIRONMENTAL COMPLIANCE ASSESSMENT AND ACTION EVENT PLANS	31
6.1	ENVIRONMENTAL COMPLIANCE	31
6.2	ACTION EVENT PLAN	33
7	OPERATIONAL MONITORING REQUIREMENTS	37
7.1	BACKFILLING OPERATIONS	37
7.2	VESSEL LOSS RATES	37
7.3	BATHYMETRY	38
8	ENVIRONMENTAL COMPLAINTS PROCEDURES	39

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9	REPORTING REQUIREMENTS	41
9.1	INTRODUCTION	41
9.2	BASELINE REPORT	41
9.3	MONITORING RESULTS	41
9.4	ENVIRONMENTAL EXCEEDANCES	42
9.5	MONTHLY EM&A PROGRESS REPORT	42
9.6	INITIAL REVIEW REPORT	42
9.7	QUARTERLY EM&A PROGRESS REPORT	42
9.7	ANNUAL REPORT	43
10	ENVIRONMENTAL AUDIT REQUIREMENTS	41

## INTRODUCTION

This document presents the Environmental Monitoring and Audit (EM&A) requirements for backfilling of the two Marine Borrow Areas (MBAs) adjacent to East Tung Lung Chau (ETLC).

### 1.1

#### BACKGROUND TO STUDY

Sand from two Marine Borrow Areas (MBAs) situated adjacent to East Tung Lung Chau was excavated primarily for the West Kowloon reclamation. Following the completion of sand extraction, in accordance with the policy of the Fill Management Committee (FMC), backfilling of the MBAs is proposed to reinstate the natural seabed level. Backfilling will also provide much needed additional disposal capacity for uncontaminated marine mud.

The MBAs consist of two pits as presented in *Figure 1.1a*. The northern of the two pits (Area A) is to the west of the Ninepins Islands and is a deep and distinct borrow pit. The southern pit (Areas B and C) is a larger, less well-defined shallow area which is located to the southeast of Tung Lung Chau. The deeper, more defined pit has been excavated to a maximum depth of approximately -47 mPD from a natural sea bed level in this area of approximately -27 mPD. In the larger, shallower MBA, up to 5 metres of sand have been removed in water depths of around -25 to -30 mPD. It is estimated, from bathymetry surveys conducted for the Civil Engineering Department Geotechnical Engineering Office (CED GEO), that the ETLC MBAs collectively have a potential backfilling capacity of over 31 Mm<sup>3</sup>.

Environmental impacts associated with backfilling operations were predicted and presented firstly in the *Initial Assessment Report (IAR)* and subsequently in the *Environmental Impact Assessment Report (EIA)*. The IAR was released in November 1995 and was endorsed by the Study Management Group in June 1995. The EIA was released in draft form in April 1997.

This document provides details of how environmental impacts will be monitored and what responses should be undertaken in response to the detection of impacts to ensure that the impacts do not become unacceptable. It incorporates an Operations Plan which specifies constraints to be imposed on backfilling in order to minimise the environmental impact of backfilling.

### 1.2

#### OBJECTIVES OF ENVIRONMENTAL MONITORING AND AUDIT

The primary objective of the EM&A programme is to verify predictions in the EIA and so ensure that unacceptable impacts do not occur as a result of backfilling the ETLC MBAs. This objective will be achieved by modifying or ceasing backfilling operations if environmental indicators show impacts above specified levels. Environmental indicators have been identified during the EIA and monitoring procedures defined in this document will be used to measure them. Should the specific levels, which are termed Action and Limit levels, be exceeded, responses specified under an Action Event Plan (AEP) will be undertaken. The responses in this plan are graded according to the level of environmental impact identified during monitoring. Action levels reflect lesser

environmental impacts than Limit levels and the required responses, which are lesser accordingly, reflect the lower level of concern.

The EM&A programme will also:

- provide a set of data which can be used to determine environmental impacts of the backfilling operations;
- monitor the performance and effectiveness of mitigation measures;
- determine project compliance with regulatory requirements, standards and Government policies;
- provide an early indication of environmental degradation should any of the environmental control measures or practices fail to achieve acceptable standards; and
- fulfill China's obligations as a signatory of the London Convention (1972).

### 1.3

#### *THE ENVIRONMENTAL MONITORING & AUDIT MANUAL*

The EM&A Manual is designed to provide information, guidance and instruction for staff responsible for site management and environmental monitoring and audit tasks. It presents measures to mitigate environmental impacts resulting from backfilling, provides a monitoring and audit programme which has been designed to determine the impacts resulting from backfilling, and details a response plan to reduce environmental impacts should they become of concern.

The remainder of the EM&A Manual is structured as follows.

- *Section 2* presents a summary of the impacts identified in the EIA, mitigation measures which are designed to minimise the impacts associated with backfilling, and the various components of the EM&A programme.
- *Section 3* presents the Operations Plan which specifies certain constraints on backfilling operations that are required to minimise environmental impacts;
- *Section 4* presents the organisation and management of the EM&A including details of the roles and responsibilities of the relevant parties with respect to environmental compliance.
- *Section 5* presents environmental monitoring requirements including the locations of monitoring stations, the parameters to be measured and the methodologies to be used. In addition, levels are defined against which monitoring results will be compared to determine whether the monitoring or backfilling operations need to be amended. These levels are termed Action and Limit levels. Any exceedances of them will require implementation of actions defined under the Action Event Plan.
- *Section 6* presents the Action Event Plan, components of which will be implemented if Action or Limit levels are exceeded in order to prevent impacts reaching unacceptable levels.



**SEABED LEVEL (metres below CD)**

-  30 - 32
-  32 - 34
-  34 - 36
-  36 - 38
-  38 - 40
-  40 - 42
-  42 - 44
-  44 - 46
-  Deeper than - 46 mCD

Levels above -30 mCD as indicated on drawing.

This plan is based on bathymetric data provided by GEO, acquired during various surveys undertaken in 1993-4.

The bathymetry is believed to be a fair representation of the present situation except in the TKO allocation where dredging is still in progress.

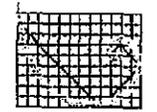
2,000 metres

- Approximate void volumes:
- Area A: 17.9 M cubic metres
  - Area B: 6.6 M cubic metres
  - Area C: 7.0 M cubic metres

FIGURE 1.1a - LOCATION PLAN AND BATHYMETRY OF THE EAST TUNG LUNG CHAU MARINE BORROW AREAS

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- *Section 7* presents operational monitoring requirements. Operational monitoring refers to the collection of data on factors such as the type and quantity of material delivered to the site.
- *Section 8* presents environmental complaints procedures.
- *Section 9* presents EM&A reporting requirements.
- *Section 10* presents environmental audit requirements which are designed to ensure the environmental monitoring programme is being effectively implemented.

## 2.1

*INTRODUCTION*

This section summarises the potential impacts and mitigation measures identified during the EIA and introduces the various different components of the EM&A programme.

Further details of the predicted environmental impacts associated with backfilling are presented in the EIA. Further details of the mitigation measures to be employed during backfilling are presented in *Section 3* which presents the Operations Plan for backfilling the ETLIC MBAs.

## 2.2

*POTENTIAL IMPACTS IDENTIFIED IN THE EIA*

The EIA examined potential effects of backfilling on water quality, marine ecology, air quality and noise levels. Short summaries of assessments of impacts for each of these media are presented in this section together with measures to mitigate impacts.

## 2.2.1

*Water Quality*

Impacts to water quality occur as a result of the introduction of sediment into the water column. Suspended sediments can cause impacts directly because of their physical presence and indirectly because of related effects including elevation of nutrients concentrations and depletion of Dissolved Oxygen (DO) concentrations.

Impacts to water quality can be minimised by limiting the amount of sediment introduced into the water column and by limiting the exposure of Sensitive Receivers (SR) to elevated suspended sediment levels. The introduction of sediment into the water column can be minimised by controlling disposal rates and by employing good site practice. Exposure at SRs can be limited by varying the location of disposal with respect to prevailing currents and by controlling disposal rates and disposal intervals.

During the wet and dry season currents are predominantly unidirectional flowing northeast and southwest respectively. Disposal operations will be located in the northeast during the dry season and in the southwest during the wet season. In this way the distance between the disposal and SRs down current will be maximised. During the transitions between the seasons, at which time current direction varies with tide and is relatively unpredictable, disposal operations will be conducted in the centre of the MBAs.

Disposal rates are specified for each of the locations in order to limit the amount of sediment introduced into the water column and hence the concentrations of suspended sediment reaching SRs. Disposal intervals are specified to avoid consecutive disposal of large material volumes in short intervals which could result in high peak suspended sediment concentrations leaving the MBA.

Modelling, which was conducted assuming the implementation of the above mitigation measures, predicted relatively large elevations of suspended sediment concentration in the immediate vicinity of the location of disposal operations. These concentrations were predicted to decline rapidly as plumes were carried away from the disposal site. Low concentrations were predicted at the nearest SRs and at none of them was an elevation of greater than 10 mg l<sup>-1</sup> predicted. This level was agreed with EPD as an appropriate assessment criterion. Impacts to DO and nutrient levels were very low and below the resolution of monitoring equipment and laboratory analyses.

On the basis of the modelling predictions water quality impacts resulting from backfilling operations were predicted be environmentally acceptable.

### 2.2.2

#### *Marine Ecology*

Impacts to marine ecology may result from elevated levels of suspended sediment because:

- elevations of suspended sediment concentrations and deposition of suspended sediment can be physically damaging to marine organisms;
- depletions of DO resulting from elevated suspended sediment levels may damage marine organisms; and
- elevations of nutrients resulting from elevated suspended sediment levels may stimulate algal growth which can lead to a number of other physical and ecological changes.

As these impacts result from impacts to water quality, mitigation measures for marine ecological impacts are the same as for water quality.

While it is accepted that benthic organisms within the MBAs will be impacted by the backfilling operations, impacts outside the MBAs are of concern and the Operations Plan (see *Section 3*) has been designed to minimise them or prevent them from occurring. Water quality simulations conducted during the EIA predict that elevations of suspended sediment concentration will exceed 10 mg l<sup>-1</sup>, the assessment criterion, over only a small area and that sediment deposition will be largely confined to within the MBAs. On these bases it was concluded that impacts to marine ecology would be acceptable.

### 2.2.3

#### *Air Quality Impacts*

No exceedances of Air Quality Objectives (AQO) were predicted to result from backfilling operations and therefore no mitigation measures will be implemented.

### 2.2.4

#### *Noise Impacts*

Because of the relatively remote location of the MBAs and the nature of backfilling operations, noise levels are not predicted to exceed noise criteria at Noise Sensitive Receivers (NSRs) except at Tung Lung Chau during night-time operations. This potential exceedance can be avoided provided the implementation of mitigation measures to control the backfilling operations at night. Consequently no noise monitoring will be required.

## 2.3 COMPONENTS OF THE EM&A PROGRAMME

Operational and environmental monitoring will be conducted during backfilling operations. Operational monitoring will provide data on disposal operations and environmental monitoring will provide data on the environmental impact of disposal operations. Additional surveying will be undertaken by CED to monitor the bathymetry of the MBAs. These data will be used to determine when the MBAs reach the maximum backfill level and hence when backfilling for each of the MBAs should cease.

### 2.3.1 *Operations Plan*

The Operations Plan which is presented in *Section 3* defines how backfilling operations should be conducted. It has been designed to incorporate measures that will mitigate the environmental impact of backfilling operations.

### 2.3.2 *Operational Monitoring*

Operational monitoring will be conducted to check whether the contractor is conforming with the specifications given in the Operations Plan (see *Section 3*) and to assist in determining whether non-compliances detected during environmental monitoring are due to the backfilling operations or to some other factor. The monitoring will be the responsibility of the contractor conducting backfilling operations. Data recorded will include:

- location of disposal;
- time of disposal;
- time of the high and low water on the same day;
- disposal volume;
- material type; and
- prevailing weather conditions.

### 2.3.3 *Environmental Monitoring*

Environmental monitoring will be conducted throughout backfilling operations to allow assessment of any environmental impacts that may arise.

The principal component of the EM&A will be water quality monitoring. Details of the locations of monitoring stations, the frequency and timing of monitoring and the parameters to be evaluated are presented in *Section 5.2*. Although potential impacts to ecological SRs may occur as a result of the proposed backfilling operations because of changes in suspended sediment loads and dissolved oxygen, environmental mitigation of water quality impacts should mitigate ecological impacts. Air quality and noise monitoring will not be required as detailed in *Sections 2.2.3* and *2.2.4*.

## 3 OPERATIONS PLAN

### 3.1 INTRODUCTION

This section presents the Operations Plan which specifies certain constraints on backfilling which are intended to minimise environmental impacts associated with backfilling operations. Engineering requirements which are essential to controlling environmental impacts have been specified. However, the plan does not constitute an engineering specification for utilisation of the MBAs.

#### 3.1.1 Objectives of the Operations Plan

The primary objective of the Operations Plan is to define operational constraints which will minimise the environmental impact associated with backfilling. Provided these constraints are implemented, impacts associated with backfilling, which have been predicted and evaluated in the EIA, should be acceptable.

The constraints to be applied to backfilling and their objectives are as follows:

- the location of disposal is controlled to limit the transport of suspended sediment toward SRs and to restrict deposition and transport of backfill material to within the boundaries of the MBAs;
- the rate of disposal is limited to control the rate at which sediment is introduced into the water column and therefore the rate at which sediment deposition occurs;
- a minimum interval between disposals is defined in order to limit peak elevations of suspended sediment concentrations;
- the level to which backfilling can be conducted is defined to limit erosion of newly deposited material; and
- disposal operations are controlled to avoid backfilling immediately prior to storms as the seabed is more prone to erosion during storms.

In addition, a number of general mitigative measures will be applied which will contribute further to the minimisation of environmental impacts.

### 3.2 CONTROL AND ADMINISTRATION OF BACKFILLING

Offshore disposal is controlled under the *Dumping at Sea Ordinance (1995)* and procedures to be followed for all works which involve the marine disposal of dredged mud are set out under the *Works Branch Technical Circular No 22/92*. All marine disposal is controlled by means of permits issued by the Director of Environmental Protection. The FMC is responsible for the management and allocation of disposal facilities. The *Technical Circular* includes procedures for notification of disposal requirements, allocation of disposal sites, determination of sediment quality and application for marine dumping licences. In addition it provides guidelines for the sampling and testing of mud which is to be dredged.

The success of measures incorporated in the Operations Plan in mitigating the environmental impact of disposal operations will depend in part on the effectiveness of control of disposal rates and disposal locations. FMC Allocations, EPD Dumping Licences and the EPD black box vessel position recording system are proposed to achieve this control. Similar arrangements, administered jointly by FMC and EPD, are in place at the South Cheung Chau and East of Ninepins open seafloor disposal sites, where they are operating smoothly and effectively. The EM&A programme serves as an alert and control mechanism by measuring operational impacts and the effectiveness of the procedures described in the Operations Plan.

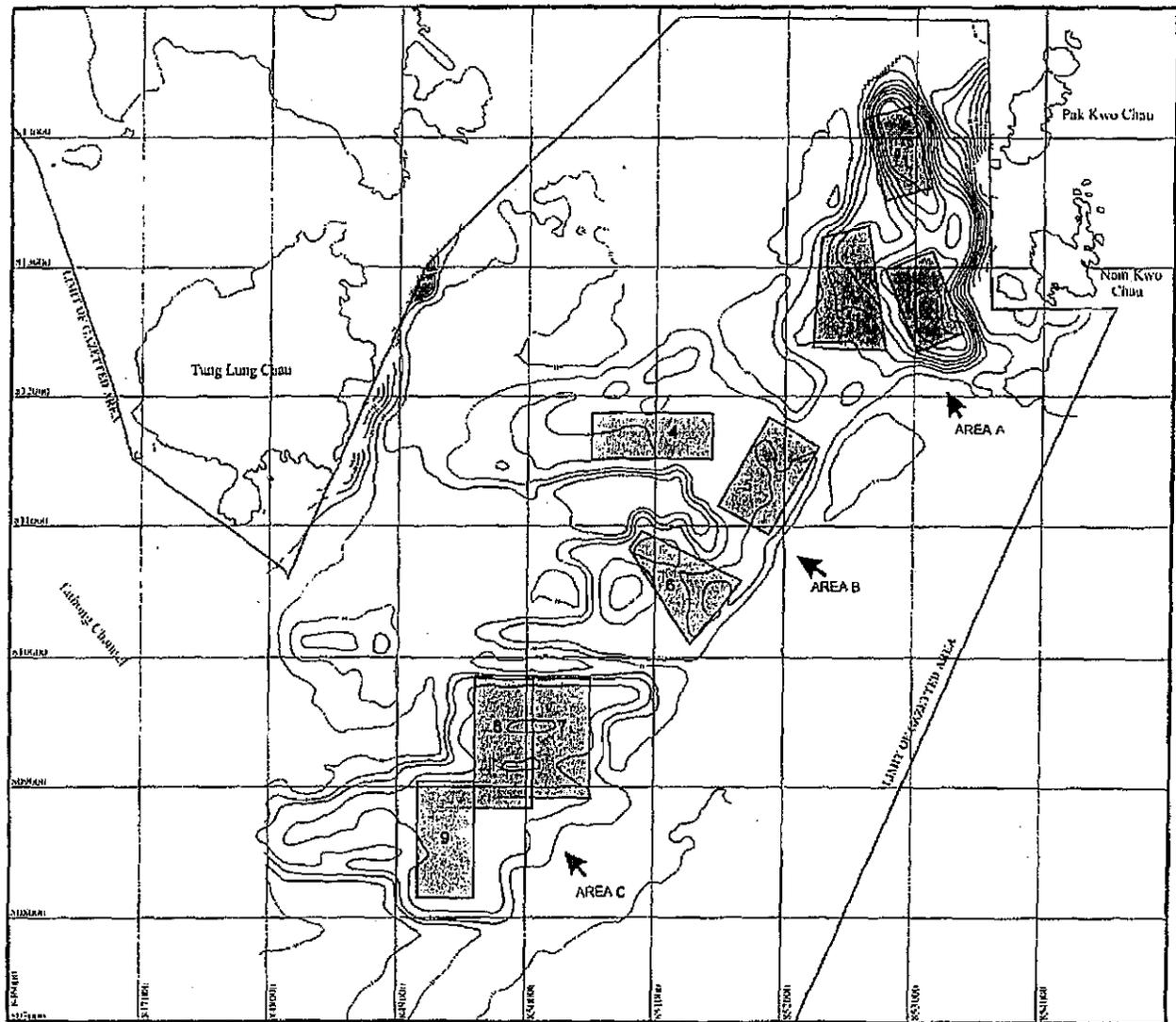
### 3.3 PLACEMENT OF DREDGED MATERIAL

#### 3.3.1 Disposal Locations

Experience gained at South Cheung Chau and East of Ninepins disposal sites shows that as long as disposal contractors are given a reasonably-sized area in which to dispose of spoil, out-of-area disposal is minimal. Disposal areas of approximately 800 m to 1000 m by 350 m to 500 m are in use at these sites, and similar sized areas are envisaged for ETLC. These are presented in *Figure 3.3a*.

The direction and strength of currents in the study area influences the impacts of disposal operations as they determine where suspended sediments are transported and hence which SRs are affected. Dry, wet and transitional season current patterns and their implications for disposal locations are outlined below.

- During the dry season currents typically flow to the southwest. By restricting disposal operations to the northeast MBA (Area A in *Figure 1.1a*) at this time, the transport of suspended sediments from the MBA to the northeast, which could result in impacts to SRs around the Ninepins Group, can be avoided as the plume generated by the disposal activities will be carried southwest over the MBAs. By the time plumes cross the southwestern boundary of the MBAs, suspended sediment concentrations will have decreased markedly and impacts to SRs lying southwest of the MBA are predicted to be minor.
- Conversely, during the wet season currents typically flow to the northeast. By restricting disposal operations to the southwest MBA (Area C in *Figure 1.1a*) at this time, the transport of suspended sediments from the MBA to the southwest can be avoided as the plume generated by the disposal activities will be carried northeast over the MBAs. By the time plumes cross the northeastern boundary of the MBAs suspended sediment concentrations will have decreased markedly and impacts to SRs to the northeast are predicted to be minor.
- Between the wet and dry seasons are transition periods during which currents may change direction. It is therefore more difficult to optimise disposal locations in the MBAs during these periods. For a significant part of the year (mid-March to mid-May and mid-August to the end of September) the currents are in a transitional state during which rapid switching (perhaps as frequently as daily) from wet to dry season conditions can take place. As it is not possible to predict the direction of the currents during these periods, disposal will be confined to the central part of the MBAs, approximately equidistant from the SRs and disposal rates will be reduced as detailed in *Section 3.3.3*.



SCALE |-----| 2000m

FIGURE 3.3a - PROPOSED MUD DISPOSAL AREAS IN THE ETLC MBAs  
 Source: FMC/344, Civil Engineering Dept

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 9 Chatham Road  
 Tsimshatsui, Kowloon  
 Hong Kong



### 3.3.2 *Disposal Material Types*

In order to avoid mounding (inadvertent backfilling above pre-existing seabed levels), only trailer dredged material will be placed in the southwestern (shallow) MBA. Both trailer and grab dredged materials will be placed in the northeastern (deep) MBA. It should be noted that in either case only uncontaminated material will be assigned for disposal at the ETLC MBAs.

### 3.3.3 *Disposal Rates*

#### *Daily Rate*

The maximum rate proposed for disposal in the northeastern part (Area A) and the southeast part of the MBAs (Area C) is 50,000 m<sup>3</sup> day<sup>-1</sup> (hopper volume). A lower rate is proposed for the central portion of the MBAs (Area B) of 25,000 m<sup>3</sup> day<sup>-1</sup> because the distances between this area and downstream SRs are less than for the other two areas.

#### *Disposal Interval*

Minimum disposal intervals have been specified for in order to ensure that the plumes from consecutive disposal events remain independent of one another. These intervals will prevent plumes from overlapping one another which could result in higher peak suspended sediment concentrations than were predicted during the EIA. No restrictions are required for the minimum disposal interval for barges because their hopper volumes are approximately an order of magnitude smaller than trailer dredgers (ie to form a plume equivalent to a trailer disposal 10 barges would have release their material simultaneously). Initially an interval of 3.84 hours will be required between trailer disposal events because this corresponds to the minimum interval that was modelled during the EIA. In order to prevent any significant overlap of plumes from barges and trailers, no more than 5 barge disposals will be undertaken in the two hour period following a trailer disposal. In addition, trailer disposals will be restricted so that they only occur after an interval of half an hour after the preceding barge disposal. There may be the potential to reduce these intervals provided monitoring data does not show adverse impacts. This will be discussed and reviewed in the initial review report which will be submitted after the first three months of monitoring, or on a suitable date agreed by CED and EPD.

### 3.3.4 *Summary of Temporal, Spatial and Material Restrictions on Disposal*

A summary of disposal location and disposal rate information presented in Sections 3.3.1, 3.3.2 and 3.3.3 is presented in Table 3.3a. Note that the Operations Plan may be modified during backfilling operations depending upon the results of environmental monitoring and the approval of CED and EPD. Revised or enhanced constraints or mitigation measures may be applied.

**Table 3.3a** *Temporal, Spatial and Material Restrictions on Disposal*

Season	Maximum Total Daily Disposal (m <sup>3</sup> in hopper)	Disposal Areas for Grab-Dredged Material <sup>(a)</sup>	Disposal Areas for Trailer-Dredged Material <sup>(a)</sup>
Dry season: beginning of October to mid-March	50,000	1,2 only <sup>(b)</sup>	1,2,3 only
Wet season: mid-May to mid-August	50,000	none	7,8,9 only
Transitional seasons: mid-March to mid-May mid-August to end September	25,000	none	4,5,6 only

Notes:  
 (a) Disposal Areas referred to are presented in *Figure 3.3a*  
 (b) Disposal of grab-dredged Material is only proposed for the northeast deep MBAs (Areas 1 & 2) due to concerns associated with mounding of grab-dredged material in the southwest shallow MBAs

**3.3.5** *Backfill Level*

The stability of recently deposited backfill material at various levels was predicted during the EIA for three locations in the MBAs. *Table 3.3b* presents results of these analyses and the levels to which backfilling should be conducted.

**Table 3.3b** *Backfill Level*

Location	Station Modelled in the EIA	Backfill Level
Area A corresponding to Areas 1, 2, 3 in <i>Figure 3.3a</i>	RP1	Up to the level of the surrounding seabed (at least -30 mPD)
Area B corresponding to Areas 3, 4, 5 in <i>Figure 3.3a</i>	RP2	Up to the level of the surrounding seabed (at least -30 mPD)
Area C corresponding to Areas 6, 7, 8 in <i>Figure 3.3a</i>	RP3	Not to exceed -30 mPD

**3.3.6** *Other Conditions*

The following additional conditions will be imposed:

- in order to avoid disruption to fishing activities, if a fishing vessel is working at the disposal location the disposal vessel will be required to wait until the fishing vessel has left the disposal area (ie move more than 1 km away from the area)<sup>(1)</sup>;
- backfilling operations at ETLC MBAs will be prohibited during dredging or backfilling or both in the Eastern Waters Marine Borrow Area;
- backfilling at ETLC MBAs will be prohibited during dredging in the ETLC, Tathong Channel and West/East Po Toi MBAs;

<sup>(1)</sup> A mechanism to deal with complaints and non-compliance cases is presented in *Section 8*

- backfilling at ETLC MBAs will be prohibited during dredging or dumping in the Tseung Kwan O area;
- backfilling at ETLC MBAs will be prohibited during disposal operations at East of Ninepins; and
- disposal operations should cease when typhoon signal 3 or higher is raised.

### 3.4 *MITIGATION MEASURES*

#### 3.4.1 *General Measures*

The following general measures should apply at all times to the backfilling operations:

- dumping should take place in strict compliance with the conditions of the EPD Marine Dumping Permits which are in force at the time;
- all barges and trailers should be fitted with tight bottom seals in order to prevent leakage of material during transport;
- all barges and trailers should be filled to a level which ensures that material does not spill over during transport to the disposal site and that adequate freeboard is maintained to ensure that the decks are not washed by wave action;
- after discharge, barges and trailers should immediately be closed before moving from the disposal area;
- after discharge, any excess materials should be cleaned from decks and exposed fittings before the vessel is moved from the disposal area;
- the contractor(s) should ensure that the works cause no visible foam, oil, grease, litter or other objectionable matter to be present in the water within and adjacent to the disposal site; and
- trailer dredgers shall be stationary while dumping and shall not wash out their hoppers after dumping.

#### 3.4.2 *Response Measures*

The Operations Plan has been formulated in order to minimise environmental impacts associated with backfilling of the ETLC MBAs, particularly with respect to loss of sediment to the water column and impacts to water quality and to the surrounding seabed that can result. The constraints given in *Section 3.3* also act as mitigation measures which can be adjusted should unacceptable impacts be detected.

Potential adjustments include:

- cessation of disposal in particular areas;
- prevention of the use of the disposal site by vessels which are known to

introduce relatively high quantities of sediment into the water column<sup>(2)</sup> (ie vessels associated with high loss rates);

- reduction of the maximum daily disposal rate;
- an increase in the disposal interval;
- reduction of the level to which backfilling should be undertaken; and
- further restrictions on backfilling operations according to tidal conditions.

### 3.5

#### INDICATIVE PROGRAMME

The programme for backfilling operations will depend on the rate at which surplus uncontaminated mud is generated and the maximum rate at which disposal can occur without unacceptable environmental impact. Present knowledge of projects which will be producing surplus muds within a 4 year period beginning January 1997 indicate that the demand for mud disposal sites will be greatest at the beginning of this period. Demand for disposal in later years may increase as additional projects are proposed and undertaken.

The relative proportions of grab dredged material and trailer dredged material cannot be estimated for the above projects at this time. However, it can reasonably be assumed that small inshore projects will use grab dredgers, while larger projects, over approximately 200,000 m<sup>3</sup>, will involve both grab and trailer dredgers.

It is anticipated that materials which are currently disposed at the East of Ninepins open seafloor disposal site will be diverted to the ETLC MBAs. On the assumption that this will occur, the length of time it will take to fill the ETLC MBAs can be predicted from the available capacity, and from the current rate of disposal at the East of Ninepins site. At this rate, which is approximately 10 Mm<sup>3</sup> year<sup>-1</sup>, or 27,000 m<sup>3</sup> day<sup>-1</sup>, the backfilling of the ETLC MBAs would be completed in approximately three and a half years. However, in considering these predictions, it must be recognised that the ETLC MBAs are not intended as a replacement of the East of Ninepins site *per se* and that the rate of generation of disposal material will vary according to the projects undertaken in the future.

### 3.6

#### MARINE TRAFFIC ISSUES

Small vessels such as fishing boats, pleasure craft and coastal freighters frequent the proposed backfilling area and are usually in transit or confined to the western side of the MBAs, near Tung Lung Chau, with occasional visits to the Ninepins Group. No restrictions will be made on the traffic of these vessels. Large vessels are required by the Marine Department to avoid the proposed backfilling area and to only use the extreme southwestern part of the ETLC MBAs, which is at the end of the Tathong Channel Traffic Separation Scheme.

<sup>(2)</sup> In the event that EM & A results show higher impacts than were predicted in the EIA, CED will require trailer dredgers to undertake a sediment loss survey.

The Marine Department has indicated that no particular problems concerning navigation issues are foreseen during the proposed backfilling at the rates which are proposed. If larger traffic flows are expected to be generated by any significantly increased rate of backfilling, the Marine Department will be consulted further.

## 4 ORGANIZATION AND MANAGEMENT OF EM&A

### 4.1 INTRODUCTION

This section presents the details of the environmental management roles and responsibilities of the parties involved in the environmental management process. These roles and responsibilities and the interaction between various components of the EM & A programme are illustrated in *Figure 4.1a*.

### 4.2 THE SITE MANAGER

The Site Manager<sup>(3)</sup> will play the pivotal role in managing backfilling operations by ensuring that disposal operations conform to the Operations Plan, by overseeing the Environmental Team and by liaising with the Environmental Protection Department (EPD) and the dredging contractor. Specific duties of the Site Manager include:

- reviewing the monthly and quarterly EM&A reports prepared by the Environmental Team;
- informing relevant parties of exceedances; and
- identifying and imposing corrective actions where necessary.

The Site Manager maintains the overall responsibility for controlling backfilling operations to ensure that environmental compliance is maintained and appropriate actions are taken in the event of any documented exceedances. The Site Manager will also have the authority to re-direct backfill material to another site at any time, enabling appropriate management of the site within the requirements of the EM&A Manual to be achieved.

### 4.3 EPD MONITORING AND AUDIT SECTION

EPD's role involves ensuring that site management practices are in compliance with all environmental regulatory criteria, that appropriate conditions are specified in the dumping licence, and that these conditions are met. This will be accomplished through liaison with the Site Manager and periodic auditing of EM&A data submitted by the Site Manager and Environmental Team in monthly and quarterly reports.

### 4.4 ENVIRONMENTAL TEAM

The Environmental Team is responsible for the following activities:

- conducting field work to collect monitoring data and samples, and conducting appropriate laboratory analyses;

<sup>3</sup> The Site Manager will be CED.

- reviewing field data to identify any exceedances of Action and Limit levels and hence determining whether actions are required under the Action Event Plan;
- notifying of the Site Manager of exceedances;
- reviewing operational data to identify whether backfilling operations are being conducted in accordance with the Operations Plan (see *Section 3*);
- preparing monthly and quarterly reports for the Site Manager; and
- assisting the Site Manager, as directed, in formulating corrective actions and liaison with government departments and other parties.

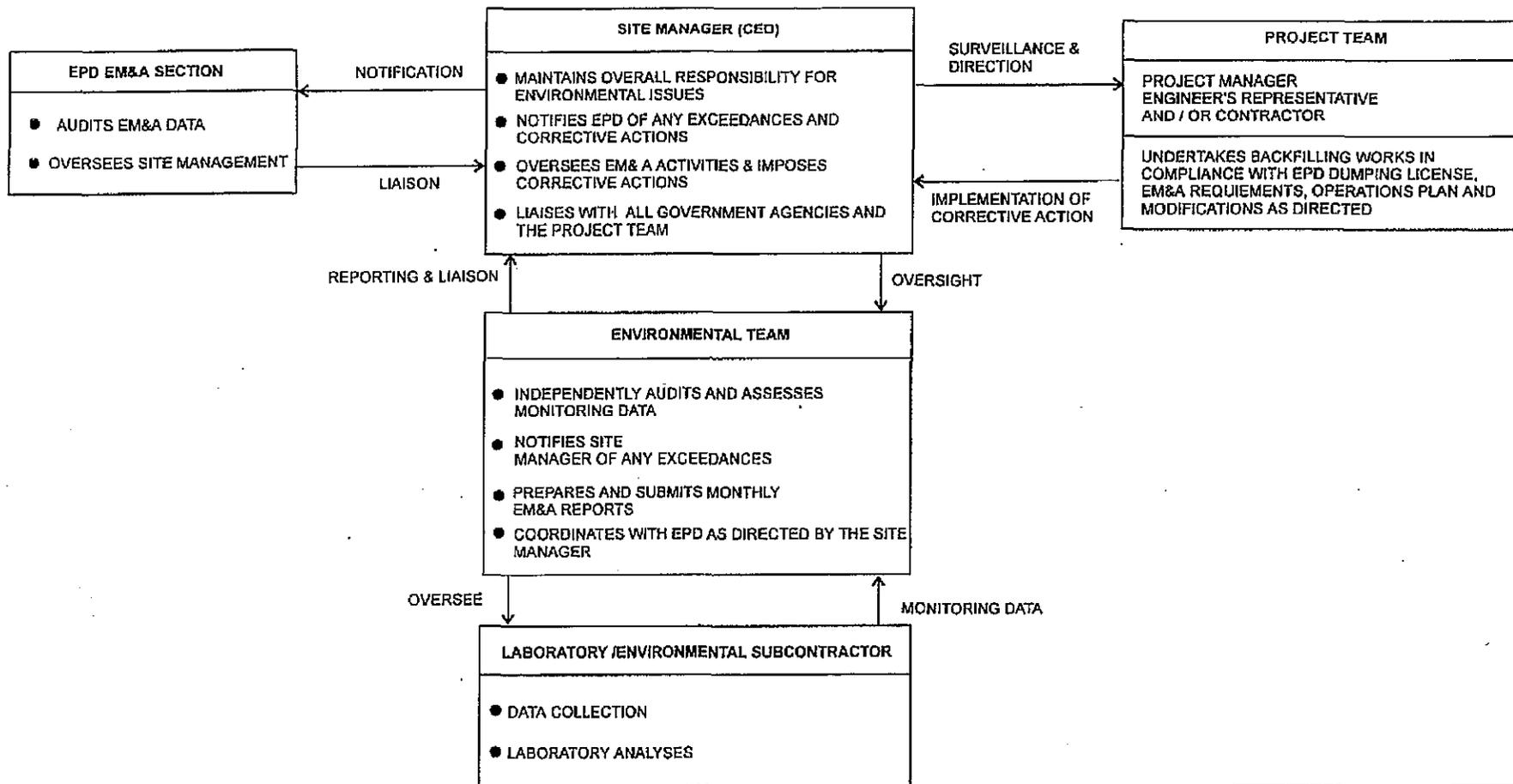


FIGURE 4.1a - ENVIRONMENTAL MONITORING AND AUDIT PROGRAMME ROLES AND RESPONSIBILITIES

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## 5.1

*INTRODUCTION*

This section provides details of the environmental monitoring programme and presents technical requirements for monitoring water quality and marine ecology. The programme and the requirements will be subject to review depending on the results of the environmental monitoring. An *Initial Review Report* will be submitted after the first three months of monitoring or on a suitable date agreed by CED and EPD. The consultants will discuss the adequacy of the monitoring programme and provide recommendations on how to improve the monitoring programme, if required. Thereafter, annual reports will be prepared to review all the monitoring results and the status of the borrow pits.

Water quality monitoring results will be compared to Action and Limit Levels to determine which stations should be monitored, whether ecological monitoring should be undertaken, and whether impacts associated with backfilling are acceptable. Action Event Plans (AEP), which are detailed in *Section 6*, provide procedures to be undertaken when monitoring results exceed Action or Limit levels. The procedures are designed to ensure that if any significant exceedances occur (either accidental or through inadequate implementation of mitigation measures on the part of the contractor), the cause is quickly identified and remedied, and that the risk of a similar event occurring is reduced.

Action and Limit levels will be used to determine whether modifications to backfilling operations are required. Action and Limit levels are environmental quality standards chosen such that their exceedance indicates potential deterioration of the environment. Exceedance of Action levels can result in an increase in the frequency of environmental monitoring and the modification of backfilling operations. Exceedance of Limit levels indicates a greater potential deterioration and may require the cessation of works unless appropriate remedial actions, including a critical review of plant and working methods, are undertaken.

## 5.2

*WATER QUALITY MONITORING*

The principal component of the EM&A programme will be water quality monitoring which is easier to conduct and allows a faster response to changes in environmental factors than ecological monitoring.

## 5.2.1

*Water Quality Monitoring Objectives*

The objectives of the water quality monitoring programme are as follows:

- to determine the effectiveness of the operational controls and mitigation measures employed, and the need for supplemental mitigation measures;
- to check compliance with relevant Water Quality Objectives (WQOs); and
- to verify the predictions of the sediment plume modelling.

The questions that the monitoring will answer are as follows:

- are impacts to water quality within predictions made in the EIA?
- and hence, are impacts to water quality acceptable?

The impact hypothesis for water quality is :

*Impacts associated with the backfilling of the ETLC MBAs are not expected to result in exceedances of WQOs at sensitive receivers.*

The statistical bases for interpretation of results are presented in *Section 6.1.1.*

#### *Water Quality Objectives*

WQOs for the Mirs Bay Water Control Zone (MBWCZ), in which the MBAs are located, and for the Southern Water Control Zone (SWCZ) and the Eastern Buffer Water Control Zone (EBWCZ), in which elevations in suspended sediment were predicted during the EIA, are as follows:

- Suspended Solids (SS): Human activities must not raise the natural ambient SS level by 30% nor cause an accumulation of SS which may adversely affect aquatic communities.
- Dissolved Oxygen (DO): DO within 2 m of the bottom should not be less than 2 mg l<sup>-1</sup> for 90% of the samples. Depth averaged DO should not be less than 4 mg l<sup>-1</sup> for 90% of the samples (not less than 5 mg l<sup>-1</sup> for fish culture zones).
- Nutrients: Nutrients will not be present in quantities that cause excessive algal growth. Annual mean depth averaged inorganic nitrogen should not exceed 0.3 mg l<sup>-1</sup> in the MBWCZ, 0.1 mg l<sup>-1</sup> in the SWCZ and 0.4 mg l<sup>-1</sup> in the EBWCZ.

#### *Water Quality Assessment Criterion*

EPD routine water quality monitoring data presented in the EIA showed very low ambient concentrations of SS. Elevations of 30 % above ambient are consequently even lower and are of a similar magnitude as the sensitivity of the analytical techniques used to determine suspended sediment concentrations. Following discussion with EPD, a 10 mg l<sup>-1</sup> elevation above ambient was agreed as an appropriate assessment criterion against which to measure the acceptability of predicted elevations in suspended sediment concentration. This assessment criterion is consistent with the EIAs for the proposed Eastern Waters MBA and for the Disposal of Contaminated Mud in the East Sha Chau MBA.

### 5.2.2

#### *Water Quality Monitoring Rationale*

Water quality monitoring objectives will be achieved by comparing monitoring results from Control Stations, Perimeter Stations and Sensitive Receiver Stations.

Control Stations are upstream of the disposal locations and are used to determine ambient water quality. Perimeter Stations are in the immediate vicinity of the MBAs and are expected to be impacted by SS plumes following disposal events. Sensitive Receiver Stations are in relatively close proximity to

SRs and are expected to experience either no elevations in SS or small elevations in SS.

### 5.2.3

#### *Sensitive Receivers (SR)*

During the EIA various SRs in the vicinity of the ETLC MBAs were identified in accordance with the Hong Kong Planning Standards & Guidelines (HKPSG). They are presented in *Figure 5.2a*. SRs at which potential impacts were identified during the EIA and IAR are highlighted. Potential impacts were only predicted at ecological resources and specifically at areas where there are known to be corals. Conservative predictions of deposition rates, made during the EIA showed sediment deposition rates of 5-25 % of a coral deposition tolerance threshold of  $0.2 \text{ kg m}^{-2} \text{ day}^{-1}$  <sup>(4)</sup>. If measured suspended sediment concentrations are within the predicted suspended sediment concentrations then actual suspended sediment deposition rates are also expected to be within predicted deposition rates.

### 5.2.4

#### *Location of Monitoring Stations*

The location of monitoring stations will vary seasonally in accordance with the backfilling operations: backfilling will be undertaken in the northeastern (deep) MBA during the dry season; in the southwest of the southwestern (shallow) MBA in the wet season and in the centre of the southwestern shallow pit during the transitions between seasons.

##### *Dry Season*

During the dry season the northeastern (deep) MBA will be backfilled with trailer and grab dredged material. Disposal operations will be conducted in Areas 1 and 2 using grab and trailer material, and in Area 3, using trailer dredged material as detailed in the Operations Plan which is presented in *Section 3*.

Stations to be monitored are presented in *Table 5.2a* and *Figure 5.2b*. These stations have been located in accordance with modelling predictions of plume transport which are also shown in *Figure 5.2b*.

<sup>(4)</sup> Binnie Consultants Ltd (1992) South Mirs Bay Borrow Area. Initial Assessment Report

Table 5.2a Dry Season Monitoring Stations

Monitoring Location	Monitoring Stations (Figure 5.2b)	Applicable Assessment Level
<i>Perimeter Stations<sup>101</sup>:</i>		
	PD1-PD3	Not applicable
<i>Sensitive Receiver Stations:</i>		
Pak Kwo Chau (West)	S1	Action and Limit
Nam Kwo Chau	S2	Action and Limit
Tung Lung Chau	S3	Action and Limit
Waglan Island	S4	Action and Limit
Sung Kong	S5	Action and Limit
Swire Marine Laboratory	S7	Action and Limit
<i>Control Stations:</i>		
	C1	Not applicable
	C2	Not applicable
	C3	Not applicable
<i>Fish Culture Zones</i>		
	FCZ1	Action and Limit
	FCZ2	Action and Limit

*Wet Season*

During the wet season, the southwestern part of the southwestern (shallow) MBA will be backfilled with trailer dredged material. Disposal operations will be conducted in Areas 7, 8 & 9 as detailed under the Operations Plan in Section 3.3.

Stations to be monitored are presented in Table 5.2b and Figure 5.2c. These stations have been located in accordance with modelling predictions of plume transport.

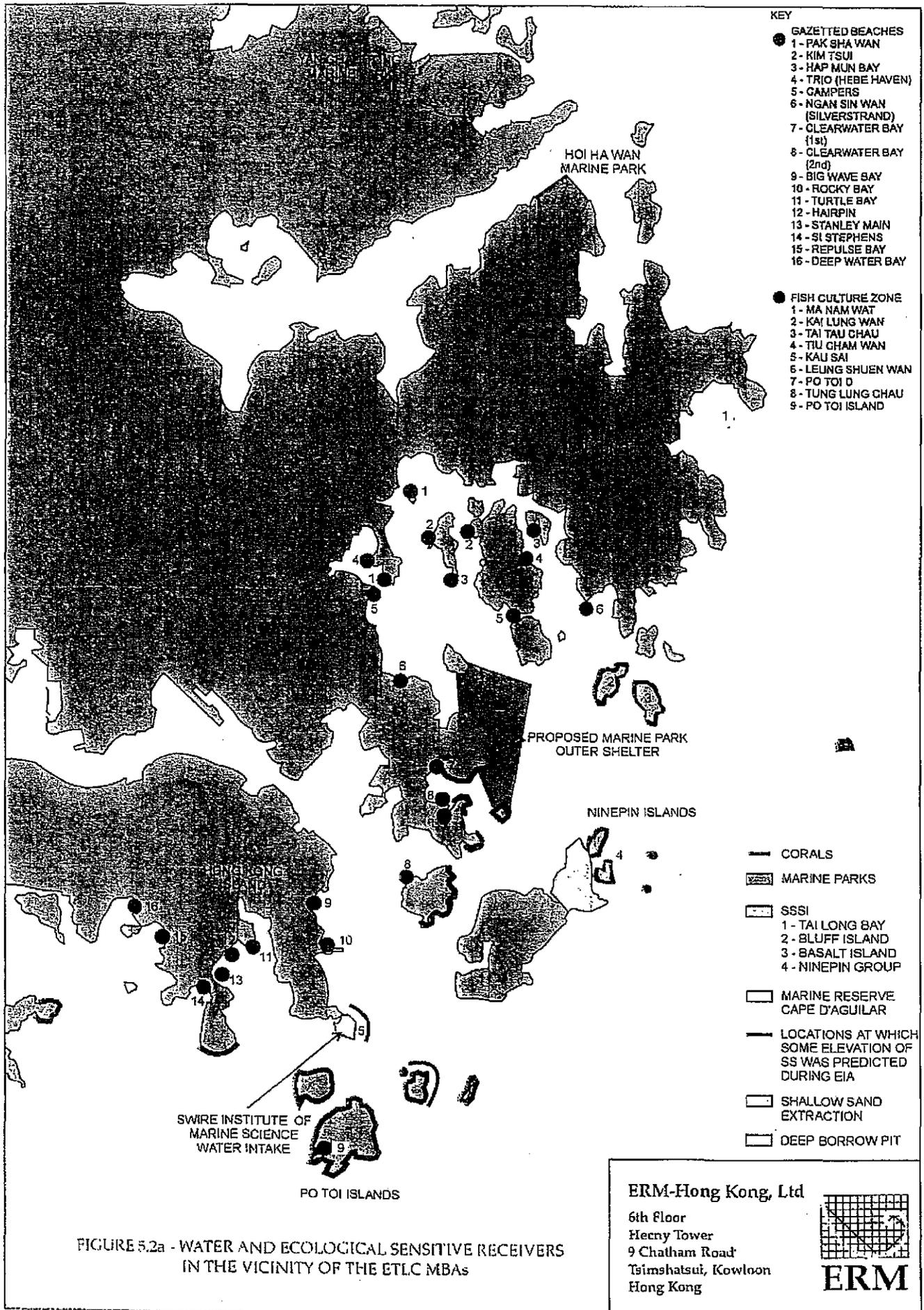
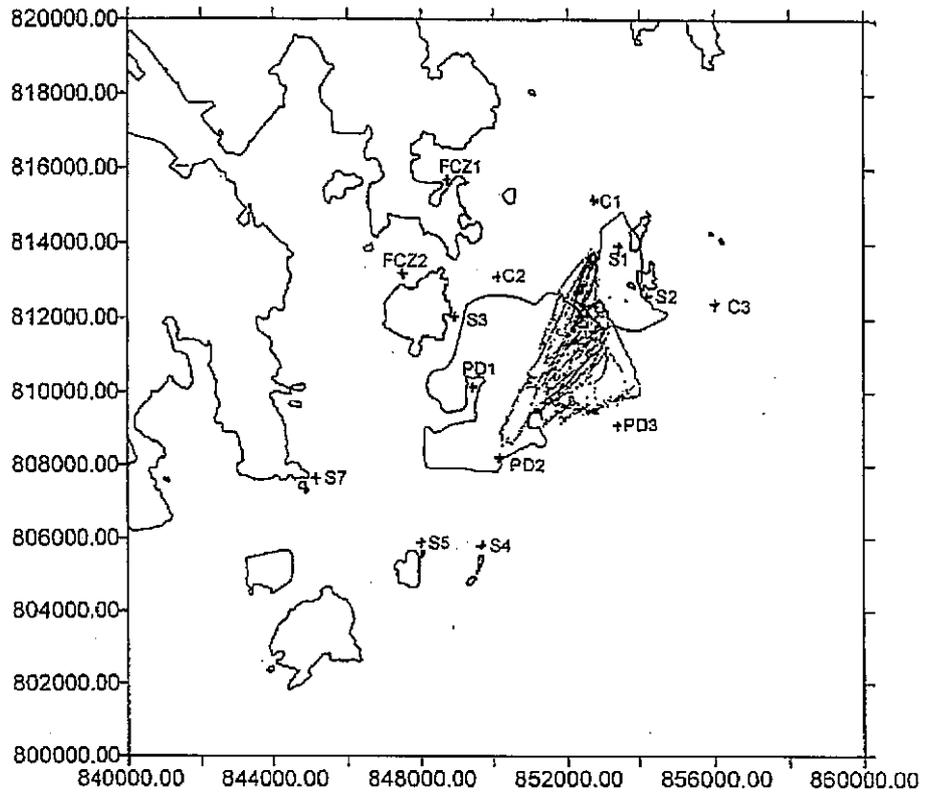


FIGURE 5.2a - WATER AND ECOLOGICAL SENSITIVE RECEIVERS IN THE VICINITY OF THE ETLIC MBAs



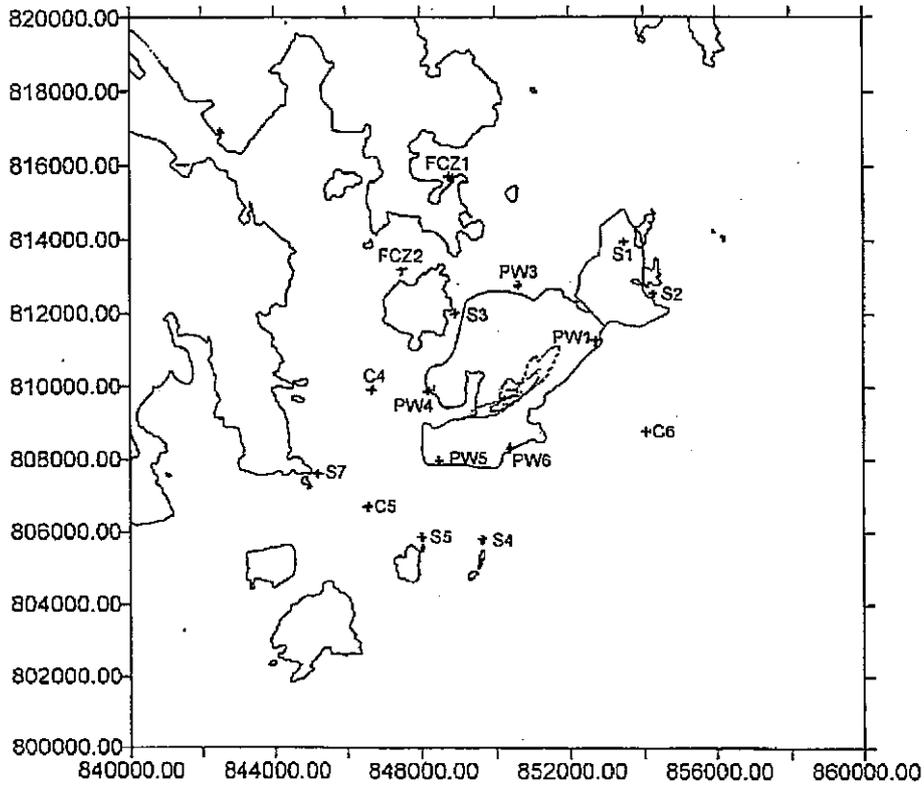
Northing	Easting	Station Name
853450	813957	S1
854217	812570	S2
848917	812029	S3
849673	805815	S4
848003	805894	S5
845187	807655	S7
849441	810176	PD1
850146	808194	PD2
853371	809119	PD3
852738	815174	C1
850126	813137	C2
855998	812377	C3
848715	815699	FCZ1
847505	813209	FCZ2

FIGURE 5.2b - DRY SEASON WATER QUALITY MONITORING STATIONS

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Northing	Easting	Station
853450	813957	S1
854217	812570	S2
848917	812029	S3
849673	805815	S4
848003	805894	S5
845187	807655	S7
852674	811302	PW1
852163	812335	PW2
850617	812764	PW3
848206	809920	PW4
848466	807980	PW5
850405	808364	PW6
846678	809914	C4
846581	806753	C5
854049	808816	C6
848715	815699	FCZ1
847505	813209	FCZ2

FIGURE 5.2c - WET SEASON WATER QUALITY MONITORING STATIONS

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Table 5.2b *Wet Season Monitoring Stations*

Monitoring Location	Monitoring Stations (Figure 5.2c)	Applicable Assessment Level
<i>Perimeter Stations<sup>(a)</sup>:</i>		
	PW1-PW6	Not Applicable
<i>Sensitive Receiver Stations:</i>		
Pak Kwo Chau (West)	S1	Action and Limit
Nam Kwo Chau	S2	Action and Limit
Tung Lung Chau	S3	Action and Limit
Waglan Island	S4	Action and Limit
Sung Kong	S5	Action and Limit
Swire Marine Laboratory	S7	Action and Limit
<i>Control Stations:</i>		
	C4	Not applicable
	C5	Not applicable
	C6	Not applicable
<i>Fish Culture Zones</i>		
	FCZ1	Action and Limit
	FCZ2	Action and Limit

*Transition Between Seasons*

During the transition between the wet and dry seasons the northeastern part of the southwestern (shallow) MBA will be backfilled with trailer dredged material. Disposal operations will be conducted in Areas 4, 5 & 6 as detailed in the Operations Plan which is presented in Section 3.

Because of the relative unpredictability of the currents in this period, Perimeter Stations have not been defined and will not be monitored. Monitoring will only be conducted at SR stations. SR and Control Stations are presented in Table 5.2c and Figure 5.2d.

Table 5.2c

*Transitional Season Monitoring Station<sup>(a)</sup>*

Monitoring Location	Monitoring Stations (Figure 5.2d)	Applicable Assessment Level
<i>Sensitive Receiver Stations:</i>		
Pak Kwo Chau (West)	S1	Action and Limit
Nam Kwo Chau	S2	Action and Limit
Tung Lung Chau	S3	Action and Limit
Waglan Island	S4	Action and Limit
Sung Kong	S5	Action and Limit
Po Toi	S6	Action and Limit
Swire Marine Laboratory	S7	Action and Limit
<i>Control Stations:</i>		
	C1	Not applicable
	C4	Not applicable
	C6	Not applicable
<i>Fish Culture Zones</i>		
	FCZ1	Action and Limit
	FCZ2	Action and Limit
<b>Notes:</b>		
(a) The unpredictability of the currents during the transitional periods between the wet and dry season makes the use of perimeter stations unfeasible		

## 5.2.5

*Monitoring Frequency*

In each season, monitoring will be conducted once per day and three times per week at three water depths.

## 5.2.6

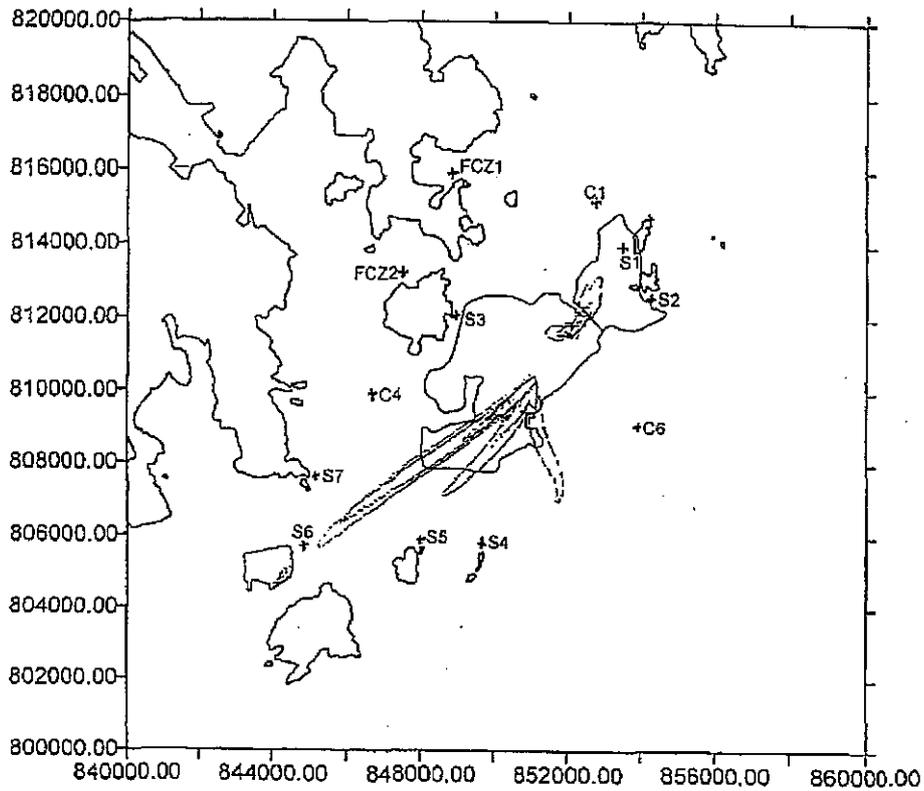
*Baseline Data*

A baseline survey will be conducted during which all perimeter, control and SR stations will be monitored three times a week for a period of three weeks in the wet and dry season. As the sampling period will be insufficient to characterize variation on a longer time scale (ie, monthly, yearly), EPD routine water quality monitoring data will be used to supplement the baseline monitoring programme. Both data sets will be used to determine the validity of the proposed control stations. Every attempt should be made to avoid sampling during other dredging or disposal projects.

## 5.2.7

*Water Quality Monitoring Methodology**Monitoring Parameters and Depth of Sampling*

The values of turbidity, dissolved oxygen (DO) and suspended solids (SS) will be determined at each designated control and monitoring stations. Two measurements of DO concentration ( $\text{mg l}^{-1}$ ) and DO saturation (%) will be taken at control and perimeter stations and one measurement will be taken at SR stations *in situ* at 1 metre below water surface, mid-depth and 1 metre above sea bed. The monitoring probes must be removed from the water after the first measurement and redeployed for the second measurement. Samples for turbidity (NTU) and for SS ( $\text{mg l}^{-1}$ ) measurement shall be taken at the same three depths. As previously, duplicates will be taken at control and perimeter stations and single measurements/samples will be taken at SR stations. The SS



Northing	Easting	Station
853450	813957	S1
854217	812570	S2
848917	812029	S3
849673	805815	S4
848003	805894	S5
844846	805736	S6
845187	807655	S7
852738	815174	C1
846678	809914	C4
854049	808816	C6
848715	815699	FCZ1
847505	813209	FCZ2

FIGURE 5.2d - TRANSITION SEASON WATER QUALITY MONITORING STATIONS

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concentration shall be ascertained by gravimetric determination in the laboratory. Where the difference in value between the first and second measurement of the DO or turbidity parameters is more than 25% of the value of the first reading, the readings shall be discarded and further readings shall be taken. For the purpose of evaluating water quality, the values obtained from individual water depths (ie surface, middle, bottom) shall be assessed individually against the specified WQOs and SS criteria. A recommended format for recording water quality monitoring data is given in *Annex A*. Note that in addition to the time of sampling, the times and heights of the preceding and following high or low waters, the sea conditions and any special phenomena observed by the field staff should be recorded; these could include the presence of trawlers and visible sediment plumes.

#### *Monitoring Equipment*

The following equipment shall be used to conduct the environmental monitoring programme:

- *Dissolved Oxygen and Temperature Measuring Equipment:* The instrument shall be portable and weatherproof, complete with cable, sensor, operation manual, and be operable from a DC power source (YSI 58 or YSI 59 Meter, YSI 5795A submersible stirrer with reel and cable or similar approved models). It shall be capable of measuring dissolved oxygen level in the range of 0-20 mg l<sup>-1</sup> and 0-200% saturation and temperature in the range of 0-45°C. It shall have a membrane electrode with automatic temperature compensation, and a cable of not less than 30 m in length. Sufficient stocks of spare electrodes and cable shall be maintained for replacement where necessary.
- *Turbidity Measurement Equipment:* Turbidity shall be measured on the monitoring vessel, immediately after collection of the water sample. The instrument shall be a portable turbidity-measuring instrument (Hach 2100P Turbidimeter or similar approved model) complete with standard formazine concentrations for calibration and cuvettes for holding the water sample. It shall be capable of measuring turbidity between 0-1000 NTU.
- *Suspended Solids Measurement Equipment:* A 'Van Dorn' type sampler, which is a transparent PVC or glass cylinder (capacity not less than 2 litres) which can be effectively sealed with cups at both ends, shall be used for sampling. Samples shall be collected in high density polythene bottles, packed in ice (cooled to 4°C without being frozen), and delivered to the laboratory as soon as possible after collection. Upon arrival at the laboratory, Method 2540D Standard Methods for the Examination of Water and Wastewater (17th ed. APHA, AWWA, WPCF), should be used to analyse the samples.
- *Water Depth Measurement Equipment:* A portable, battery-operated Echo Sounder shall be used for the determination of water depth within the MBA and at each designated monitoring station. This unit (Seafarer 701 or similar approved models) can either be hand held or affixed to the bottom of the work boat if the same vessel is to be used throughout the monitoring programme.
- *Positioning Device:* A self-positioning device (Global Positioning System with an accuracy of ±10 m) shall be used to ensure that the vessel is at the correct position before taking measurements. Positioning equipment must be approved by the Site Manager prior to use in monitoring operations.

All monitoring instruments shall be checked, calibrated and certified by an approved accredited laboratory before use and subsequently returned to the laboratory for re-calibration at 3-month intervals throughout the water quality monitoring programme. Responses of sensors and electrodes shall be checked with certified standard solutions before each use. The turbidity meter shall be calibrated to establish the relationship between turbidity readings (in NTU) and levels of suspended solids (in mg l<sup>-1</sup>) where possible. In addition to using accredited laboratories, inter-laboratory comparisons will be conducted in order to check monitoring results collected throughout the lifetime of the pits are comparable.

#### *Monitoring Review*

To ensure the monitoring programme is cost effective, it will be subject to review after the first three months of monitoring and on an annual basis (see *Section 5.1*).

#### 5.2.8 *Monitoring At the Fish Culture Zones*

Although the Fish Culture Zones (FCZ) at Tung Lung Chau and Po Toi O are not predicted to be impacted during disposal in any of the three main disposal areas (dry, wet and transition season areas) special monitoring measures will be adopted because of the concerns raised by the mariculturists. In addition to the measures described above, dissolved oxygen, suspended solids and turbidity measurements will be taken at each FCZ for the first two months of use of each of the three areas. The monitoring at the FCZs will then be reviewed and if the two months monitoring data indicates no significant impact and if mariculturists have raised no disposal-related complaint, monitoring at the FCZs will be discontinued. It will recommence if any perimeter station exceedances indicate possible problems at a FCZ.

#### 5.3 *ECOLOGICAL MONITORING*

Ecological monitoring is a secondary component<sup>(5)</sup> of the EM&A programme because impacts to ecological resources were not predicted in the EIA. Water quality monitoring is generally preferred to ecological monitoring because:

- changes to marine ecology are often caused directly and indirectly by changes in water quality;
- affects of backfilling on water quality are immediately manifested whereas changes to ecology are typically manifested a considerable time after backfilling operations. In many cases measures undertaken after detection of ecological impacts are too late to mitigate impacts to ecological resources;
- water quality monitoring data are easier to interpret than ecological data and impacts can be assigned to causes with greater certainty; and
- water quality monitoring is easier to conduct and is less costly than ecological monitoring.

<sup>5</sup> Note that marine ecological impacts were predicted to be insignificant in the EIA.

### 5.3.1 *Ecological Monitoring Objectives*

The objective of ecological monitoring is to detect whether impacts to water quality result in unacceptable impacts to ecological resources. Measurement of ecological impacts will contribute to the overall objective of the EM&A programme which is to control environmental impacts resulting from backfilling operations.

The question that ecological monitoring will answer is :

- Do backfilling operations at ETLIC MBAs result in ecological impacts at ecological sensitive receivers?

The impact hypothesis for marine ecology is :

*Ecological Impacts at Sensitive Receivers resulting from backfilling of the ETLIC MBAs are not expected to be detectable.*

The statistical bases for interpretation of ecological monitoring results are presented in *Section 6.1.2*.

### 5.3.2 *Ecological Monitoring Rationale*

Impacts to ecological resources will be assessed in both qualitative and quantitative diving assessments. Qualitative assessments will include observations on sediment deposition levels and the general health of the organisms observed. Quantitative assessments will include comparison of specific aspects of the flora and fauna to assess whether damage can be identified. Backfilling induced changes will be isolated, as far as is possible, from changes induced by other factors by comparing the ecology at control stations with the ecology at stations which water quality monitoring results suggest may be impacted. Ecological SRs are presented in *Figure 5.2a* and are described in detail in the EIA.

### 5.3.3 *Ecological Monitoring Methodology*

Ecological monitoring will consist of dive surveys to assess the health of the corals which have been identified around islands to the northeast and southwest of the MBAs. Monitoring of the benthos around the MBAs will not be conducted because only very small areas outside the pits are predicted to be impacted by sedimentation and in these areas the rates of sedimentation are very low (<10 gm<sup>-2</sup> per tidal cycle).

It is inappropriate to specify precise details of the dive monitoring methodology because this would preclude incorporation in the methodology of site specific knowledge and other relevant knowledge held by the diving consultant. However, general guidance on station location, monitoring frequency, and baseline data assessment are given in the following sub-sections.

#### *Baseline Data*

Numerous dive surveys have been conducted around the MBAs which will be used as baseline information against which to compare results for surveys that may be undertaken during backfilling operations. The location of key surveys are presented in *Figure 5.3a*. Prior to commencement of the backfilling the

Environmental Team, including the diving consultant, should review previous monitoring data to determine where impact and control stations should be located. This will enable baseline ecological monitoring which will be conducted prior to the commencement of backfilling operations, to be targeted to best effect. The data generated from any subsequent ecological monitoring will be compared to the baseline data set<sup>(6)</sup> to determine what ecological changes have occurred between the two monitoring events. Backfilling induced changes will be isolated, as far as possible, from changes induced by other factors by comparing ecological monitoring results from control stations prior to and during backfilling operations. Ecological sensitive receivers are described in Section 5.2.3 and presented in Figure 5.2a.

#### *Location of Monitoring Stations*

Modelling conducted during the EIA predicted small elevations of SS concentrations ( $0.5$  to  $7 \text{ mg l}^{-1}$ ) and low rates of sediment deposition ( $<10 \text{ gm}^{-2}$  per tidal cycle) to the southwest of the MBAs at Beaufort Island (Lo Chau), Sung Kong, Po Toi and Waglan Island. All these locations are associated with corals as shown in Figure 5.2a. Water quality monitoring will be conducted at some of these locations and dive surveys should be conducted in accordance with the Action Event Plan should Limit levels be exceeded. No elevations in suspended sediment concentrations or deposition of sediment were predicted at North and South Ninepin which are also associated with corals (see Figure 5.2a).. However, because of their proximity to the disposal areas that will be used during the dry season, dive surveys are also recommended at these locations if Limit levels are exceeded at the adjacent water quality monitoring stations.

Control stations should also be monitored in order to try to isolate the effects of backfilling from the effects of other environmental perturbations. The location of control stations will depend upon the impact stations to be monitored. Control stations should be located in an area as close to the impact station as is feasible within constraints such as similar depth but which would be sheltered from sediment plumes arising from disposal operations at the ETLC MBAs.

Provisional locations for Sensitive Receiver stations and for Control Stations are presented in Figure 5.3b. The contractor employed for the diving survey should specify the exact location of stations, the number of transects to be conducted at each and a detailed methodology for the recording data and for analysing the results.

#### *Monitoring Frequency*

During the baseline survey all stations, including control stations, will be surveyed once. During backfilling operations dive surveys will be triggered separately for the stations to the northeast of the MBAs (ie the Ninepins Islands) and to the southwest of the MBAs (ie Lo Chau, Sung Kong, Po Toi and Waglan Island) by exceedances of the Limit levels as SRs as detailed in the AEP. Monitoring of stations to the northeast of the MBAs will be triggered by detection of unacceptable water quality impacts at the water quality sensitive receiver stations to the northeast of the MBA (see Figures 5.2b, 5.2c & 5.2d). Monitoring of the stations to the southwest of the MBAs will be triggered by detection of unacceptable impacts to water quality at water quality sensitive receiver stations to the southwest of the MBAs. Results of these dive surveys are

<sup>6</sup> This data set will consist of historic data and data collected during the baseline survey.

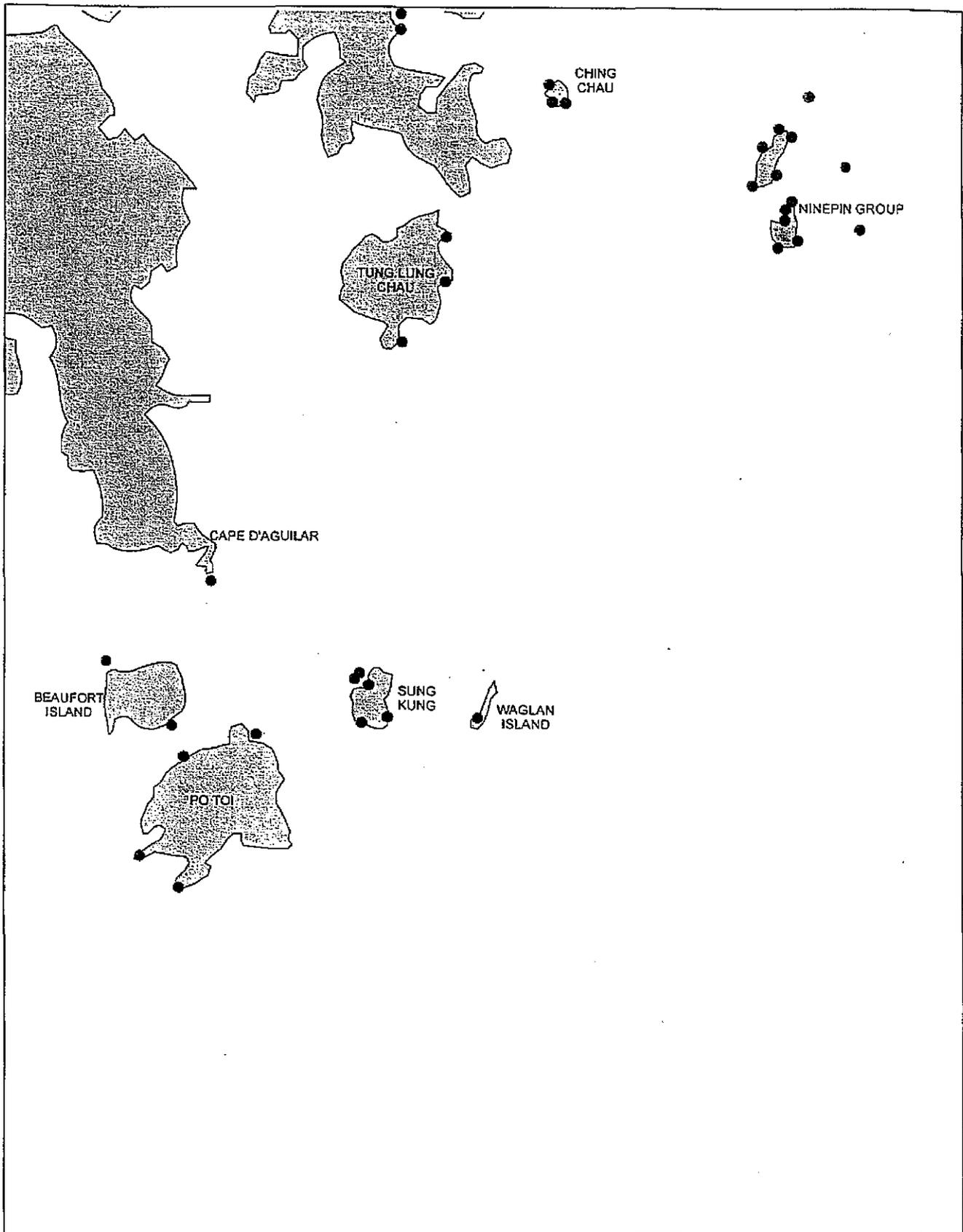


FIGURE 5.3a - DIVING SURVEYS CONDUCTED IN THE VICINITY OF THE ETLC MBAs  
 SOURCE: BINNIE CONSULTANTS LTD (1996) FINAL INCEPTION REPORT COASTAL ECOLOGY STUDIES

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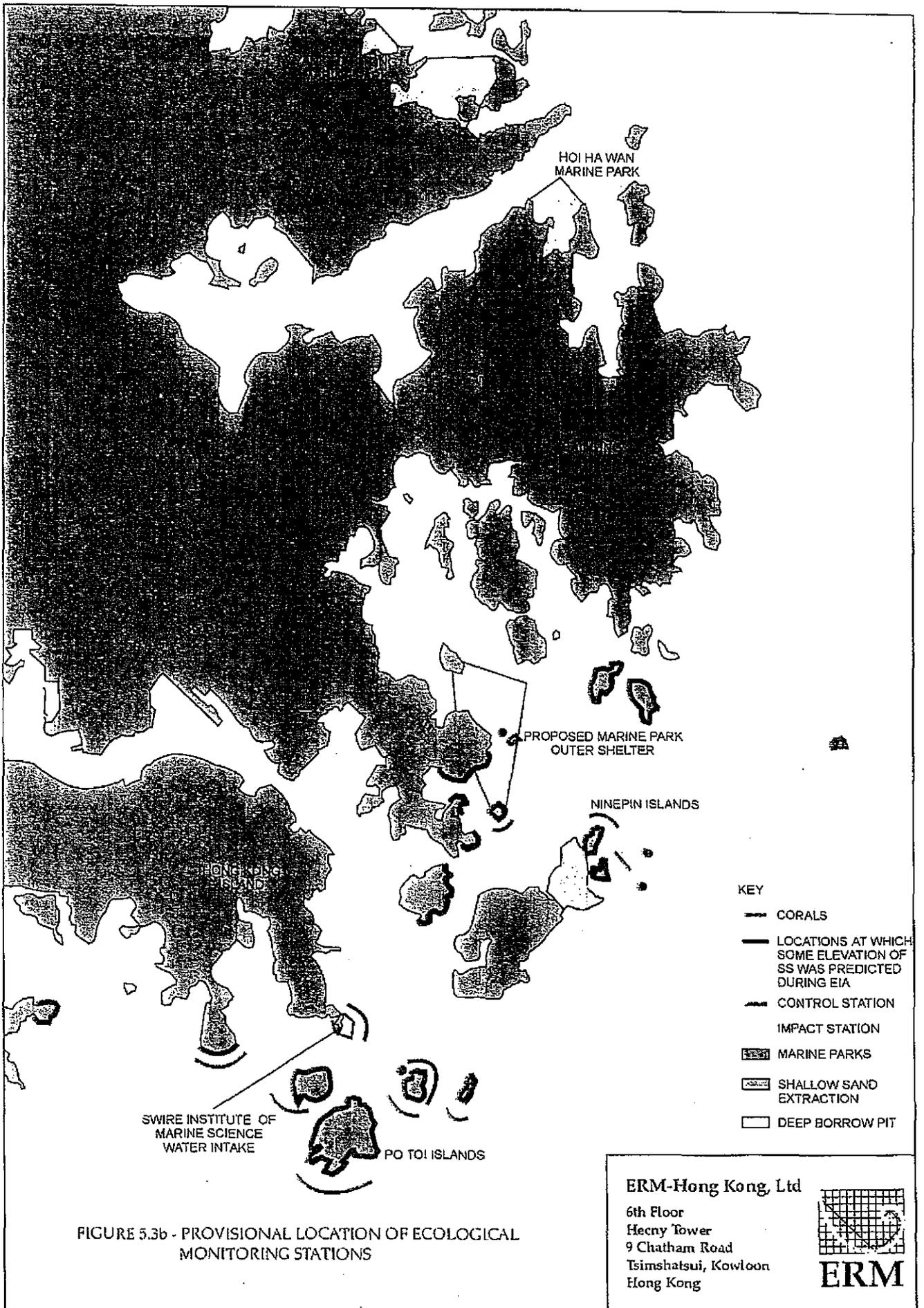


FIGURE 5.3b - PROVISIONAL LOCATION OF ECOLOGICAL MONITORING STATIONS

to be reported to AFD, EPD and CED within one week. The major aim of the dive survey is to confirm whether high coral mortality and sedimentation are recorded at the dive sites.

In addition to monitoring conducted following exceedances of Limit levels, half yearly diving surveys will be carried out to monitor the condition of the corals.

6 ENVIRONMENTAL COMPLIANCE ASSESSMENT AND ACTION EVENT PLANS

6.1 ENVIRONMENTAL COMPLIANCE

Water quality and ecological assessment criteria are defined in order to provide guidance for evaluating environmental impacts and for considering changes to environmental monitoring and backfilling operations. Both marine water quality and ecological criteria are discussed below.

6.1.1 Water Quality Compliance

Water quality monitoring results will be evaluated against Action and Limit levels. Exceedance of the Action or Limit level will result in changes to the monitoring and may result in changes to backfilling operations. Statistical analyses will be conducted after every third monitoring event.

Perimeter impact levels, which have been based on modelling predictions conducted for the EIA, are presented in *Table 6.1a*. Note these levels apply to perimeter stations which are prefixed with WP (Wet Perimeter) and DP (Dry Perimeter) for stations to be monitored in the wet and dry seasons respectively (see *Section 5.2*).

*Table 6.1a Perimeter Impact Levels for Perimeter Stations (prefixed with DP and WP)*

Parameter	Impact Assessment Criteria	Significance Level
SS	Pooled data from perimeter stations from three consecutive monitoring events show an elevation of > 30% compared with corresponding data from control stations	$p < 0.05$
	and	
	Concentrations at two or more stations exceed 20 mg l <sup>-1</sup>	Not applicable

Note:

- (a) This value has been estimated on the basis that elevations of approximately 10 mg l<sup>-1</sup> are predicted at the perimeter stations and that ambient SS levels are approximately 5 mg l<sup>-1</sup>. Therefore, under normal operations, during which no exceedance would be expected at the SRs, SS levels at the perimeter stations would be expected to be around 15 mg l<sup>-1</sup>. If a further elevation equivalent to the ambient concentration (5 mg l<sup>-1</sup>) is experienced, it is considered that SS concentrations are likely to have been elevated beyond that predicted to result from backfilling operations.

Action levels are presented in *Table 6.1b*. Note that these levels apply to stations adjacent to SRs which are prefixed with a S (see *Section 5.2*).

Table 6.1b Action Levels for Sensitive Receiver Stations (prefixed with an S)

Parameter	Impact Assessment Criteria	Significance Criteria
DO in mg l <sup>-1</sup>	Pooled data from sensitive receiver stations from three consecutive monitoring events show depletion of 30% compared with corresponding data from control stations	p < 0.05
	or Impacts identified at perimeter stations for two or more consecutive occasions <sup>(a)</sup>	p < 0.05
SS	Pooled data from sensitive receiver stations from three consecutive monitoring events show an elevation of 30% compared with corresponding data from control stations	p < 0.05
	or Impacts identified at perimeter stations for two or more consecutive occasions <sup>(a)</sup>	p < 0.05
Turbidity	Pooled data from sensitive receiver stations for SS from three consecutive monitoring events show an elevation of 30% compared with corresponding data from control stations	p < 0.05
	or Impacts identified at perimeter stations (for SS) <sup>(a)</sup>	p < 0.05
<p>Note:</p> <p>(a) This criterion will not apply in the transition season at which time perimeter stations will not be monitored.</p>		

Limit levels are presented in Table 6.1c.

Table 6.1c *Limit Levels for Sensitive Receiver Stations (prefixed with an S)*

Parameter	Impact Assessment Criteria
DO	<p><u>Surface and Middle</u> Exceedance of the Action level</p> <p>and</p> <p>DO &lt; 4 mg/l<sup>1</sup></p> <p><u>Bottom</u> Exceedance of the Action level</p> <p>and</p> <p>DO &lt; 2 mg/l<sup>1</sup></p>
SS	<p>Exceedance of (mean value from baseline data and/or historical data) + (10 mg l<sup>-1</sup>)</p> <p>or</p> <p>Impacts identified at Perimeter stations for three or more consecutive occasions<sup>(a)</sup></p>
Turbidity	Not Applicable
<p>Note:</p> <p>(a) This criterion will not apply in the transition season at which time perimeter station will not be monitored.</p>	

### 6.1.2 *Marine Ecological Compliance*

Impacts to corals were not predicted during the EIA. Detection of any ecological impact will be considered significant and lead to a comprehensive review of disposal operations.

Ecological impact assessment will be achieved both qualitatively and quantitatively. Qualitative assessments will rely on factors such as the presence of deposited sediment, and any evidence of recent mortality or other changes to benthic ecology. Quantitative assessments will determine whether there have been statistically significant ( $p < 0.05$ ) changes to coral diversity and the percentage of cover of live coral heads. These criteria may be refined by the diving contractor conducting the survey prior to, and during, ecological monitoring.

## 6.2 *ACTION EVENT PLAN*

Action and Limit levels, which apply to SR stations, are used to determine whether operational modifications are necessary to mitigate environmental impacts arising from backfilling operations. In the event that the levels defined in *Table 6.1a*, *6.1b* and *6.1c* are exceeded, appropriate actions in *Table 6.2a* should be undertaken and a review of backfilling activities should be carried out by the Site Manager. The latter may include a combination of the following:

- a review of operational controls as defined under the Operations Plan (see *Section 3*);

- a review of general mitigation measures such as working methods and practices; and
- inspection of any marine plant or equipment suspected of contributing to the exceedance.

The Site Manager should inform EPD of any actions taken in response to an Action or Limit level exceedance. In addition, a record of all actions taken during each current month should be kept and forwarded to the Environmental Team, for inclusion in the EM&A monthly report.

Table 6.2a Action Event Plan (AEP) for Water Quality

Event	Environmental Team (ET)	Site Manager (SM)
Exceedance of Action level	<ul style="list-style-type: none"> <li>Repeat in-situ measurement to confirm findings</li> <li>Identify source(s) of impact</li> <li>Inform SM, EPD and AFD</li> <li>Check monitoring data</li> <li>Discuss potential mitigation measures with SM</li> </ul>	<ul style="list-style-type: none"> <li>Discuss potential mitigation measures with ET and agree mitigation measures to be implemented</li> <li>Assess the effectiveness of the implemented mitigation measures</li> </ul>
Exceedance of Limit level on one occasion	<ul style="list-style-type: none"> <li>Repeat in-situ measurement to confirm findings</li> <li>Identify source(s) of impact;</li> <li>Inform SM, EPD and AFD</li> <li>Discuss further mitigation measures with SM</li> <li>Increase the monitoring frequency to daily until no exceedance of Limit level.</li> </ul>	<ul style="list-style-type: none"> <li>Critical review of working methods<sup>(a)</sup></li> <li>Conduct a sediment loss survey of trailer-dredgers</li> <li>Check plant, equipment and contractor's working methods</li> <li>Discuss further mitigation measures with ET and agree any further mitigation measures to be implemented</li> <li>Ensure mitigation measures are being implemented</li> <li>Assess the effectiveness of the implemented mitigation measures</li> </ul>
Exceedance of Limit level on two or more occasions	<ul style="list-style-type: none"> <li>Identify source(s) of impact;</li> <li>Inform SM, EPD and AFD</li> <li>Commence ecological monitoring.</li> </ul>	<ul style="list-style-type: none"> <li>Consider and if necessary slow down (reduce disposal frequency) or to stop<sup>(b)</sup> all or part of the marine work until no exceedance of Limit level</li> <li>Instruct commencement of ecological monitoring</li> </ul>
Identification of ecological impacts	<ul style="list-style-type: none"> <li>Inform SM, EPD and AFD</li> </ul>	<ul style="list-style-type: none"> <li>Cessation of disposal operations</li> <li>Comprehensive review of disposal operations</li> </ul>
<p><b>Notes:</b></p> <p>(a) The critical review of working methods will include examination of: disposal volumes, disposal rates, disposal intervals, disposal locations, vessel types and, if necessary, vessel loss rates. Actions will include reducing disposal volumes and disposal rates, increasing disposal intervals, modifying disposal locations, and, if necessary prohibiting the use of specific vessels.</p> <p>(b) In the event that disposal at ETLIC MBAs is ceased, barges will be diverted to other disposal sites. Options include the East of Ninepins and South Cheung Chau disposal sites.</p>		

## OPERATIONAL MONITORING REQUIREMENTS

Operational monitoring will be achieved by reviewing data recorded by the dredging contractors undertaking backfilling. Operational monitoring is required to ensure that backfilling is conducted in accordance with constraints (including mitigation measures) detailed in the Operations Plan (see *Section 3*). If these measures are not undertaken there is the potential for unacceptable environmental impacts to occur.

### 7.1

#### BACKFILLING OPERATIONS

The following information will be recorded by the dredging contractor during backfilling:

- name of vessel;
- volume of material;
- type of material (ie barge or trailer);
- time and date of disposal;
- the depth of the water column at the time of disposal;
- the location of disposal; and
- time of the previous and following low and high, or, high and low water.

This information will be submitted to the Environmental Team who will check that:

- the backfilling operations are conducted in the correct part of the MBA given the prevailing season;
- the rate of backfilling operations does not exceed the maximum specified in the EIA;
- the type of material used for backfilling is suitable for the disposal location (ie grab dredged material is not used for backfilling the southwestern (shallow) MBA; and
- the disposal interval complies with requirements given in *Section 3.3.3*.

### 7.2

#### VESSEL LOSS RATES

Impact predictions presented in the EIA are based upon assumed loss rates for trailer and grab dredged materials. Assumed loss rates for grab dredged material are very conservative and will not require verification. Loss rates for trailer dredgers are dependent on various factors some of which are specific to the vessel used for backfilling. Vessels with loss rates higher than those assumed in the EIA could result in environmental impacts in excess of those predicted in the EIA. To prevent this from occurring, loss rates for trailer dredgers will be measured and where necessary an alternative method of placement associated with lower loss rate, such as material placement using the trailer arm, will be used. A similar system has been proposed for vessels involved in backfilling at MBAs East of Sha Chau.

**BATHYMETRY**

Bathymetry will be monitored periodically to ensure that mounding of material does not occur and that the pits are not backfilled above the levels detailed in the Operations Plan (see *Section 3*). This monitoring will be conducted by CED at intervals corresponding to disposal of approximately 0.6 Mm<sup>3</sup> of material. In addition, to verify the impact of erosion induced by a storm with a return period of 1 year, a bathymetric survey will be conducted within three weeks after typhoon signal 8, or higher, is raised.

## ENVIRONMENTAL COMPLAINTS PROCEDURES

In the event that a direct or indirect complaint is received (including complaints from fishermen), an assessment of the validity and relevance of the complaint will first be made by the party receiving the complaint or by the Site Manager or by both. Following this step, the Site Manager shall immediately take any necessary and appropriate action.

The Site Manager should consider implementing the following steps to rectify the situation:

- identifying the source of impacts;
- taking necessary action to mitigate the situation;
- increasing the scope or frequency of monitoring or both;
- checking compliance with Action Limit levels and environmental regulations;
- if monitoring results show exceedances, repeating review procedures, identifying possible areas of improvement and checking procedures;
- delaying trailers and barges disposal at the ETLIC MBAs to prevent interference with fishing operations;
- documenting all complaints in the monthly EM&A report to EPD including details of remedial measures taken, and the additional monitoring results for the period; and
- where possible, preparing a formal reply to complaints to notify the concerned person(s) that action has or will be taken, within two weeks of receipt of the complaint.

*Figure 8.0a* is an illustration of the procedures to be undertaken in the event of complaints.

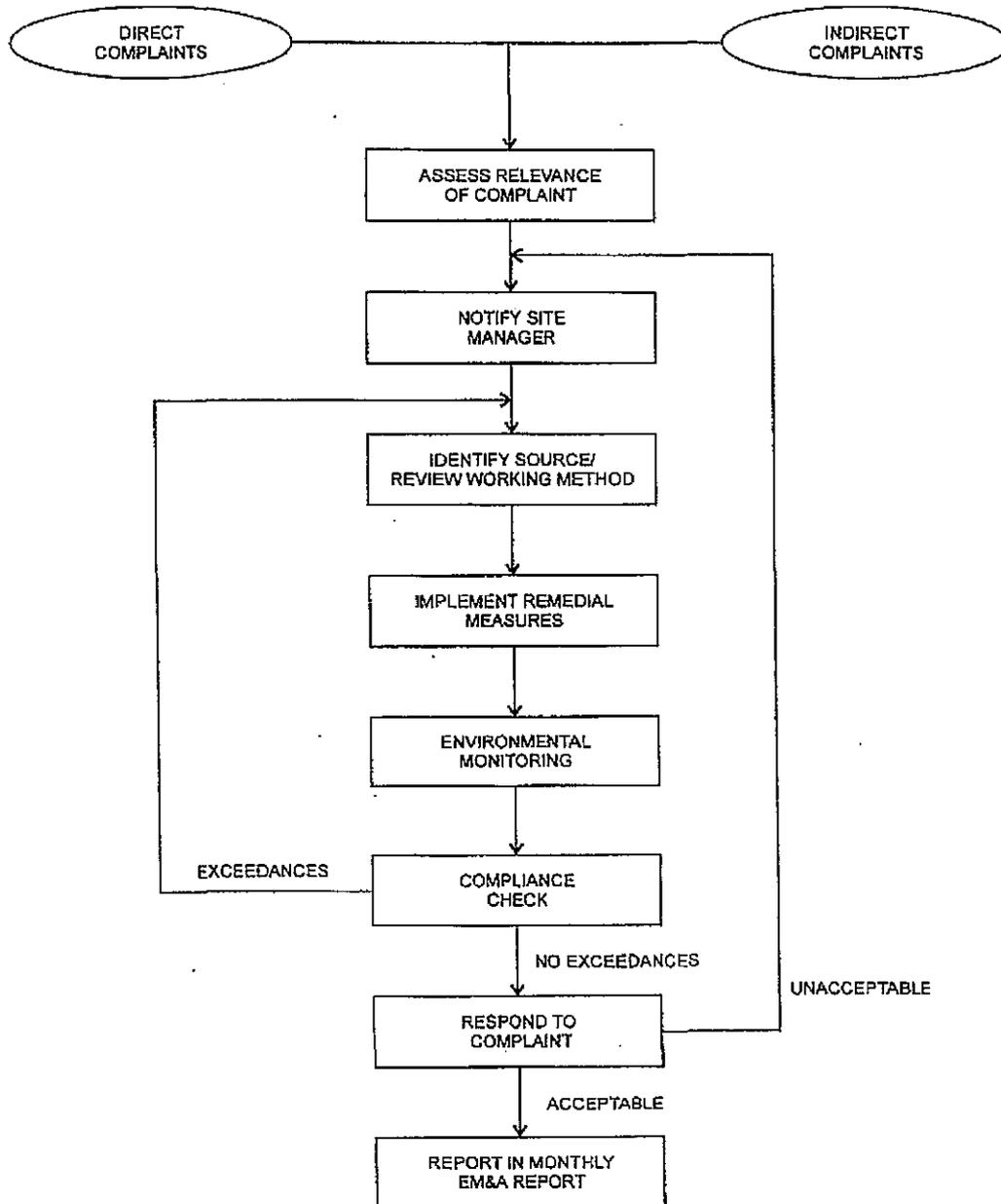


FIGURE 8.0a - COMPLAINT HANDLING PROCEDURE

ERM-Hong Kong, Ltd

6th Floor  
 Hecny Tower  
 9 Chatham Road  
 Tsimshatsui, Kowloon  
 Hong Kong



## 9 REPORTING REQUIREMENTS

### 9.1 INTRODUCTION

The proposed reporting requirements for the backfilling operations are discussed below. This reporting structure includes the methodology for recording data, the treatment of exceedances and the format of the monthly and quarterly (3-monthly) progress reports. The audit requirements set out the procedures to be used to ensure the efficacy of the environmental management and monitoring systems.

### 9.2 BASELINE REPORT

A baseline report will be prepared detailing results of the baseline water quality and ecological monitoring results. It will include an assessment of the suitability of control stations.

### 9.3 MONITORING RESULTS

Environmental monitoring data shall be reported in parallel with operational monitoring data on standardised record sheets. Examples for water quality and operational data are presented in *Annex A* and *Annex B* respectively.

Environmental monitoring data shall contain the following information, as appropriate:

- sampling point(s);
- sampling depth(s);
- sampling parameter(s);
- number of measurements;
- weather conditions;
- brief description of the backfilling activities (eg location of disposal operations, rates of disposal, backfill level, operational restrictions);
- Action and Limit levels; and
- checks on compliances.

Operational monitoring data will contain the following information

- name of vessel;
- volume of material;
- type of material (ie barge or trailer);
- time and date of disposal;
- the depth of the water column at the time of disposal;

- location of disposal; and
- time of the previous and following low and high, or high and low, water.

9.4 ENVIRONMENTAL EXCEEDANCES

In the event of environmental exceedances, the appropriate AEP should be adopted. The Environmental Team should notify the Site Manager immediately if any exceedances occur. In addition, in the event of Limit level exceedances, the Site Manager should inform EPD and AFD by fax. Action(s) taken should be reported immediately to the EPD and AFD, as well as reported in the monthly progress report. If any of the Action Limit levels are exceeded on more than two consecutive days, EPD and AFD shall be informed by a report which summarizes the monitoring data, describes implemented mitigation measures and proposes actions to avoid further occurrences of non-compliance.

9.5 MONTHLY EM&A PROGRESS REPORT

A monthly EM&A progress report should be prepared and submitted to the Site Manager on the tenth working day of each month in an agreed format (printed or magnetic media format or both). The report should include the following:

- a summary of major points and the month's backfilling activities;
- monitoring data and audit/review of these monitoring results;
- compliance check and report on exceedances;
- remedial measures adopted to mitigate any adverse impacts;
- record of complaints and remedial measures;
- forecast of work programme and monitoring schedule;
- proposals for changes to monitoring requirements, as appropriate; and
- comments and conclusions.

9.6 INITIAL REVIEW REPORT

After three months of backfilling, an *Initial Review Report* will be prepared. This will assess the acceptability of disposal operations and propose potential improvements to the EM & A programme.

9.7 QUARTERLY EM&A PROGRESS REPORT

A quarterly EM&A Report should also be prepared and submitted to the Site Manager on the tenth working day following the subject 3 month period, in an agreed format. The report should include:

- past 3 months data;
- trend analysis of environmental conditions over the monitoring period;
- annotated figures of events (environmental conditions, Action Limit level exceedances, etc); and
- remedial measures undertaken and the efficacy of these measures.

This quarterly report will be made publicly available, in accordance with the draft Technical Circular on EM&A currently being assessed by SPEL, which will be in line with PELB's General Circular No. 2/94 on the Public Access to Environmental Impact Assessment (EIA) Reports.

9.8

#### *ANNUAL REPORTS*

An annual report will be prepared with every fourth quarterly report. It will summarise all the data, draw firm conclusions on the environmental impact of the project and review the general success of the operational control methods and the monitoring programme that is employed. This should help ensure that the monitoring work is kept sharply focused and cost effective throughout the operational lifetime of the disposal site.

The report will summarise operational activities over the year and include a critical review of the monitoring approach and detailed methodology in order to identify opportunities for streamlining or refocussing. The report will identify specific impact hypotheses for further testing, as necessary, over the forthcoming monitoring period and refine the monitoring programme where necessary to ensure that these hypotheses can be tested in a statistically sound way. Results of related works undertaken by FMC, such as bathymetric surveys, will also be incorporated in order to ensure that the report provides as comprehensive a review as is possible.

## ENVIRONMENTAL AUDIT REQUIREMENTS

Environmental auditing is recommended to test the adequacy and effectiveness of the environmental monitoring programme.

These audits should be carried out by an independent body on a regular basis, for example at monthly intervals. The audit should cover the following:

- review and verification of information available in records generated through the monitoring programme;
- identification of specific issues of non-compliance and recommendations to meet them; and
- checking the effectiveness of operational controls and mitigation measures and reviewing the need for further mitigatory measures.

In addition, an audit of the environmental complaints handling procedures should be carried out to verify that complaints are properly channelled and addressed. The results of the environmental auditing shall be reported in the subsequent monthly EM&A Report.

Annex A

Water Quality Monitoring  
Data Record Sheet

Figure Aa Water Quality Monitoring Data Record Sheet

Location			
Date			
Start Time (hh:mm)			
Weather			
Sea Conditions			
Time of Preceding High or Low Water			
Time of Following Low or High Water			
Tidal Mode (Flood or Ebb)			
Water Depth (m)			
Monitoring Depth	Surface	Middle	Bottom
Salinity			
Temperature (°C)			
DO Saturation (%)			
DO (mg l <sup>-1</sup> )			
Turbidity (NTU)			
SS Sample Identification			
SS <sup>(a)</sup>	(mg l <sup>-1</sup> )		
Observed Construction Activities	<100 m from location		
	>100 m from location		
Other Observations			

Note (a) The SS results are to be filled in once they are available from the laboratory.

	<u>Name &amp; Designation</u>	<u>Signature</u>	<u>Date</u>
Recorded By:	_____	_____	_____
Checked By:	_____	_____	_____

Annex B

# Operational Monitoring Data Record Sheet

Figure Bb

Operational Monitoring Data Record Sheet

Vessel	
Backfill Material (Grab or Trailer)	
Material Volume	
Date	
Location	
Disposal Time (hh:mm)	
Weather	
Sea Conditions	
Time of Preceding High or Low Water (hh:mm)	
Time of Following Low or High Water (hh:mm)	
Tidal Mode (flood / ebb)	
Water Depth (m)	
Other Observations	