Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area

Agreement No. CE 12/2002(EP)

Environmental Monitoring and Audit (EM&A) Manual

23rd May 2005

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Civil Engineering and Development Department

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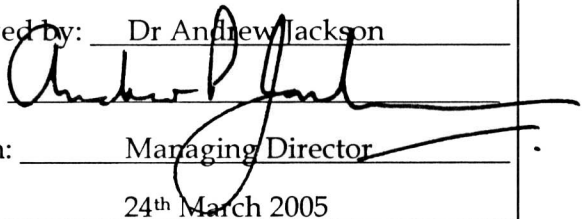
24th March 2005

Reference C2693

For and on behalf of

Environmental Resources Management

Approved by: Dr Andrew Jackson

Signed: 

Position: Managing Director

Date: 24th March 2005

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1 INTRODUCTION

1.1 PURPOSE OF THE MANUAL

This Environmental Monitoring and Audit (EM&A) Manual ("the Manual") has been prepared by ERM-Hong Kong, Limited (ERM) on behalf of the Civil Engineering and Development Department (CEDD) of the Hong Kong Special Administrative Region (SAR) Government. The Manual is a supplementary document of the Environmental Impact Assessment (EIA) Study of the Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East / East of Sha Chau Area (Agreement CE 12 / 2002 (EP)) (hereafter referred to as the Project).

The Manual has been prepared in accordance with the *EIA Study Brief* (No. ESB-095 / 2001) and the *Technical Memorandum of the Environmental Impact Assessment Process (EIAO TM)*. The purpose of the Manual is to provide information, guidance and instruction to personnel charged with environmental duties and those responsible for undertaking EM&A work during construction and operation. It provides systematic procedures for monitoring and auditing of potential environmental impacts that may arise from the works.

1.2 PROJECT DESCRIPTION

1.2.1 Background to the Study

From December 1992 to November 1997, a series of purpose-dredged seabed pits at East Sha Chau (Contaminated Mud Pits (CMPs) I to III) were used to dispose of dredged contaminated mud in Hong Kong. In 1996, as the capacity in these pits began to dwindle, the Hong Kong Government commissioned a study to examine the need for continued marine disposal of dredged material in Hong Kong in order to manage ongoing contaminated sediment arisings (1). The study reviewed potential land-based options in Hong Kong including strategic landfills, treatment of materials, and the incorporation of contaminated dredged material into land reclamation projects, but found each to have inherent drawbacks. The study's review of environmental monitoring data collected at CMPs I-III from 1992-1995 concluded that there was no evidence of contaminant impacts on biota due to disposal, and that contaminants in dredged materials had been successfully contained. The study therefore recommended continued disposal in capped seabed pits in the East Sha Chau area as the preferred option. This finding led the Hong Kong Government to commission an EIA evaluating the use of disused borrow pits in the East Sha Chau area as the next contaminated mud disposal facility. This facility, known as CMP IV, consisted of three pits

(1) EVS Environment Consultants (1996a) Review of Contaminated Mud Disposal Strategy and Status Report on Contaminated Mud Disposal.. Final Report. For the Civil Engineering Department, Hong Kong Government..

(CMP IV a, b and c) which had been dredged for sand during construction of the new airport at Chek Lap Kok and represented a total capacity of approximately 30 million cubic metres. The CMP IV EIA study (1) formulated an environmental design for disposal operations, which included specifications for disposal rates, cap thickness, and backfilling level. The Study concluded that impacts to water quality, marine ecology, air and noise were expected to be maintained within acceptable limits under the specifications of the agreed Operations Plan. The CMP IV EIA Report was endorsed by the Advisory Council on the Environment (ACE) in March 1997.

In December 1997, disposal operations commenced in CMP IVa in conjunction with an environmental monitoring programme that encompassed water and sediment chemistry, fisheries assessment, tissue and whole body analysis, and benthic recolonisation studies. A review of the collection and analysis of the environmental data from the first 38 months of operations demonstrated that there had not been any adverse environmental impacts resulting from disposal activities (2).

Capacity to dispose of contaminated mud is currently predicted to be exhausted by early 2009 with the completion of backfilling of CMP IV at East of Sha Chau. When CMP IV is full, a new environmentally acceptable disposal capacity for essential arisings will be required. A capacity of 8 Mm^3 is needed to provide disposal capacity up to 2015. The assignment *Strategic Assessment and Site Selection Study for Contaminated Mud Disposal (Agreement CE 105/98)* recommended a Contained Aquatic Disposal facility (CAD - capped seabed pit such as those already used at East of Sha Chau) at Airport East (3).

Although members of ACE had no objection to proceeding with the recommended EIA, they considered that all sites, in particular remaining portions of East of Sha Chau, and other disposal options, in particular a confined disposal facility (CDF – material confined within an artificial island) should still be considered. To meet these requirements of ACE, the present study identified the most suitable sites and disposal option within both the Airport East and East of Sha Chau areas and, secondly it evaluated the environmental acceptability of impacts associated with construction and operation of these, through an EIA, and thirdly, based on a comparison of the outcomes of the two EIAs, a preferred disposal facility is recommended.

The conclusion of the Study was that both of the proposed facilities could be operated in an environmentally acceptable manner.

As part of the Study requirements, this Project specific EM&A Manual has been prepared to provide further details of the specific EM&A requirements that have been recommended during construction and operation of the

(1) ERM – Hong Kong, Ltd (1997) EIA for Disposal of Contaminated Mud in the East Sha Chau Marine Borrow Pit. EIA Report. For the Civil Engineering Department, Hong Kong SAR Government..

(2) ERM – Hong Kong, Ltd (2002) Environmental Monitoring and Audit for Contaminated Mud Pit IV at East of Sha Chau. Final Report. For the Civil Engineering Department, Hong Kong SAR Government..

(3) ERM - Hong Kong, Ltd (1999) Strategic Assessment and Site Selection Study for Contaminated Mud Disposal. Final Report. For the Civil Engineering Department, Hong Kong SAR Government.

Project. In particular, the requirements for ensuring compliance with mitigation measures specified for water quality, marine ecology and fisheries are defined.

1.2.2 The Project

The Project is classified as a Designated Project by virtue of Item C (Reclamation, Hydraulic and Marine Facilities, Dredging and Dumping), Item C.10 (A Marine Dumping Area) and C.12 (A Dredging Operation Exceeding 500,000 m^3) of Part I of Schedule 2 under the *Environmental Impact Assessment Ordinance (Cap. 499) (EIAO).*

The works that are the subject of the EIA Study include the construction and operation phases of the Project. The key components of the Project include the following:

i. Dredging of a series of seabed pits within the proposed facility boundaries (*Figures 1.2a* and *1.2b*);

ii. Backfilling each dredged pit with contaminated mud that has been classified as requiring Type 2 disposal in accordance with ETWBTC 34 / 2002 (1); and,

iii. Capping each backfilled pit with uncontaminated mud effectively isolating the contaminated mud from the surrounding marine environment.

1.2.3 Construction Programme

Once the EIA Report has been formally approved by Government, CEDD will obtain an Environmental Permit (EP) for construction of the Project. Once the EP has been obtained the first pit is expected to be dredged during 2008 in order to be ready to receive contaminated mud in early 2009. According to the arisings estimates, the fourth pit at the East of Sha Chau Facility will be backfilled and capped during the first half of 2015 *(Figure 1.2c).* It should be noted that should the rate at which contaminated mud arises change (either increasing or decreasing) then the fourth pit may be capped earlier and the South Brothers pits activated before end 2015. The tentative construction programme is presented in *Figure 1.2d.* It should be noted that the timeline presents predicted timeframes for each works component.

(1) ETWBTC (2002). Management of Dredged / Excavated Sediment. Environment, Transport and Works Bureau Technical Circular 34 / 2002.

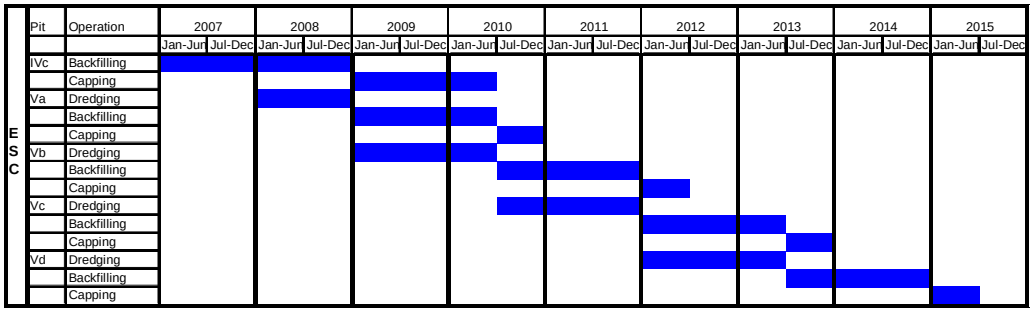


Figure 1.2c Tentative Programme of Works for Option 1

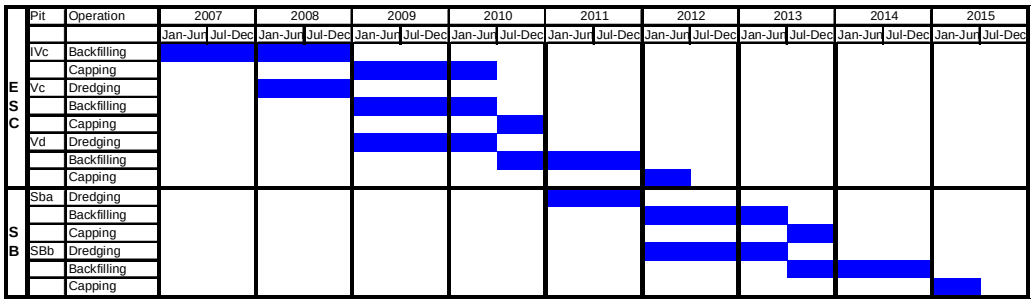


Figure 1.2d Tentative Programme of Works for Option 2

There is a possibility that capacity will be reached at the East of Sha Chau Facility before predicted, this is dependant upon arisings of contaminated mud over the next 10 years. Concurrent projects in the South Brothers area are due to be finished by 2009, after which, the South Brothers facility may be utililsed if there is a need to provide further disposal capacity. Monitoring stations have been included in this EM&A manual to reflect monitoring at whichever pit is active. In addition to the South Brothers facility being required due to increased arisings of contaminated mud, uncertainties in developments in the area may also require the facility to come into operation as presented in *Figure 1.2e.*

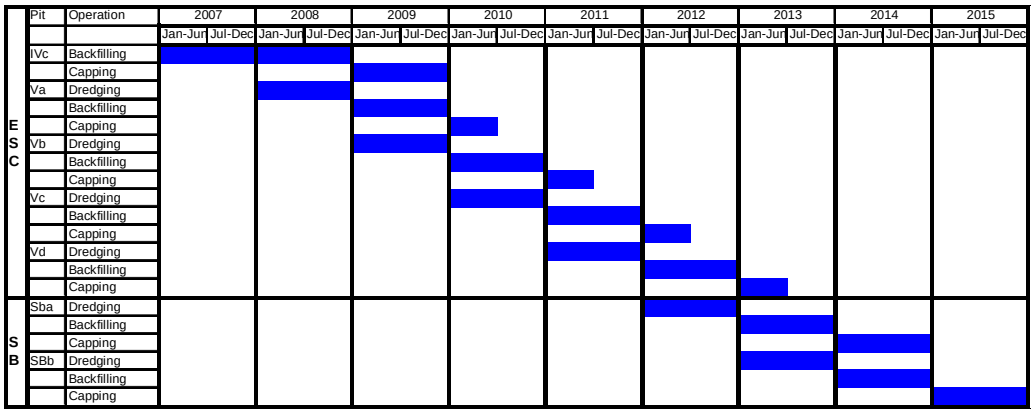
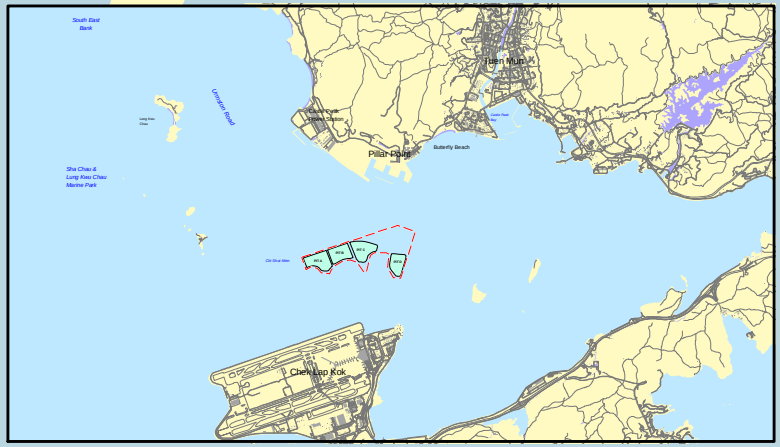


Figure 1.2e Tentative Programme of Works for Option 3

This manual has been written and designed to cover all of the above options (*Figures 1.2c – 1.2e*).



KEY

EAST OF SHA CHAU USABLE AREA

CAD PIT

AREA CONSIDERED UNSUITABLE FOR A CAD PIT DUE TO STEEP SEABED SLOPE

Pit A (29.6 ha)

Pit B (25.2 ha)

Pit C (29.7 ha)

Pit D (22.1 ha)

N

Meters

0 500 1,000

NOTE: THIS LAYOUT SHOULD BE REGARDED AS PRELIMINARY AND CAN BE EXPECTED TO CHANGE

FIGURE 1.2a

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PRELIMINARY LAYOUT FOR A MULTI-PIT CONTAINED AQUATIC DISPOSAL (CAD) FACILITY IN THE EAST OF SHA CHAU AREA

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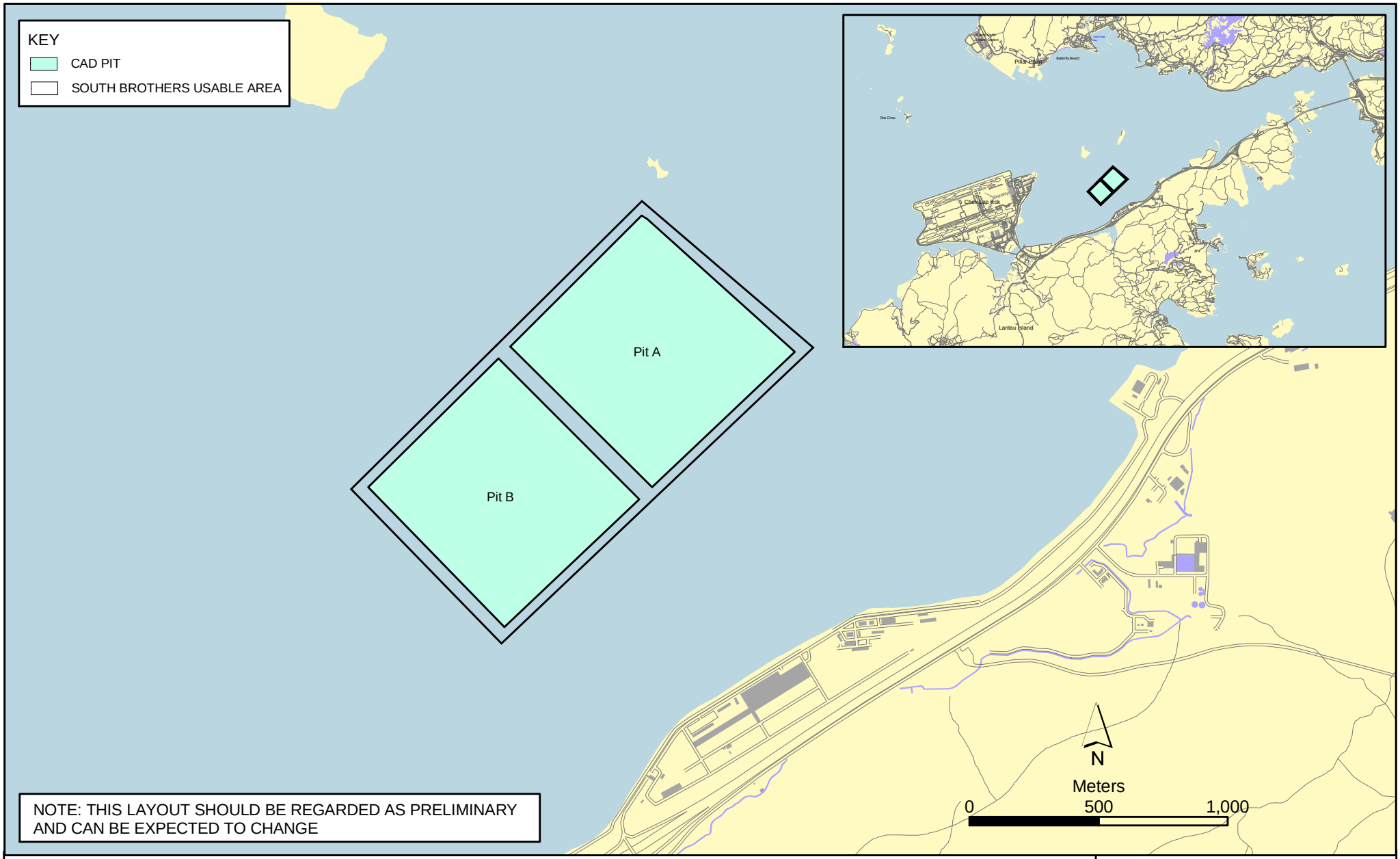

FIGURE 1.2b

PRELIMINARY LAYOUT FOR A MULTI-PIT CONTAINED AQUATIC DISPOSAL (CAD) FACILITY AT THE SOUTH BROTHERS

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1.3 BACKGROUND TO THE EM&A PROGRAMME

The construction and operational impacts resulting from the implementation of the Project are specified in the EIA Report. The EIA Report also specifies mitigation measures that need to be implemented to ensure compliance with the required environmental criteria. These mitigation measures and their implementation requirements are presented in the Implementation Schedule (*Annex A).* The EIA recommends that environmental monitoring will be necessary to assess the effectiveness of measures implemented to mitigate potential water quality, marine ecology and fisheries impacts during the construction and operation of the proposed facility. Regular environmental auditing is also recommended to ensure that potential impacts from other sources are adequately addressed through the implementation of the mitigation measures defined in the EIA Report.

This Manual provides the EM&A requirements that have been recommended in the EIA Report in order to ensure compliance with the specified mitigation measures.

1.4 THE SCOPE OF THE EM&A PROGRAMME

The scope of this EM&A programme is to:

- establish baseline water quality levels at specified locations;
- implement monitoring and inspection requirements for water quality monitoring programme;
- establish baseline sediment quality levels at specified locations;
- implement monitoring and inspection requirements for sediment quality monitoring programme;
- establish baseline sediment toxicity levels at specified locations;
- implement monitoring and inspection requirements for sediment toxicity monitoring programme;
- establish baseline body burden levels in marine biota at specified locations;
- implement monitoring and inspection requirements for the body burden (marine biota) monitoring programme;
- liaise with, and provide environmental advice (as requested or when otherwise necessary) to site staff on the comprehension and consequences of the environmental monitoring data;

- identify and resolve environmental issues and other functions as they may arise from the works;

- check and quantify the Contractor's overall environmental performance, implementation of Event and Action Plans (EAPs), and remedial actions taken to mitigate adverse environmental effects as they may arise from the works;

- conduct monthly reviews of monitored impact data as the basis for assessing compliance with the defined criteria and to ensure that necessary mitigation measures are identified and implemented, and to undertake additional *ad hoc* monitoring and auditing as required by special circumstances;

- evaluate and interpret all environmental monitoring data to provide an early indication should any of the environmental control measures or practices fail to achieve the acceptable standards, and to verify the environmental impacts predicted in the EIA;

- manage and liaise with other individuals or parties concerning other environmental issues deemed to be relevant to the construction and operation process;

- conduct regular site inspections of a formal or informal nature to assess:
  - the level of the Contractor's general environmental awareness;
  - the Contractor's implementation of the recommendations in the EIA;
  - the Contractor's performance as measured by the EM&A;
  - the need for specific mitigation measures to be implemented or the continued usage of those previously agreed;
  - to advise the site staff of any identified potential environmental issues;
  - submit regular EM&A reports which summarise project monitoring and auditing data, with full interpretation illustrating the acceptability or otherwise of any environmental impacts and identification or assessment of the implementation status of agreed mitigation measures; and
  - Details of the methodology of implementing the capping works through using excavated soil can be found in *Annex C.*

1.4.1 Environmental Management Plan (EMP)

To ensure effective implementation and reporting on compliance with the stated mitigation measures, as well as the monitoring and auditing requirements and remedial actions defined in the EIA, an appropriate contractual and supervisory framework needs to be established. The basis of the framework within which implementation should be managed overall is through the preparation of EMPs by the Contractor(s).

An EMP is similar in nature to a quality plan and provides details of the means by which the Contractor (and all subcontractors working to the Contractor) will implement the recommended mitigation measures and achieve the environmental performance standards defined in Hong Kong environmental legislation, the contract and in the EIA documentation. The primary reason for adopting the EMP approach is to make the Contractor aware of his environmental responsibilities and to be pro-active about the commitment to achieve the standards specified, rather than relying on the EM&A programme.

The EMP also provides opportunities for the Contractor to draw upon the strength of other institutional processes such as ISO 9000 / 14000 to ensure that the achievement of the required standards and fulfilment of commitments are documented.

The contractual requirement for an EMP would generally comprise appropriate extracts from (and references to) the EIA Report and EM&A Manual, and include such typical elements as the relevant statutory environmental standards, general environmental control clauses and specific environmental management clauses, as well as an outline of the scope and content of the EMP. In drafting the documentation, due consideration should be given to the predictive nature of the EIA process and the consequent need to manage and accommodate the actual impacts arising from the construction process. In particular, the Contractor must be placed under a clear obligation to identify and control any implications arising from changes to the working methods assumed in the EIA, or to the progress rates and other estimates made during the preliminary design phase.

1.5 OBJECTIVES OF THE EM&A PROGRAMME

The objectives of the EM&A programme are as follows:

1. To monitor and report on the environmental impacts of the dredging operations associated with the construction of the disposal pits;

2. To monitor and report on the environmental impacts due to capping operations of the exhausted pits;

3. To monitor and report on the environmental impacts of the disposal of contaminated marine sediments in the active pits and specifically to determine:

    - changes / trends caused by disposal activities in the concentrations of contaminants in sediments adjacent to the pits;
    - changes / trends caused by disposal activities in the toxicity of sediment adjacent to the pits;
    - changes / trends caused by disposal activities in the concentrations of contaminants in tissues of demersal marine life adjacent to and remote from the pits;
    - impacts on water quality and benthic ecology caused by the disposal activities and capping works
    - the risks to human health and dolphin of eating seafood taken in the marine area around the active pits.

4. To monitor and report on the environmental impacts of the disposal operation and specifically to determine whether the methods of disposal are effective in minimising the risks of adverse environmental impacts.

5. To monitor and report on the benthic recolonisation of the capped pits including previous ones and specifically to determine the difference in infauna between the capped pits and adjacent sites.

6. To assess the impact of a major storm (Typhoon Signal No. 8 or above) on the containment of any uncapped or partially capped pits.

7. To design and continually review the operation and monitoring programme and:

    - to make recommendations for changes to the operation that will rectify any unacceptable environmental impacts; and
    - to make recommendations for changes to the monitoring programme that will improve the ability to cost effectively detect environmental changes caused by the disposal activities.

8. To establish numerical decision criteria for defining impacts for each monitoring component.

9. To provide supervision on the field works and laboratory works to be carried out by contractors / laboratories.

The specific objectives of each component are discussed in the relevant sections of this EM&A Manual.

1.6 ORGANISATION AND STRUCTURE OF THE EM&A

1.6.1 General

The Civil Engineering and Development Department (CEDD) shall appoint an Environmental Team (ET) to conduct the monitoring and auditing works and to provide specialist advice on the undertaking and implementation of environmental responsibilities.

The ET shall have previous relevant experience with managing similarly sized EM&A programmes and the Environmental Team Leader (ET Leader) shall be a recognised environmental professional, preferably with a minimum of seven years relevant experience in impact assessments and impact monitoring programmes.

To maintain strict control of the EM&A process, the ET shall also appoint independent auditor(s) to verify and validate the environmental performance of the Contractor and the ET.

1.6.2 Project Organisation

The roles and responsibilities of the various parties involved in the EM&A process are further expanded in the following sections and in *Figure 1.6a*. The ET Leader shall be responsible for, and in charge of, the Environmental Team; and shall be the person responsible for executing the EM&A requirements.

Contractor

Reporting to CEDD, the Contractor shall:

- work within the scope of the construction contract and other tender conditions;
- provide assistance to the ET in conducting the required environmental monitoring;
- participate in the site inspections undertaken by the ET, as required, and undertake any corrective actions instructed by CEDD;
- provide information / advice to the ET regarding works activities which may contribute, or be contributing to the generation of adverse environmental conditions;
- implement measures to reduce impact where Action and Limit levels are exceeded; and

- take responsibility and strictly adhere to the guidelines of the EM&A programme and complementary protocols developed by their project staff.

Civil Engineering and Development Department (CEDD)

CEDD shall:

- monitor the Contractor's compliance with contract specifications, including the effective implementation and operation of environmental mitigation measures and other aspects of the EM&A programme;
- comply with the agreed Event and Action Plan in the event of any exceedance; and
- instruct the Contractor to follow the agreed protocols or those in the Contract Specifications in the event of exceedances or complaints.

Environmental Team

The duties of the Environmental Team (ET) and Environmental Team Leader (ET Leader) are to:

- monitor the various environmental parameters as required by this or subsequent revisions to the EM&A Manual;
- assess the EM&A data and review the success of the EM&A programme determining the adequacy of the mitigation measures implemented and the validity of the EIA predictions as well as identify any adverse environmental impacts before they arise;
- conduct regular site inspections and to investigate and inspect the Contractor's equipment and work methodologies with respect to pollution control and environmental mitigation, monitor compliance with the environmental protection specifications in the Contract, and to anticipate environmental issues that may require mitigation before the problem arises;
- audit the environmental monitoring data and report the status of the general site environmental conditions and the implementation of mitigation measures resulting from site inspections;
- review Contractor’s working programme and methodology, and comment as necessary;
- investigate and evaluate complaints, and identify corrective measures;
- advice to the Contractor on environmental improvement, awareness, enhancement matters, etc, on site;
- employ an Independent Auditor(s) to audit the results of the EM&A works carried out by the ET;

- report on the environmental monitoring and audit results and the wider environmental issues and conditions to the Contractor, CEDD and the EPD; and
- adhere to the agreed protocols or those in the Contract Specifications in the event of exceedances or complaints.

The ET shall be led and managed by the ET leader. The ET leader shall have relevant education, training, knowledge, experience and professional qualifications subject to the approval of the Director of Environmental Protection. Suitably qualified staff shall be included in the ET, and ET should not be in any way an associated body of the Contractor.

1.7 STRUCTURE OF THE EM&A MANUAL

The remainder of the Manual is set out as follows:

- *Section 2* sets out the EM&A general requirements;
- *Section 3* details the methodologies, parameters to be tested and the requirements for the marine water quality monitoring for the dredging, backfilling and capping operations at the active pits;
- *Section 4* details the methodologies, parameters to be tested and the requirements for sediment quality monitoring for the backfilling activities at the active pits;
- *Section 5* details the methodologies, parameters to be tested and the requirements for sediment toxicity quality monitoring for the backfilling activities at the active pits;
- *Section 6* details the methodologies, parameters to be tested and the requirements for marine biota monitoring for the backfilling activities at the active pits;
- *Section 7* details the requirements for Human Health and Dolphin Risk Assessment;
- *Section 8* details the requirements for benthic re-colonisation assessment;
- *Section 9* details the methodologies, parameters to be tested and the requirements for the assessment of impacts due to major storms; and
- *Section 10* details the EM&A reporting requirements.

The EM&A Manual is an evolving document that should be updated to maintain its relevance as the Project progresses. It is suggested that the first revision to the EM&A Manual takes place when the detailed design phase of the Project has been completed. The primary focus for reviews of the EM&A Manual will be to ensure the impacts predicted and the recommended mitigation measures remain consistent and appropriate to the manner in which the works are to be carried out.

2 EM&A GENERAL REQUIREMENT

2.1 INTRODUCTION

In this section, the general requirements of the EM&A programme are presented with reference to the EIA Study findings that have formed the basis of the scope and content of the programme.

2.2 EM&A

Key environmental issues associated with the construction and operation of the Project will be addressed through monitoring and controls specified in the EM&A Manual. Water and sediment quality, marine ecology and fisheries issues will be subject to EM&A, the details of which are outlined in *Sections 3* to *9*.

2.2.1 Action and Limit Levels

Action and Limit (A/L) Levels are defined levels of impact recorded by the environmental monitoring activities which represent levels at which a prescribed response is required. This processes by which these levels should be quantitatively defined are presented in the relevant sections of this manual and described in principle below:

- *Action Limits:* beyond which there is a clear indication of a deteriorating ambient environment for which appropriate remedial actions are likely to be necessary to prevent environmental quality from falling outside the *Limit Levels*, which would be unacceptable; and

- *Limit Levels:* statutory and/or agreed contract limits stipulated in the relevant pollution control ordinances, HKPSG or *Environmental Quality Objectives* established by the EPD. If these are exceeded, works should not proceed without appropriate remedial action, including a critical review of plant and working methods.

2.2.2 Event and Action Plan

The purpose of an Event and Action Plan (EAP) is to provide, in association with the monitoring and audit activities, procedures for ensuring that if any significant environmental incident (either accidental or through inadequate implementation of mitigation measures on the part of the Contractor) does occur, the cause will be quickly identified and remediated, and the risk of a similar event recurring is reduced. This also applies to the exceedances of A/L criteria to be identified in the EM&A programme.

2.2.3 Enquiries, Complaints and Requests for Information

Enquiries, complaints and requests for information can be expected from a wide range of individuals and organisations including members of the public, Government departments, the press and television media and community groups.

All enquiries concerning the environmental effects of the Project, irrespective of how they are received, shall be reported to CEDD and directed to the ET Leader who shall set up procedures for handling, investigation and storage of such information (*Figure 2.2a*). The following steps shall then be followed:

1) The ET Leader shall notify CEDD of the nature of the enquiry.

2) An investigation shall be initiated to determine the validity of the complaint and to identify the source of the problem.

3) The ET Leader shall undertake the following steps, as necessary:

   - investigate and identify source of the problem;
   - if considered necessary by CEDD undertake additional monitoring to verify the existence and severity of the alleged complaint;
   - liaise with EPD to identify remedial measures;
   - liaise with CEDD and the Contractor to identify remedial measures;
   - implement the agreed mitigation measures;
   - repeat the monitoring to verify effectiveness of mitigation measures; and
   - repeat review procedures to identify further possible areas of improvement if the repeat monitoring results continue to substantiate the complaint.

4) The outcome of the investigation and the action taken shall be documented on a complaint proforma (*Annex B*). A formal response to each complaint received shall be prepared by the ET Leader within a maximum of five working days and submitted to CEDD, in order to notify the concerned person(s) that action has been taken.

5) All enquiries which trigger this process shall be reported in the EM&A reports which shall include results of inspections undertaken by the ET Leader, and details of the measures taken, and additional monitoring results (if deemed necessary). It should be noted that the receipt of complaint or enquiry will not be, in itself, a sufficient reason to introduce additional mitigation measures.

In all cases the complainant shall be notified of the findings, and audit procedures shall be put in place to ensure that the problem does not recur.

2.2.4 Reporting

Monthly, Quarterly and Annual reports submitted to CEDD, EPD and AFCD shall be prepared by the ET. The reports shall be prepared and submitted within a specified period. Additional details on reporting protocols are presented in *Section 10*.

3 WATER QUALITY

3.1 INTRODUCTION

This Section provides details of the water quality monitoring to be undertaken by the ET during the construction and operation of the active pits. Water quality modelling carried out for the EIA indicates that the potential water quality impacts associated with the dredging, backfilling and capping works at the active pits will be within acceptable levels and no adverse water quality impacts are expected. However, the monitoring programme is designed to verify the predictions of the EIA and ensure compliance with the WQOs.

3.2 OBJECTIVE

The main objective of this component of the study is to determine the impacts on water quality caused by the dredging operations, disposal activities and capping works. Three separate components of water quality monitoring are necessary.

- *Routine Water Quality Monitoring* - conducted to examine the effects of overall operation of the active pits on the level of compliance with the water quality objectives (WQOs) for the NWWCZ;
- *Dissolved Metal Testing* - conducted to examine the levels of contaminants in plumes arising from the backfilling operations; and,
- *Water Column Profiling* - conducted to examine *in situ* the effects of dredging, backfilling and capping operations on water quality parameters within the water column.

3.3 HYPOTHESES

The impact hypothesis for this work component has been defined based on the predictions from the EIA regarding impacts from the construction of the proposed contaminated mud disposal facilities, the associated contaminated mud disposal operations and the objectives for the study.

Dredging, disposal (backfilling) and capping operations do not result in any exceedances of Northwestern Water Quality Control Zone Water Quality Objectives.

As a consequence of performing three separate tasks for assessing the impacts of dredging works, disposal operations and capping activities on water quality, three null hypotheses will be tested:

Routine Water Quality Monitoring

H_0 There are no differences in the level of compliance with the appropriate WQOs for the NWWCZ as a result of the overall operation of the active contaminated mud disposal facility.

Dissolved Metal Testing

H_0 There are no differences between the concentrations of contaminants in water samples collected in areas downcurrent of the active contaminated mud disposal facility as compared to areas upcurrent of the facility during backfilling operations.

Water Column Profiling

H_0 There is no change in the level of compliance with the NWWCZ WQOs of samples taken from the plume arising from dredging, backfilling and capping activities (EIA predicted location).

3.4 SAMPLING DESIGN

3.4.1 Routine Water Quality Monitoring

The design for this component of the programme allows impacts to water quality as a result of the overall operation of the active facility to be assessed. Replicate water samples shall be collected at specific sites (fixed locations as indicated on *Figures 3.4a* and *3.4b*) which should be located in three areas at increasing distances from the active facility: near field, mid field and far field / reference. The samples should be collected at eight times during the year, twice in the dry season, twice during the wet season and twice in each of the two transitional seasons. The approach will ensure that the impact of temporal changes on the hydrodynamic conditions in the area is considered in the sampling.

The number of samples to be collected and the sampling frequency shall be confirmed in advance of the commencement of the disposal activities and agreed with EPD based on the detailed design of the facility. In principle, reference stations should be located in areas that are free from the influence of sediment plumes resulting from the operation of the facility. For standardisation purposes, consideration of selecting reference sites at similar locations to the EM&A programmes for the East Sha Chau CMP IV is proposed (*Figures 3.4a* and *3.4b*). The approach to be adopted for the sampling shall ensure that the impacts on the hydrodynamic conditions in the area resulting from the overall operation of the disposal facility are thoroughly considered.

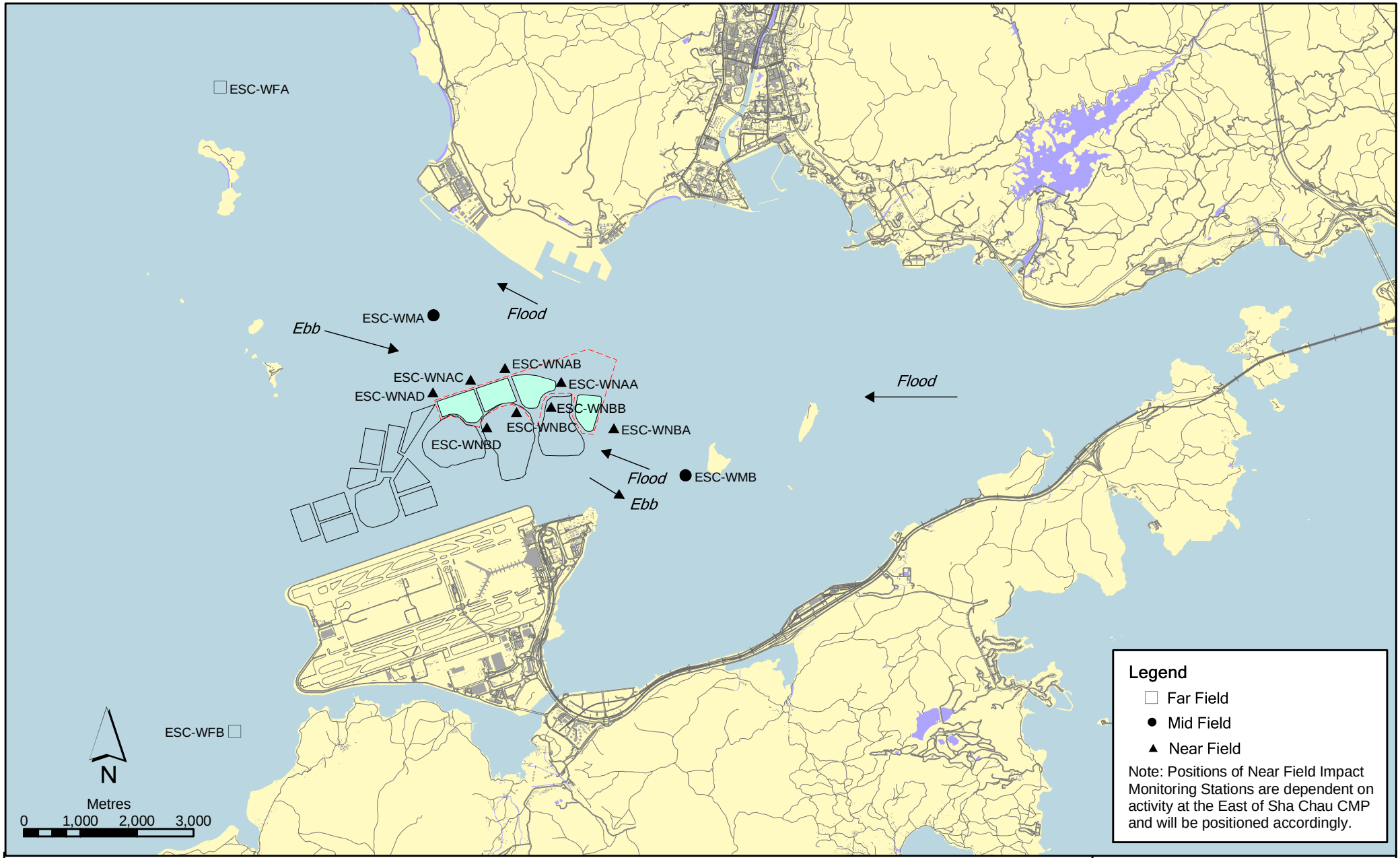

Figure 3.4a

ROUTINE WATER QUALITY MONITORING STATIONS
WHEN EAST OF SHA CHAU FACILITY IS ACTIVE

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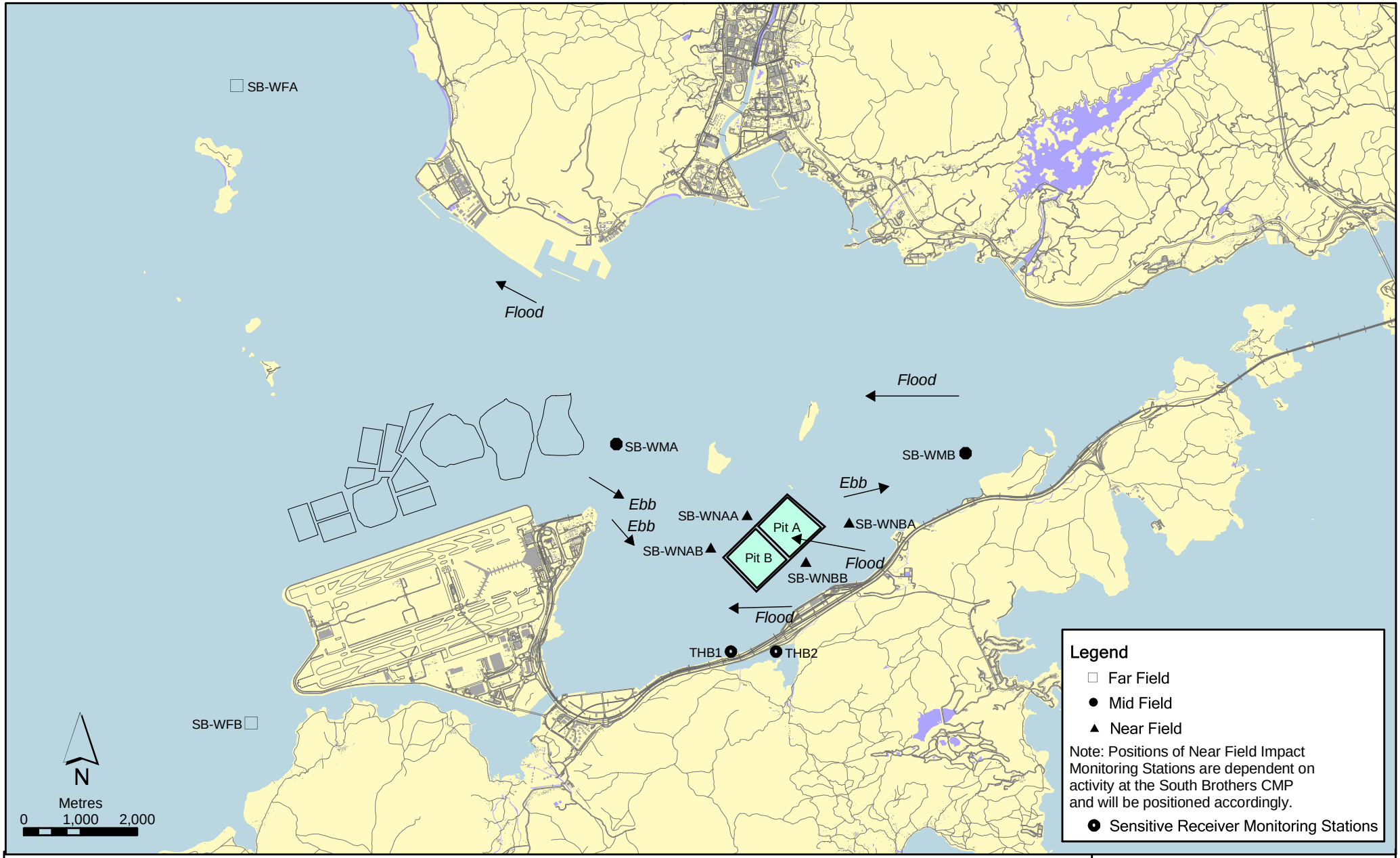

Figure 3.4b

ROUTINE WATER QUALITY MONITORING STATIONS
WHEN SOUTH BROTHERS FACILITY IS ACTIVE

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Date: 26/01/2005

Environmental Resources Management

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3.4.2 Dissolved Metal Testing

Dissolved metal stations shall be located at fixed stations within the predicted trajectories of the plume. Samples shall be collected from two dissolved metal stations located on a transect running up-current (flood tide) and five down-current (ebb tide) of the active pits. The total number of dissolved metal stations and the spacing between sampling stations should be confirmed in advance of the commencement of the disposal activities and agreed with EPD based on the detailed design of the disposal facility. Making reference to the previous sampling protocol developed for the East Sha Chau CMP monitoring programmes is recommended when devising the sampling protocol for this Project.

In order to increase the likelihood of sampling within the plume trajectory and hence increase the ability to detect potential impacts to water quality, the location of the dissolved metal transect should be determined in the field on each sampling occasion depending on the current direction and the location of backfilling at the time of sampling (if backfilling is concurrent). The position of the dissolved metal stations shall be determined in the field on each sampling occasion depending on two factors: the current direction; and the location of backfilling at the time of sampling (if backfilling is concurrent).

In principle, water samples shall be collected from stations located on a transect running up-current and down-current of the active pit. The first down-current station and the first up-current station of the dissolved metal station transect shall be positioned on the edge of the disposal facility at the most appropriate position depending on the factors mentioned above. The remainder of the up-current or down-current stations shall be positioned at appropriate distances apart from the respective first up-current or down-current station along the transect.

The following methodology shall be adopted for monitoring at dissolved metal stations:

- contact the CEDD barge at the start of each survey on every sampling occasion to determine the backfilling schedule for that particular day and to determine the likely location of backfilling at the proposed time of sampling.
- undertake Water Column Profiling to determine current direction.
- determine a suitable location for the dissolved metal station transect (with the down-current station should be located on the down current edge, and first up-current station should be located on the up-current edge, of the East of Sha Chau Facility according to the current direction and the position of backfilling at the time of sampling.
- collect samples from the dissolved metal stations located on a transect running up-current and down-current of the active pit.

The above measures shall ensure that water samples are collected from locations directly down-current of the active pits (to determine whether contaminants are being dispersed outside the boundary of the pit), and up-current of the active pit (to determine background concentrations of contaminants).

3.4.3 Water Column Profiling

A one hour survey shall be conducted at regular intervals (eg monthly) at one station located either in the flood or ebb tide plume depending on the current direction, in order to provide enough time (at least one hour) to identify the optimum sampling location for the dissolved metal testing component. Water column profiling shall be conducted at mid-depth.

3.4.4 Baseline Monitoring

Baseline monitoring shall be conducted at all Routine Monitoring Stations in the vicinity of the active facility (*Figures 3.4a* and *3.4b*) and in reference areas (EPD Water Quality Monitoring Stations NM1, 2, 3, 5 and 6) for a period of one month prior to the commencement of marine works in order to gather representative water quality data for the EM&A.

The baseline water quality monitoring shall be undertaken three days per week at all stations within a 3 hour window of 1.5 hours before or after mid-flood and mid-ebb tides for four weeks prior to construction works commencing. The interval between 2 sites of monitoring shall not be less than 36 hours.

Each station will be sampled and measurements will be taken at three depths, 1 m below the sea surface, mid depth and 1 m above the seabed. Where water depth is less than 6m the mid-depth station may be omitted. If water depth is less than 3m, only the mid-depth station will be monitored. Duplicate water samples shall be taken and analyzed.

The ET shall be responsible for undertaking the baseline monitoring and submitting the results within 10 working days from the completion of the baseline monitoring work.

Impact Monitoring for Dredging and Capping

Impact monitoring during dredging and capping operations of the active pits shall be conducted at mobile stations around the facility where their location is dependent on the location of either the dredging or capping activities. These mobile stations should be located at an appropriate distance between each other along the up-current or down-current transect for the dredging or capping area. The positioning of the Impact Monitoring stations shall follow the same rationale as that described above for the Dissolved Metal Stations. The precise location of the mobile stations shall be determined on each sampling occasion by the contractor conducting the monitoring, after contacting CEDD barge on site to determine the programme and location for dredging and capping. Sufficient number of sampling stations shall be

identified for taking samples to ensure a representative set of sampling data is collected. The number of samples to be collected and the sampling frequency shall be confirmed in advance of the commencement of the disposal activities and agreed with EPD based on the detailed design of the facility.

3.4.5 Statistical Treatment of Data

3.4.6 Routine Water Quality Monitoring

The hierarchy of sampling design should allow for the application of nested analysis of variance to statistically test any changes or trends in the dataset. Under the nested design, differences shall be tested between sites in a particular area and between the three areas (ie near field, midfield and farfield). Once a time series of data has been gathered temporal changes in water quality parameters can be analysed for significant differences. In addition, the data gathered shall be examined against the water quality objectives for the NWWCZ to determine if the relevant water quality objectives have been exceeded.

3.4.7 Dissolved Metal Testing

The data gathered during this programme shall be plotted and examined for apparent impacts to water quality or contaminant dispersion in the plumes arising from the backfilling activities. These data shall be compared with the predictions in the EIA.

3.4.8 Water Column Profiling

The data gathered shall be examined against the water quality objectives for the NWWCZ to determine if the relevant water quality objectives have been exceeded.

3.5 USE OF DATA

Should increases be detected in the level of contaminants in dissolved metal samples, or exceedances of the NWWCZ WQOs be detected, a review of the other monitoring parameters shall be undertaken. This shall focus on sampling stations in the vicinity of the water quality stations where increases are detected to see if these can be attributed to contaminant spread from the active pits. If so, consideration will be given to revising the facility operations plan.

3.6 DATA COLLECTION PARAMETERS

The following suite of parameters shall be measured for each task as detailed below:

3.6.1 Routine Water Quality Monitoring

- Dissolved Oxygen (mg L^{-1}) (*in situ* and laboratory analysis);
- pH *(in situ* and laboratory analysis);
- Suspended Solids (mg L^{-1}) (laboratory analysis);
- Ammonia (mg L^{-1}) (laboratory analysis);
- Nutrients (TIN mg L^{-1}) (laboratory analysis);
- 5-Day Biochemical Oxygen Demand (BOD) (mg L^{-1})(laboratory analysis); and
- Turbidity (NTU) (*in situ* and laboratory analysis).

3.6.2 Dissolved Metals Contaminant Testing

The measurements listed above for the routine water quality monitoring along with the following inorganic contaminants shall be tested:

- Cadmium;
- Chromium;
- Copper;
- Lead;
- Mercury;
- Nickel;
- Silver;
- Zinc; and
- Arsenic.

3.6.3 Water Column Profiling

- Salinity (ppt) (*in situ)*;
- Dissolved Oxygen (mg L^{-1}) (*in situ* and laboratory analysis);
- Suspended Solids (mg L^{-1})(laboratory analysis);
- Turbidity (FTU) (*in situ*);
- Temperature (^{o}C) (*in situ*); and
- Current Velocity and Direction (m s^{-1}) (*in situ*).

3.7 SAMPLING PROCEDURE

The position of the survey vessel shall be positioned to within 3 m of the designated coordinates at each monitoring station using a differential Global Positional System (GPS). *In situ* water quality (salinity, temperature, DO and SS) and, current velocity and direction, shall be conducted from the survey vessel using the equipment recommended in *Section 3.8*. In order to ensure the reliability and quality of the data, the measuring instrument shall be calibrated prior to each sampling cruise and the probe of the measuring instrument shall be maintained at a suitable distance from the seabed to avoid re-suspension of bottom sediments from skewing the results.

Water quality profiling shall be conducted continuously for a one-hour period from a fixed point. After deployment, the probe of the measuring equipment shall be allowed to equilibrate with the surrounding seawater for approximately 30 seconds. Subsequently, average readings shall be taken every few seconds to minimise sampling noise arising from the sensitivity of the equipment. To further calibrate the *in-situ* turbidity measurements, water samples shall be collected for calibrating and converting to turbidity measurements in the laboratory. In addition to *in-situ* water quality monitoring, water samples shall be collected in a water sampler at mid-depth. Samples shall be stored in sealed sampling bottles and chilled, and on completion of the survey shall be transported to the laboratory for immediate analysis. Samples not for immediate analysis shall be stored at $4 \pm 2°C$.

3.8 EQUIPMENT

The following equipment shall be supplied and used by the contractor for the water quality monitoring:

- ***Positioning Device*** - A Global Positioning System (GPS) shall be used during monitoring to ensure the accurate recording of the position of the monitoring vessel before taking measurements. The GPS shall be calibrated daily before each survey period or results reported.

- ***Dissolved Oxygen and Temperature Measuring Equipment*** - The instrument shall be a portable, weatherproof dissolved oxygen measuring instrument complete with cable, sensor, comprehensive operation manuals, and shall be operable from a DC power source. It shall be capable of measuring: dissolved oxygen levels in the range of 0 - 20 mg L^{-1} and 0 - 200% saturation; and a temperature of 0 - 45 degrees Celsius.

  It shall have a membrane electrode with automatic temperature compensation complete with a cable of not less than 20 m in length. Sufficient stocks of spare electrodes and cables shall be available for replacement where necessary (for example, YSI model 59 metre, YSI 5739 probe, YSI 5795A submersible stirrer with reel and cable or an approved similar instrument).

- ***Turbidity Measurement Equipment*** - Turbidity within the water shall be measured *in situ* by the nephelometric method. The instrument shall be a portable, weatherproof turbidity-measuring unit complete with cable, sensor and comprehensive operation manuals. The equipment shall be operated from a DC power source, it shall have a photoelectric sensor capable of measuring turbidity between 0 - 1000 NTU and shall be complete with a cable with at least 20 m in length (Hach 2100P or an approved similar instrument).

- ***Salinity Measurement Instrument*** - A portable salinometer capable of measuring salinity in the range of 0 - 40 ppt shall be provided for measuring salinity of the water at each monitoring location.

- ***Suspended Solid Measurement Equipment*** - A water sampler (eg Kahlsico Water Sampler), which is a PVC cylinder (capacity not less than 2 litres) which can be effectively sealed with latex cups at both ends, shall be used for sampling. The sampler shall have a positive latching system to keep it open and prevent premature closure until released by a messenger when the sampler is at the selected water depth. Water samples for suspended solids measurement shall be collected in high density polythene bottles, packed in ice (cooled to 4^{o}C without being frozen), and delivered to the laboratory in the same day as the samples were collected.

- ***Water Depth Gauge*** - A portable, battery-operated echo sounder (Seafarer 700 or a similar approved instrument) shall be used for the determination of water depth at each designated monitoring station. This unit shall 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.

- ***Water Sampling Equipment*** - A water sampler, consisting of a transparent PVC or glass cylinder of not less than two litres which can be effectively sealed with cups at both ends, shall be used (Kahlsico Water Sampler 13SWB203 or an approved similar instrument). The water sampler shall have a positive latching system to keep it open and prevent premature closure until released by a messenger when the sampler is at the selected water depth.

- ***Current Velocity Measuring Equipment*** – A Valeport 108 MKIII current meter or a similar approved instrument shall be used for measuring current velocity and direction. The instrument shall be calibrated before taking data.

3.9 LABORATORY PROCEDURES

Using chain of custody forms, collected water samples shall be transferred directly to laboratory for immediate processing of dissolved oxygen, pH, suspended solids, ammonia, nutrients, BOD_5 and turbidity. Water samples shall be analysed for pH and BOD within 4 hours of their arrival at the laboratory. All other parameters shall be analysed within 48 hours of arrival.

During this period samples shall be held at 4 ± 2ºC. Prior to subjecting the sample to metals analysis, samples shall be filtered to remove solids and colloidal matter. Filtration shall be accomplished using acid washed, single-use 0.45 micron membrane filters within a maximum of 8 hours from sample collection. Where necessary, samples shall undergo further preparation involving preconcentration which allows lower method detection limits to be achieved and removes some of the possible sources of interference.

3.10 QA/QC

3.10.1 Field Logs

Field logs shall be maintained for all survey work, noting the date of the survey, equipment used, survey manager and a record of all activities and observations. Field logs shall be retained for the duration of the Project and archived on completion.

In-situ measured data shall be digitally recorded from the instruments and converted into Microsoft Excel format, or manually noted. Both disc copy and hard copy shall be retained for the file records. Any deviation from the standard procedure shall be noted in the log and the reason for the deviation recorded. In addition, field logs shall contain notes of events or activities in the vicinity of the monitoring location which might give rise to anomalous data being recorded.

3.10.2 Sampling

The sampling, collection, storage and identification procedures are described in *Section 3.7* of this Manual and the person who conducts the sampling shall record all data from *in-situ* testing and from any analysis carried out on the boat in a Field Log. All samples shall be identified with a unique date / time / location / depth / sample-type code which shall be attached to the sample container or written in indelible ink directly on the container. In order to avoid contamination of the samples, all containers shall be new and unused and of analytical grade quality. Sources of contamination shall be isolated from the working area (for example, vessel fuel and exhaust fames) and any sample contaminated by local material (such as printed circuit boards) shall be discarded and the sampling repeated. Low level metal analysis in seawater is easily contaminated through inappropriate handling and sampling techniques. Site staff involved in seawater sample collection intended for dissolved metal analysis shall ensure that they wear non-contaminating disposable gloves if they have previously been operating or have handled metallic equipment.

3.10.3 Measurement Procedures

All *in-situ* monitoring instruments shall be checked, calibrated and certified and subsequently re-calibrated at 3 monthly intervals throughout all stages of the water quality monitoring, or as required by the manufactures specification. Certificate(s) of Calibration specifying the instrument shall be attached to the monitoring reports.

3.10.4 Transport of Samples

All samples transferred from one sub-contractor to another shall be accompanied by Chain of Custody (COC) forms. Any missing or damaged samples require notification to ET Leader following logging in the laboratory QA system. The number of samples, the parameters to be tested and the time of delivery should be clearly stated on the COC forms to ensure that samples are analysed for the correct parameters and suitable time is provided to the analytical laboratory for provision of resources required in the analyses.

3.10.5 Laboratory Procedures

For details of the contaminants to be tested, the methods to be used, the accreditation status of laboratory analytical methods, instruments and procedures to be used, sample preparation information, method detection limits (MDLs), QA / QC protocols and turnaround times, contractor should refer to the previous monitoring programme for the ESC CMPIV (1) (2).

The analytical techniques to be adopted for this Project must conform to HOKLAS (or similar overseas) accreditation.

3.10.6 Data Quality Objectives

Data Quality Objectives (DQOs) have been developed in the previous monitoring programme for ESC CMPIV (3) (4) to address precision, accuracy and analyte recovery. The contractor is recommended to follow the DQOs developed for data analysis.

Inorganic Analyses

Details of quality control specifications for inorganic testing should be included in the updated EM&A Manual prior to commencement of disposal activities.

Precision

Duplicates (1 in every 10 samples) shall be used to monitoring the precision of the analysis. Results should be flagged for reference when:

- In water samples, for metals with a concentration >4x MDL, the duplicate results have more than a 15% RPD
- For all analytes with concentration <4x MDL, the duplicate results shall be reported as analysed and no bounds should be quoted

(1) ERM (2001) Environmental Monitoring and Audit for Contaminated Mud Pit IV at East Sha Chau: Monitoring and Audit Manual. Submitted to CED, February 2001.

(2) Mouchel (2001) Consultancy for Environmental Monitoring and Audit for Contaminated Mud Pit IV at East Sha Chau (2000-2005): Monitoring and Audit Manual. Submitted to CED, May 2001.

(3) ERM (2001) *Op cit.*

(4) Mouchel (2001) *Op cit.*

Accuracy

Standard and certified reference material (CRM) shall be used to monitor accuracy and precision within and between batches: Results should be flagged for reference if:

- The variation of the standard from its true value is more than ± 15% (for mercury: ± 20%).

Recovery

Post digest spikes shall be used to determined the recovery of determinants in complex sample matrices. Results should be rejected if:

- Spike recoveries are more than ± 25% from the theoretical recovery for water samples. An exceptional case would be if the sample concentration is greater than four times the spike value, the spike may be disregarded.

3.11 WATER QUALITY COMPLIANCE AND EVENT & ACTION PLAN

Water quality monitoring will be evaluated against Action and Limit Levels. The key assessment parameters are dissolved oxygen and suspended sediment and thus Action and Limit Levels based on the assessment criteria are identified for these. However turbidity can also provide valuable instantaneous information on water quality and thus an Action Limit is also recommended for this parameter to facilitate quick responsive action in the event of any apparent unacceptable deterioration attributable to the works. The baseline data will be taken into account in setting the Action and Limit Levels, however, the rationale are shown in *Table 3.1*

Action and Limit levels are used to determine whether operational modifications are necessary to mitigate impacts to water quality. In the event that the levels are exceeded, appropriate actions in Event and Action Plan (*Table 3.2)* should be undertaken.

Table 3.1 Action and Limit Levels for Water Quality

Parameter	Action Level	Limit Level
Dissolved Oxygen		
Surface and Middle Depth Averaged	The depth average of the impact station readings are <5%ile of baseline data and significantly less than the reference stations mean DO (at the same tide of the same day)	The average of the impact station readings are <4mg/L and Significantly less than the reference stations mean DO (at the same tide of the same day)
Bottom	The average of the impact station readings are <5%ile of baseline data and Significantly less than the reference stations mean DO (at the same tide of the same day)	The average of the impact station readings are <2mg/L and Significantly less than the reference stations mean DO (at the same tide of the same day)
Suspended Solids		
Depth Averaged	The depth average of the impact station readings are >95%ile of baseline data and 120% or more of the reference stations SS (at the same tide of the same day)	The depth average of the impact station readings are >99%ile of baseline data and 130% or more of the reference stations SS (at the same tide of the same day)
Turbidity		
Depth Averaged	The depth average of the impact station readings are >95%ile of baseline data and 120% or more of the reference stations turbidity (at the same tide of the same day)	The depth average of the impact station readings are >99% of baseline data and 130% or more of the reference stations turbidity (at the same tide of the same day)

Table 3.2 Water Quality Event and Action Plan

Event	Environmental Team (ET)	Contractor
Action Level Exceedance for one sample	• Repeat *in-situ* measurement to confirm findings; • Identify the source(s) of impact; • Inform contractor and contractor informs CEDD, EPD and AFCD and confirm notification of the non-compliance in writing; • Check monitoring data; • Discuss potential mitigation measures if exceedance is attributed to the works with contractor.	• Discuss potential mitigation measures with ET and agree on mitigation measures to be implemented if exceedance is attributed to the works; • Ensure mitigation measures are implemented; • Assess the effectiveness of the implemented mitigation measures.
Limit Level Limit level for one occasion	• Repeat *in-situ* measurement to confirm findings; • Identify source(s) of impact; • Inform contractor and contractor informs CEDD, EPD and AFCD; • Discuss further mitigation measures if exceedance is attributed to the works with contractor; • Increase the monitoring frequency to daily if exceedance is attributed to the works until no exceedance of the Limit Level.	• Critical review of working methods; • Check plant, equipment and working methods; • Discuss further mitigation measures with ET to be implemented if exceedance is attributed to the works; • Ensure mitigation measures are being implemented; • Assess the effectiveness of the implemented mitigation measures.
Limit Level exceeded on two or more occasions	• Identify source(s) of impact; • Inform contractor and contractor informs, CEDD, EPD and AFCD.	• If exceedance is attributed to the works consider and if necessary reduce works until no exceedance of Limit Level.
Impacts attributable to works	• Inform contractor and contractor informs, CEDD, EPD and AFCD.	• Comprehensive review of works; • Reduce works; and • Suspension of works.

4 SEDIMENT QUALITY

4.1 INTRODUCTION

In accordance with the recommendations of the EIA for the present Project, a monitoring programme examining sediment quality will be instituted to verify the EIA predictions and ensure that there is no build-up in contamination adjacent to the pits. Sediment chemistry has long been an important component of monitoring programmes at the East of Sha Chau mud disposal complex. Since 1997 a comprehensive list of Contaminants of Concern (COCs) comprising 8 heavy metals and 1 metalloid, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), organochlorine pesticides (eg DDT) and Tributyltin (TBT). These contaminants (which correspond to the list of COCs in *ETWBTCW 34/2002*) in sediments should be measured in the present monitoring programme and changes over time and distance should also be examined.

4.2 OBJECTIVE

The main objective of this task is to determine if there are any changes and/or trends in the concentrations of contaminants in sediments adjacent to the pits caused by disposal activities. This objective is most appropriately addressed through two separate but intrinsically linked sub-tasks:

- *Near-field monitoring of sediment quality* - conducted to examine near field impacts of backfilling operations on the spread of contaminants from the pits and to allow for rapid detection of any adverse environmental impacts and, if necessary, changes to the operations plan.

- *Regional monitoring of sediment quality* - conducted to analyse the ambient conditions in the North Lantau region and to investigate whether any impacts to marine sediments are occurring due to the dispersion of contaminants from the active pits.

4.3 HYPOTHESES

The impact hypothesis for this task is as follows:

There is no increase in sediment contaminant concentrations over time at individual stations or a trend of increasing concentrations with proximity to the active pit.

As a result of the separation of this programme into two sub-tasks, two sets of null hypotheses should be tested:

Near-field monitoring of sediment quality

H_0 There is no increase in sediment contaminant concentration in the area adjacent to the active pits as compared to levels observed in the area under recently conducted, comparable monitoring programmes.

Regional monitoring of sediment quality

H_0 There is no increase in sediment contaminant concentration over time in the area of contaminated mud disposal activity.

H_0 There is no increase in sediment contaminant concentration with proximity to the active pits.

4.4 SAMPLING DESIGN

The designs for assessing the impacts of disposal of contaminated mud in the active pits on the sediment chemistry of remote and adjacent areas take into account the following factors:

- The null hypotheses being tested;
- Background levels of contaminants in the region;
- Predictions taken from the EIA on sediment plume locations;
- Spatial variability in sediment chemistry;
- Temporal variability in sediment chemistry; and,
- Expected statistical treatment of the data.

As mentioned in *Section 1.7.2* the EM&A Manual is an evolving document that should be updated to maintain its relevance as the Project progresses. This includes the relocation of monitoring stations to best suit the requirements of the monitoring programme and to take into account other work that is occurring in the direct vicinity of the active facility.

4.4.1 Near-field monitoring of sediment quality

Sediment samples shall be collected on a monthly basis from two sites in the active pit, two sites on the edge of the active pits and two sites in close proximity to the pits (*Figures 4.4a* and *4.4b*). Twelve replicates of composite samples (ie 5 grab samples obtained using a cluster grab) will be collected from each of the sites. Replicates have been based on analysis of data conducted as part of the monitoring of CMP IVa (Agreement No. CE 44/97). Under this EM&A programme, Cumulative Running Mean Tests determined optimum sample size for stabilising mean and standard error values was 12 samples for sediment analysis. The technique of clustering stations within one site has been proven to be an effective way of testing hypotheses and removing the confounding effects of spatial variation from the interpretation.

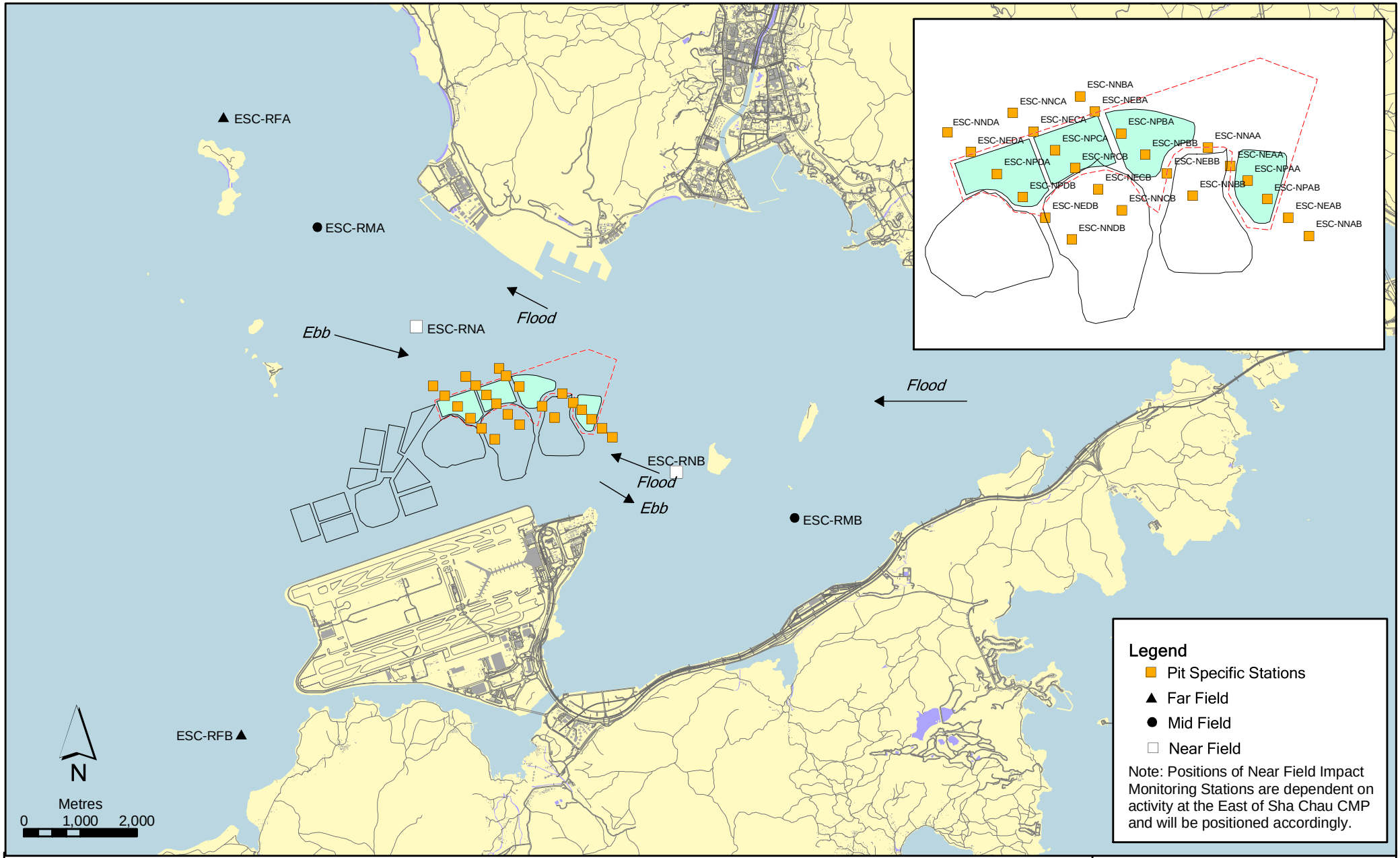

Figure 4.4a

SEDIMENT QUALITY MONITORING STATIONS
WHEN EAST OF SHA CHAU FACILITY IS ACTIVE

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Date: 02/02/2005

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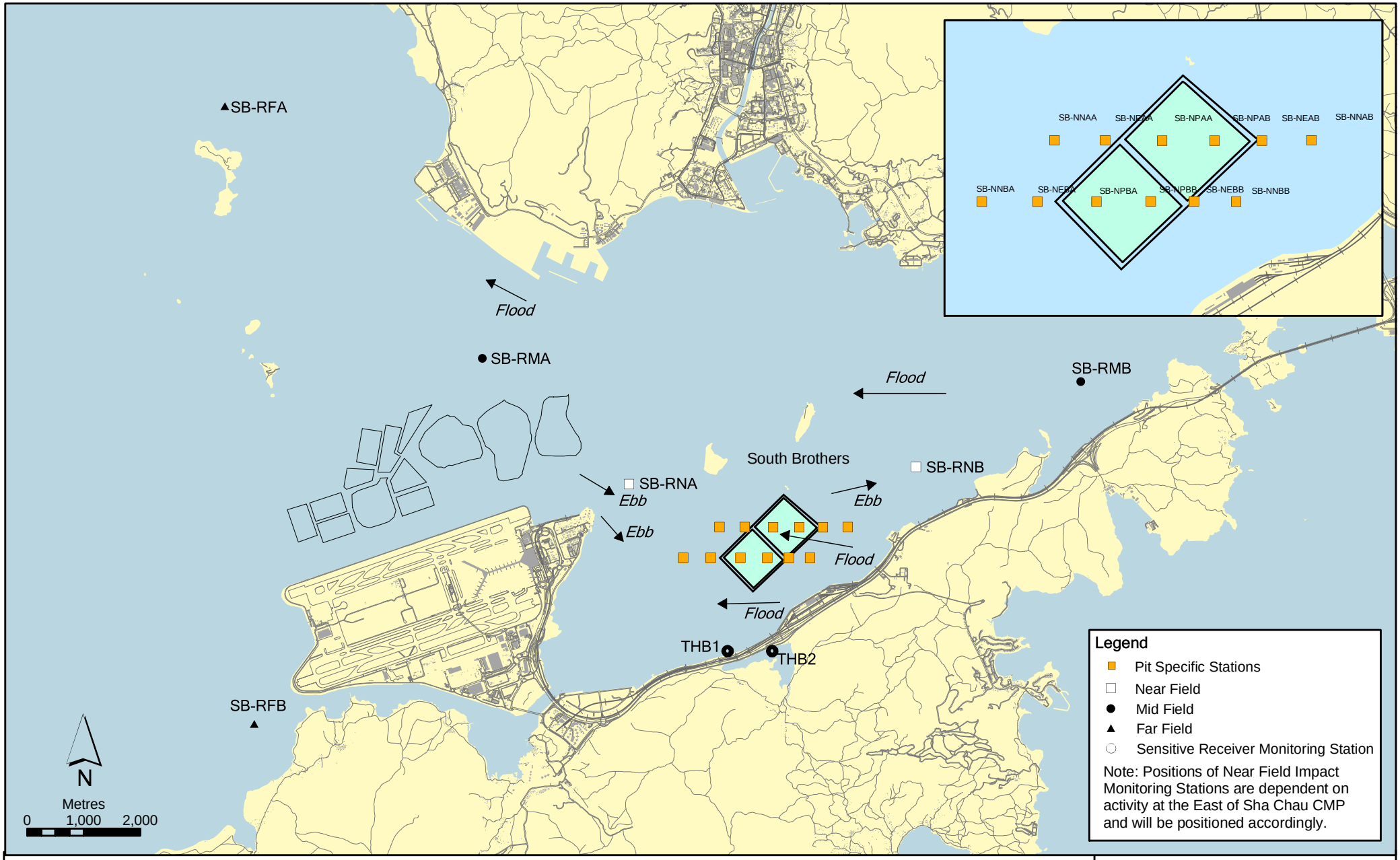

Figure 4.4b

SEDIMENT QUALITY MONITORING STATIONS
WHEN SOUTH BROTHERS FACILITY IS ACTIVE

File: c2693_45a.mxd
Date: 26/01/2005

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The number of stations within a site and the precise locations of the sampling stations should be confirmed in advance of the commencement of disposal activities and agreed with EPD subject to the detailed design of the disposal facility.

4.4.2 Regional monitoring of sediment quality

Sediment samples should be collected twice during the dry season and twice during the wet season at stations distributed throughout the North Lantau area. The stations should be located in three discrete areas, with two sites in each area. The areas should be located at increasing distances from the disposal operations (ie Near Field, Mid Field, Far Field and any additional sensitive receiver sites indicated on *Figures 4.4a* and *4.4b*). Twelve replicates of composite samples (ie 5 grab samples obtained using a cluster grab) will be collected from each of the sites. The exact positions of the stations should be determined in advance of the commencement of disposal activities and agreed with EPD.

4.5 STATISTICAL TREATMENT OF DATA

4.5.1 Near-field monitoring of sediment quality

Observed differences in the levels of contaminants should be tested each month using analysis of variance (factors = Area and Site) followed by Student Newman Keuls (SNK) multiple comparison procedures to isolate which treatments differ from others. Once a time series of data has been gathered, the data should be re-analysed to examine the differences within and between the sites over time. This should be achieved using an analysis of variance with site, Area and Month as the factors.

For all of the analysis of variance techniques performed during the monitoring programme, initial analyses should be performed to ensure that the data complies with the specific assumptions of analysis of variance. These assumptions state:

- the data within and among samples must be independent of each other;
- the variance within samples must be equal (tested through the use of tests such as Levene's median test); and,
- the data among the samples must be normally distributed (tested through the use of tests such as the Kolgomorov-Smirnov test).

Should the data not comply with these assumptions then the appropriate transformation should be applied to the data (eg, arc-sin for percentage data, $\log^{(x+1)}$ for abundance data, or rank transformation if necessary). If, after transformation, the data are still non-compliant then non-parametric equivalents to ANOVA such as Kruskal-Wallis tests should be used.

4.5.2 Regional monitoring of sediment quality

The design of the regional monitoring programme should allow the use of nested analysis of variance techniques to be employed. These techniques shall be used to analyse the data at different spatial and temporal scales of replication. Statistical differences should be tested at the following levels: between sites in each area and between each area at each sampling time. An advantage of this sampling design is that it removes the possibility of detecting differences simply due to inherent variation over spatial scales in the active area and thus facilitates clearer attribution to disposal operations. By replicating within each area, ie by sampling two sites in one area, any statistically significant differences detected between areas are more likely to be due to factors other than spatial variation (eg, disposal operations). This approach is now an internationally recommended technique for use in monitoring programmes (1). Multidimensional scaling ordination techniques shall also be applied to the data.

4.6 USE OF DATA

Should significant increases be detected in the level of contaminants in sediment samples, a review of the other monitoring parameters should be undertaken. This review shall focus on sampling stations in the vicinity of the sediment quality monitoring stations where increases were detected to see if these can be attributed to contaminant migration from the active pits. Assessment of the statistical significance of the data, confidence in the data and the presence of supporting data from other components of the monitoring programme should be jointly assessed. If appropriate, changes to the operations plan should be considered.

4.7 DATA COLLECTION PARAMETERS

The parameters that should be measured in sediments collected during the two sub-tasks and the rationale for each are given below. The contaminants listed are the "Contaminants of Concern" for which Lower and Upper Chemical Exceedance Limits (LCEL / UCEL) exist.

4.7.1 Near-field monitoring of sediment quality

(a) **Total Organic Carbon (TOC)** - an indicator of organic load and the impact on bottom layer dissolved oxygen. TOC is an important factor influencing the chemical partitioning and toxicity of hydrophobic organic compounds such as PAHs, PCBs and pesticides. High TOC often infers that hydrophobic contaminants are less bioavailable;

(b) **Inorganic Contaminants** - metals and metalloids present in the disposed sediments which may be bioaccumulated;

(1) AJ Underwood (1997) Experiments in Ecology: their logical design and interpretation using analysis of variance.

(c) **Polycyclic Aromatic Hydrocarbons (PAH)** - a class of organic compounds some of which are persistent and carcinogenic. These compounds may be bioaccumulated and stored in the fatty body tissues of mammals;

(d) **Total Polychlorinated Biphenyls (PCB)** - a class of persistent man-made chemicals which tend to bioaccumulate through the food chain and can cause reproductive failure and cancer;

(e) **Organochlorine Pesticides (DDE & DDT)** - contaminants which are persistent, highly lipophilic (can be accumulated and stored in fat), have high bioaccumulation and biomagnification potential, and high toxicity to aquatic organisms; and,

(f) **Tributyltin (TBT) (in sediment and interstitial water)** - moderately persistent toxic compound found in marine sediments which may be bioaccumulated and cause growth abnormalities and reproductive failure.

4.7.2 Regional monitoring of sediment quality

(a) **Percentage of Silt/Clay (% < 63μm)** - organic contaminants and metals bind more readily to finer particles than coarser particles due to their larger surface area and consequent larger number of binding sites;

(b) **Total Organic Carbon (TOC);**

(c) **Inorganic Contaminants** (1)**;**

(d) **Polycyclic Aromatic Hydrocarbons (PAH)** (2)**;**

(e) **Total Polychlorinated Biphenyls (PCB);**

(f) **Organochlorine Pesticides (DDE & DDT)** (3)**; and,**

(g) **Tributyltin (TBT) (in sediment).**

4.8 SAMPLING PROCEDURE AND EQUIPMENT

All samples should be collected by an experienced sampling team (with ISO 9002 certification), deployed on a survey boat equipped with fully calibrated sampling equipment and precision navigational instruments. All vessel positioning should be accomplished with a calibrated Differential Global Positioning System (DGPS), ensuring station location accuracy to < ± 1 m (95% confidence), with sample position automatically logged and mapped by the navigation computer. Where sample stations are located in close proximity

(1) Cadmium (Cd), Chromium (Cr), Copper (Cu), Lead (Pb), Mercury (Hg), Nickel (Ni), Silver (Ag), Zinc (Zn) and Arsenic (As).

(2) Acenapthene, Acenaphthylene, Anthracene, Fluorene, Napthalene, Phenanthrene, Low Molecular Weight PAHs, Benzo(a)anthracene, Benzo(a)pyrene, Chrysene, Dibenzo(a,h)anthracene, Fluoranthene, Pyrene, High Molecular Weight PAHs and Total PAHs

to the pit area, positioning should be further validated by use of an echo sounder to detect whether the vessel is within the boundaries of the pit.

At each sampling station the top 5 cm of seabed sediment should be collected using a 5-component cluster grab sampler which collects surficial sediments with a minimal disruption to the surface layer and is designed to work effectively in soft sediment such as those found in the area. The cluster grab should be deployed once at each of the stations located within each sampling area (eg Pit, Pit-Edge). The grabs can customised and a fine mesh lid added, which ensures that the fine fluid sediments on the surface of the seabed are retained in the sample. Utilisation of this cluster sampler allows a large volume of sediment to be collected in a single deployment. Other similar samplers (eg Petit-ponar) collect less sediment in each deployment and can have difficulty collecting adequate samples in soft sediments, such as those within the study area, thereby reducing efficiency and increasing collection time. The five-cluster grab should be collected and combined, and the sample, labelled, double-bagged and stored in an ice chest cooled to a temperature of 4^{o}C with ice packs. The sediment sampler and all other utensils should be rinsed with seawater after each sample has been collected to avoid cross contamination between samples. On completion of the survey, all samples should be promptly transported, in chilled containers, to the testing laboratory for analysis.

4.9 QUALITY CONTROL & ASSURANCE PROCEDURES

A broad range of contaminants should be analysed in sediment samples including metals, metalloids, PAHs, PCBs, pesticides and Tributyltin in both sediment and interstitial water. The method detection limits should be consistent with previous monitoring programmes at East of Sha Chau. Other QA / QC procedures to be implemented for marine sediment analyses include:

- *Laboratory blanks* - an analyte free matrix to which all reagents shall be added in the same volumes or proportions as used in the standard sample preparation to monitor contamination introduced in the laboratory (organics and inorganics);
- *Batch duplicates* - an intralaboratory split sample randomly selected from the sample batch to monitor method precision (intrabatch) in a given sample matrix (inorganics only);
- *Certified Reference Materials* - analysis of a material with a known concentration of contamination to determine the accuracy of results in a given matrix (inorganics only);
- *Single Control Samples* - a known, interference-free matrix spiked with target analytes used to monitor laboratory preparation techniques (organics only);
- *Duplicate Control Samples* - multiple single control samples designed to monitor preparation technique reproducibility (organics).

(1) Total Dichlorodiphenyl-trichloroethane (DDT) and Dichlorodiphenylchloroethane (p,p'-DDE).

4.10 DATA QUALITY OBJECTIVES

Data Quality Objectives (DQOs) have been developed to address precision, accuracy and analyte recovery.

4.10.1 Inorganic Analyses

Details of quality control specifications for inorganic testing should be included in the updated EM&A Manual prior to commencement of disposal activities.

Precision

Duplicates (1 in every 10 samples) should be used to monitoring the precision of the analysis. Results should be flagged for reference when:

- For all analytes, except metals, with concentration >4x Method Detection Limit (MDL), the duplicate results have more than a 20% Relative Percentage Deviation (RPD)
- In water samples, for metals with a concentration >4x MDL, the duplicate results have more than a 15% RPD
- In sediment and biota samples, for metals with a concentration >4x MDL, the duplicate results have more than a 25% RPD
- For all analytes with concentration <4x MDL, the duplicate results should be reported as analysed and no bounds should be quoted

Accuracy

Standard and certified reference material (CRM) shall be used to monitor accuracy and precision within and between batches: Results should be flagged for reference if:

- The variation of the standard from its true value is more than ± 15% (for mercury: ± 20%).

Recovery

Post digest spikes should be used to determined the recovery of determinants in complex sample matrices. Results should be rejected if:

- Spike recoveries are more than ± 25% from the theoretical recovery for waters, sediment and marine biota. An exceptional case would be if the sample concentration is greater than four times the spike value, the spike may be disregarded.

4.10.2 Organic Analyses

Samples should be analysed in lots of less than 20. In order to measure the laboratory performance within each batch of samples, a single control sample (SCS), a duplicate control sample (DCS) and a method blank (MB) should be processed concurrently with the samples. A SCS or DCS consists of an interference free control matrix that is spiked with a group of target compounds representative of the method analytes.

Method blanks, also known as reagent, analytical, or preparation blanks, should be analysed to assess the level of contamination that exist in the analytical system and which might lead to the reporting of elevated concentration levels or false positive data. For organic analyses, the concentration of target analytes in the blank must be below the reporting limit for that analyte in order for the blank to be considered acceptable.

Accuracy is expressed as the average percent recovery of the SCS / DCS pair and precision is expressed as the relative percent difference (RPD). For control limits that are not established due to insufficient data sets, the QC Acceptance Criteria of US EPA Method 8080 and 8270A should be used as a supplement. Once enough data are collected, the in-house control limits should then be calculated.

The accuracy and precision data for SCS and DCS should be evaluated against laboratory established control limits. QC results falling outside the control limits should be automatically flagged. The acceptance criterion is that 100 percent of the precision and accuracy values must fall within the control limits. If this criterion is not met, corrective action must be taken. This may include repeat sample analysis.

The relative percentage difference of SCS / DCS pair should be compared to the limit set for each compound being monitored (*Table 4.1*). In normal instances, an RPD of less than 20% is deemed to be acceptable.

For multianalyte organic tests, if greater than 20% of the accuracy or precision results for the DCS are outside of the control limits, the data are considered suspect and the samples associated with the unacceptable DCS are reprepared and / or reanalysed.

Table 4.1 Quality Control Acceptance Criteria for Organic Analyses

Target Analytes	Percent Recovery Measured
Naphthalene	74 - 126
Acenaphthalene	69 - 125
Acenaphthene	73 - 119
Fluorene	81 - 129
Phenanthrene	74 - 131
Anthracene	63 - 116
Fluoranthene	73 - 134
Pyrene	59 - 129
Benzo(a)anthracene	77 - 136
Chrysene	53 - 130
Benzo(a)pyrene	51 - 103
Dibenzo(a,h)anthracene	78 - 126
DDE	73 - 121
DDT	87 - 120
Total PCBs	79 - 127
Tributyltin	80 - 115

D B Detected, result must be greater than zero

5 SEDIMENT TOXICITY

5.1 BACKGROUND

In addition to the water quality monitoring programme, monitoring of sediment toxicity is recommended in the EIA to ensure that the disposal activities are not causing sediments adjacent to the pits of the mud disposal facility to become toxic to marine life. This programme will employ standard techniques for sediment toxicity testing which are detailed in the following sections of this Manual.

The ecotoxicological testing programme shall feature a suite of tests that include three phylogenetically distinct species that interact with bedded sediments in different ways. Unacceptable impacts will have occurred if the levels of contaminants in the sediments collected in the area of the active pits are shown to have caused toxicity to marine fauna. The findings of the sediment toxicity tests shall be compared to the results of the sediments chemistry.

5.2 OBJECTIVE

The objective of this task is to determine if there are any changes and / or trends caused by disposal activities in the toxicity of sediments adjacent to the pits as a result of disposal activities.

5.3 HYPOTHESIS

In accordance with the prediction of the EIA and the objectives of the Study, the impact hypothesis for this task shall be as follows:

There is no increase in sediment toxicity over time at individual stations or a trend of increasing toxicity with proximity to the pit.

The null hypothesis which should be statistically tested is as follows:

H_0 Sediment collected at sites adjacent to the active pits exhibits no greater toxicity than sediment collected at sites remote from the facility.

5.4 SAMPLING DESIGN

In order to determine whether contaminated sediment placed in the active pits represents an ecological risk to biota in areas adjacent to the mud pit, ecotoxicological evaluations shall be performed on sediment collected from these surrounding areas.

The toxicological testing programme should feature a suite of tests that includes three phylogenetically distinct species that interact with bedded sediments in different ways. The testing programme shall include whole-sediment, or solid-phase toxicity tests using the epibenthic amphipod, *Ampelisca abdita*, the burrowing polychaete, *Neanthes arenaceodentata*, and free-swimming larvae of bivalves (*Mytilus galloprovincialis*) or other equivalent species. The species to be used, either international or local, for the toxicity testing should be confirmed with EPD / AFCD before commencement of the testing.

The experimental designs for assessing the impacts of disposal of contaminated mud in either the East of Sha Chau facility or the South Brothers facility on the toxicity of sediments in remote and adjacent areas take into account the following factors:

- The null hypotheses being tested;
- Location of other potential sources of contaminants in the North Lantau region, eg, Pearl River;
- Predictions taken from the EIA on sediment plume locations; and,
- Expected statistical treatment of the data.

Sediment samples shall be collected from two treatment areas. The first treatment is represented by samples taken from two stations in an area close to the active pits (Near-Field) and the second treatment is represented by samples collected from stations in a reference area (Far-Field) (*Figure 5.4a* and *5.4b*). At each of the stations, five replicate composite grab samples shall be taken and used for the sediment toxicity tests. The stations shall be sampled twice per year (wet season and dry season). The sediment sampling shall be carried out when the pits are active. The precise positions of the sampling stations should be confirmed in advance of the commencement of disposal activities and agreed with EPD based on the detailed design of the disposal facility.

5.5 STATISTICAL TREATMENT OF DATA

Each of the toxicological tests shall be evaluated for statistically significant increases in toxicity. Statistically significant toxicity shall be determined by performing an analysis of variance (ANOVA) test that compares the responses observed in the test treatments with those of the reference treatments. At the end of the monitoring programme changes in the toxicity of the sediments over time shall be evaluated through the use of two-factor ANOVA incorporating both spatial and temporal scales of variation.

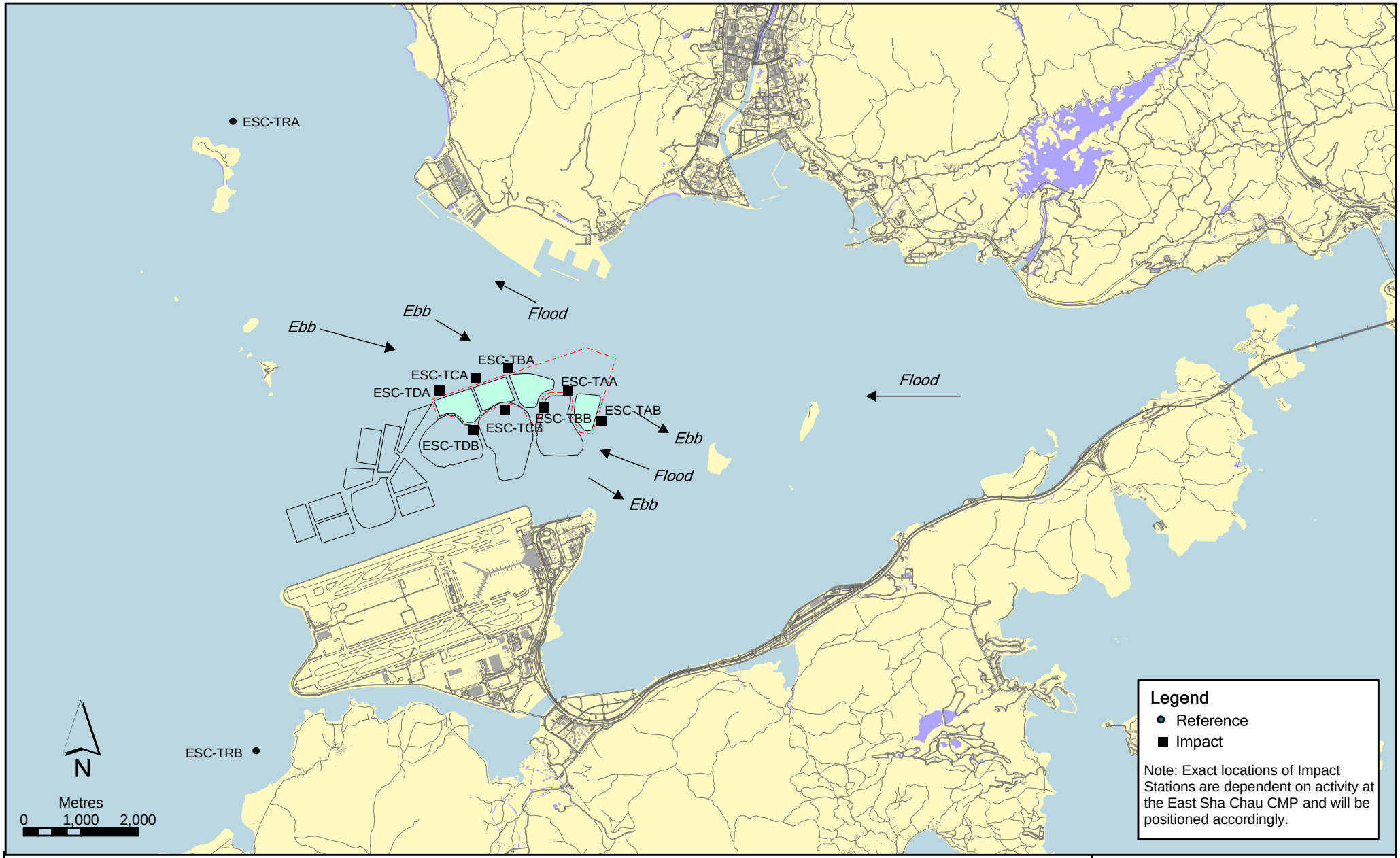

Figure 5.4a

SEDIMENT TOXICITY MONITORING STATIONS
WHEN EAST OF SHA CHAU FACILITY IS ACTIVE

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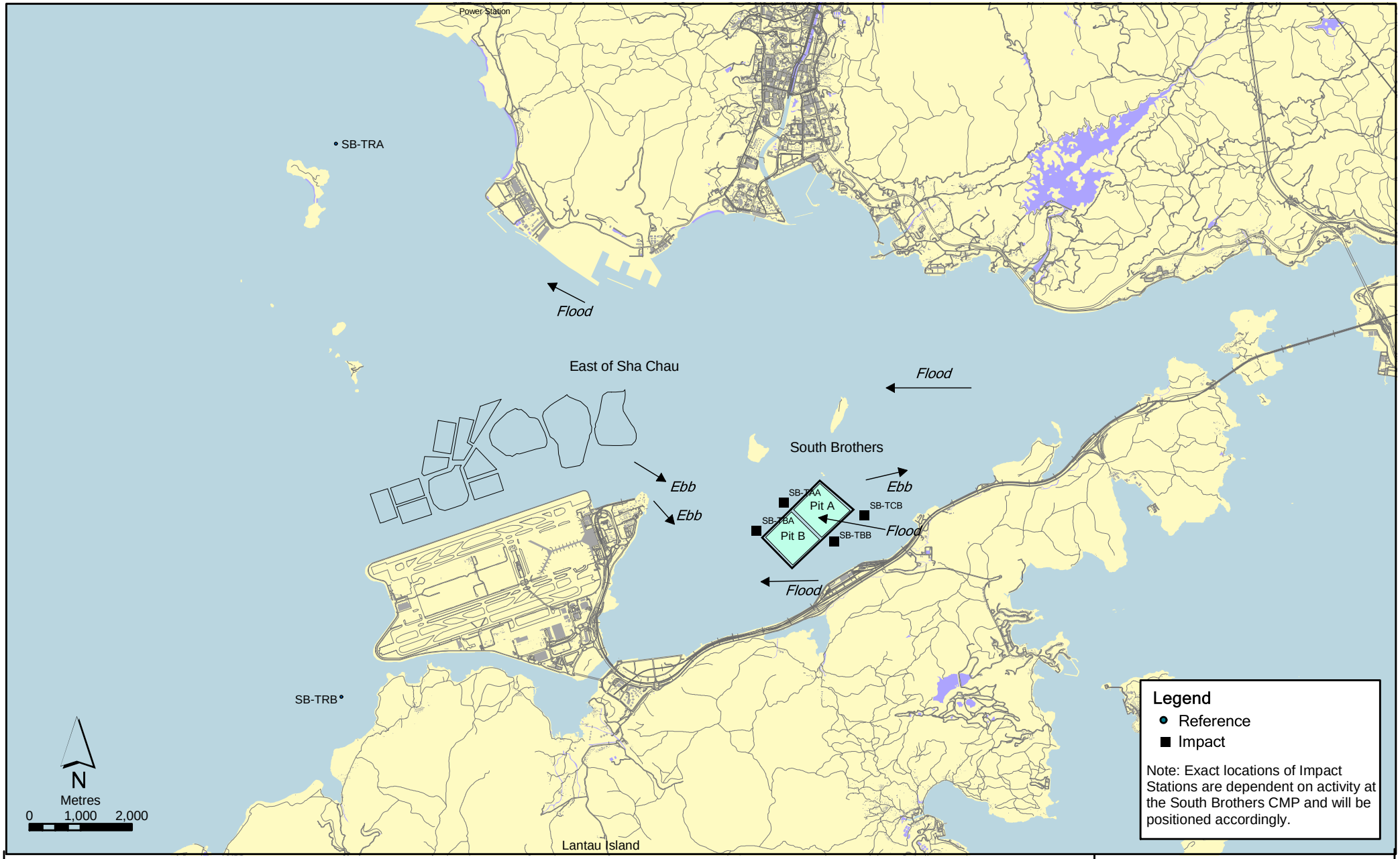

Figure 5.4b

SEDIMENT TOXICITY MONITORING STATIONS
WHEN SOUTH BROTHERS FACILITY IS ACTIVE

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5.6 *USE OF DATA*

Once the data have been evaluated for significance, it is important to identify potential causes of toxicity and the biological significance of the observed effects. The cause of the observed effects needs to be distinguished between 1) non-persistent contaminants, 2) persistent contaminants, and 3) physical factors. It is most important to determine if the cause of the toxicity is due to persistent contaminants that are derived from the contaminated sediment placed in the pits (eg metals, pesticides, PAHs, TBT), to non-persistent contaminants (eg sulfides, ammonia, salinity) or to physical factors (eg grain size).

If the toxicity is due to persistent contaminants that are associated with disposal operations, the operations plan for the active pitsmay not be effective enough at managing the containment of contaminated sediment to acceptable levels and thus should be modified. If the observed toxicity is due to non-persistent contaminants, the effects may be due to the pit but they are transient. The toxicity of these types of contaminants can be assimilated by the environment in relatively short time periods, and are thus less harmful. If the effects are related to physical factors, they are again of less concern and would not likely require changes in the facility operations plan.

As non-contaminant factors and physical factors can confound toxicity test interpretation, the ET shall monitor ammonia, sulfides, interstitial salinity, and sediment-grain size. Each of these factors has been observed to elicit a Atoxic@ response in test organisms, however, they are not factors related to persistent contaminants of concern. This information shall be used to investigate any observed toxicity responses and determine whether the response is due to persistent contaminants or to more transient factors.

5.7 *DATA COLLECTION PARAMETERS*

The amphipod toxicity test with *Ampelisca abdita* (or a equivalent species as agreed with EPD / AFCD prior to conduct of the toxicity test) shall evaluate survival following a 10-day exposure to test sediment. Procedures shall follow those outlined in PSEP (1995) (1) and CEDD's Environmental Laboratory Guidance Document (1996) (2). The amphipod benthic test shall be conducted as a static test and shall be performed with 175 ml of sediment and 800 ml of overlying seawater placed in a 1-L glass jar. At test initiation, each of five replicate test chambers shall be seeded with 20 amphipods. Test chambers shall be maintained at 20°C and shall be checked daily throughout the test to establish trends in sediment avoidance. After the 10-day exposure, the benthic tests shall be terminated by sieving the sediments and enumerating the live and dead amphipods.

(1) PSEP (Puget Sound Estuary Program) 1995 Recommended guidelines for conducting laboratory bioassays on Puget Sound sediments. Prepared for the US EPA.

(2) EVS (1996) Testing of Dredged material for Marine Disposal: Environmental Laboratory Guidance Document. Prepared for CED.

The test on *Neanthes arenaceodentata* (or a equivalent species as agreed with EPD / AFCD prior to conduct of the toxicity test) shall evaluate polychaete survival and growth following a 20-day exposure to test sediment. Test methods will follow those outlined in PSEP (1995) (3). The test shall be conducted as a static test, performed in 175 ml of sediment and 800 ml of overlying seawater in 1-L glass jars. At test initiation, each of five replicate test chambers shall be seeded with five polychaetes. Test chambers shall be maintained at 20°C and shall be checked daily to record mortality and sediment avoidance. To promote growth, worms shall be fed TetraMarin[8] every third day throughout the test. After 20 days, the *N. arenaceodentata* test shall be terminated by sieving each test chamber and enumerating both live and dead organisms. Surviving polychaetes shall be dried and weighed for each test chamber. Average dry weight shall be compared to initial biomass to determine mean growth for each test chamber.

The larval-development toxicity test shall be performed with fertilized bivalve embryos eg *Mytilus galloprovincialis* or a equivalent species as agreed with EPD / AFCD prior to conduct of the toxicity test, and shall evaluate larval survival and development following a 48 to 96-hour exposure to test sediments. This procedure shall follow those outlined in PSEP (1995) (1). This test shall be conducted in 20 mg of test sediment with 800 ml of seawater in 1-L glass jars. At test initiation, test jars shall be seeded with 20 to 40 embryos per ml. Test chambers shall be maintained at 16°C. At termination, overlying water shall be decanted and subsamples drawn from the supernatant. Survival and normal larval development shall then determined under an inverted compound microscope.

In each of the sediment tests, a native / seawater control (consisting of sediment from the amphipod or polychaete collection site or clean seawater for the larval test) shall be tested concurrently with the test sediments. The control treatment should be included to determine the health of the test organisms. Sediments collected from the reference stations shall also be tested concurrently with test sediments to provide a basis for statistical comparison. For the larval tests, grain-size controls shall be tested concurrently with the test sediments to discern any effects related to sediment grain size. Additionally, a water-only reference toxicant test using cadmium (from $CdCl_2$) or copper (from $CuNO_3$) shall be conducted with each batch of test organisms. This reference-toxicant test provides a measure of relative sensitivity for each group of test organisms. All toxicity tests shall be completed and reported within 2 months from collection of the samples.

Prior to the commencement of disposal activities, the data collection parameters and testing protocols described above shall be reviewed and revised where necessary and agreed with the relevant government departments (eg EPD / AFCD).

(1) PSEP (1995) *op cit*.
(2) PSEP (1995) *op cit*

5.8 SAMPLING PROCEDURE AND EQUIPMENT

Procedures for sampling shall be as for the sediment chemistry for Sediment Quality Monitoring as detailed in *Section 4.8* of this Manual. Shipments of the sediments shall be packaged in ice-boxes in order to maintain the sediments at a constant temperature of 4°C and dispatched by express courier for immediate testing.

5.9 QA/QC

To ensure the quality and integrity of the ecotoxicological data and subsequent analyses, a QA / QC control program shall be followed that meets or exceeds the QA / QC program outlined in Chapter 4 of A Testing of Dredged Material for Marine Disposal: Environment Laboratory Guidance Document. The QA / QC program for the facility ecotoxicological program is described below.

5.9.1 Sediment Handling and Chain-Of-Custody

Upon sample receipt, samples shall be held at 4° ± 2° C in the dark until required for testing. Sediment holding times for biological testing begin the day of sample collection and shall be kept at a minimum. The holding time for sediment intended for biological testing shall be 6 weeks. Chain-of-custody forms shall accompany each batch of samples to track samples and to provide temperature data before and after shipping.

5.9.2 Bioassay Seawater

Clean seawater for holding test organisms shall be sand-filtered seawater piped directly into the testing laboratory. Seawater used for test water and control water should be additionally gravity-feed filtered through a 0.45 -µm filter before use for all test species. Bioassay seawater should be continually monitored for water quality and the presence of algal blooms.

5.9.3 Instrument Maintenance and Calibration

Procedures for calibration and maintenance of water quality equipment shall follow MSL protocols. All measuring and testing equipment used on this Project should be traceable to the data collected and should be calibrated before use.

The pH meters used for obtaining water quality data must be calibrated daily before use according to MSL-M-045, Calibration and Use of pH Meters. The calibration shall be documented on the pH Meter Calibration Record sheet. Maintenance on pH meters shall be performed monthly. Maintenance should include visual inspection, cleaning probes in 0.1 M HCl, and cleaning any corroded contacts.

Refractometers used for obtaining water quality data shall be calibrated monthly using IAPO Standard Seawater according to MSL-M-048, Calibration and Use of Refractometers. The calibration should be documented on the Refractometer Calibration Record sheet. Refractometers should be inspected visually and cleaned monthly.

Digital thermometer calibrations shall be performed monthly by comparison to a certified mercury thermometer as specified in MSL-M-047, Calibration and Use of Thermometers. The calibration shall be documented on a Thermometer Calibration Record. Maintenance should include visual inspection and cleaning of salt and corrosion from connectors and contacts.

Dissolved oxygen meters should be calibrated daily before use according to MSL-M-046, Calibration and Use of Dissolved Oxygen Meters. The calibration should be documented on the Dissolved Oxygen Meter Calibration Record. Maintenance should be performed once monthly and should include visual inspection, cleaning the probe, and replacing of probe membrane.

The Fisher Accumet 1003 pH / selective ion electrode meter with ammonia electrode should be maintained according to manufacturer's instructions. The meter should be calibrated on each day of use with three concentrations of NH_4Cl standards bracketing the expected test concentrations of ammonia. The ammonia probe should be stored in 0.02 M NH_4Cl when not in use.

5.9.4 Data Review and Validation

In addition to QA / QC mentioned above, a series of reviews by qualified laboratory personnel should be implemented to ensure that the data generated for this Project meets the data quality objectives. These reviews should include the following:

- Data should be reviewed periodically by laboratory personnel to ensure that sample testing activities are completely and adequately documented.

- Sample holding times, sample integrity, test animal handling and acclimation, equipment calibration, water quality measurements, reference toxicity results, observations, and control survival shall be reviewed by qualified laboratory personnel. The results of QC measurements shall be compared to pre-established criteria as a measure of data acceptability.

- A final data audit by the Quality Assurance Officer shall be performed prior to submission of the data and report. This audit will ensure that the data are accurate, traceable, defensible, and complete, as compared to the Manual. The audit procedure (MSL-Q-005, Quality Assurance Data Audits) is a statistical, randomized check which involves comparing selected reported values to the original data. This procedure is designed to ensure a 95 percent chance of detecting whether one percent or more reported values disagree with the original data.

The overall quality assurance objective for this Project is to implement procedures that will ensure the collection of representative data that is of acceptable and defensible quality. The data quality objectives for the ecotoxicological tests shall be devised with reference to the previous data quality objectives established for the previous monitoring programmes for the East of Sha Chau CMPs.

A negative control provides a measure of test organism health. Negative control treatment shall be running concurrent to each toxicity test as a measure of the test organism's health. For the amphipod (eg *Ampelisca* sp) and polychaete (eg *Neanthes* sp) toxicity tests, the negative control should consist of clean, native sediment that is to be collected from the test organism's natural habitat. For the bivalve larval test, the negative control should consist of clean seawater. Acceptable limits for the negative controls shall be defined with reference to the limits established for the East of Sha Chau CMP monitoring programmes. If survival or normal development do not meet the acceptability criteria, all data should be evaluated and the test may need to be repeated.

Water quality measurements provide documentation of environmental conditions within the test chambers during the exposure. Temperature, dissolved oxygen, pH, and salinity shall be measured daily throughout the test. Conditions that are acceptable to maintain the health of the test organisms shall be defined with reference to the acceptable conditions defined for the East Sha Chau CMP monitoring programmes. If test conditions are outside the acceptability criteria, the data will need to be qualified.

The positive control provides a relative measure of test organism sensitivity. For each of the bioassays for the active pits, a separate reference-toxicant test should be performed with each batch of test organisms. The results of the reference-toxicant tests shall be compared with control charts generated by the testing laboratory for that species and toxicant. Those results within two standard deviations of the cumulative mean are considered to be similar in sensitivity to previous test populations. For amphipods (eg *A. abdita)* the reference-toxicant test shall be performed with cadmium in the form of cadmium chloride; for polychaetes (eg *N. arenaceodentata*) and bivalve larvae reference-toxicant tests shall be performed with copper as copper nitrate. If the test results are outside the control limits, the data will need to be qualified.

6 MARINE BIOTA

6.1 BACKGROUND

The bioaccumulation of contaminants by prey organisms and consequent biomagnification of contaminants up the food chain has long been an issue of concern for the disposal of contaminated mud at East Sha Chau. Although the public at large may not appreciate the technical details of a biomonitoring programme, especially concerning mobile populations, they are well aware of the potential for contaminated mud disposal to taint seafood products. These issues have been voiced not only in meetings with the Advisory Council on the Environment (ACE) but also during presentations of the findings of the EIA for CMP IV at District Board meetings(1). In recognition of these issues, a comprehensive biomonitoring programme which will address public concerns about contamination of seafood in the area through use of the data in a risk assessment framework should be undertaken for the disposal activities at the active pits.

6.2 OBJECTIVE

As well as examining the influence of contaminated sediment disposal on contaminant levels in demersal fisheries resources, the impact of disposal on the abundance and structure of demersal fisheries should also be assessed. Consequently, there are two objectives for this task:

- *Biomonitoring of Contaminants* - To identify any increases in the concentrations of contaminants in tissues of demersal marine life adjacent to and remote from the active pits.
- *Trawling, Sorting & Analysis* - To assess the impact of contaminated mud disposal at the active pits on the fisheries resources of the North Lantau area.

6.3 HYPOTHESIS

In accordance with the predictions of the EIA and the objectives for the Study, the impact hypothesis for this task is as follows:

There is no increase in tissue or whole body contaminant concentration over time in selected target species.

In order to reflect the dual workstreams under this task, two sets of null hypotheses should be tested:

(1) ERM (1997) *op cit.*

Biomonitoring of Contaminants

H_0 The concentrations of contaminants in tissue and whole body samples of demersal marine life adjacent to the active pits are not greater than contaminant concentrations from samples collected at stations remote from the active pits.

H_0 The concentrations of contaminants in tissue and whole body samples of demersal marine life do not increase over time.

Trawling, Sorting & Analysis

H_0 There are no differences in the composition or abundance of demersal fisheries resources near to and remote from the active pits Facility.

H_0 There are no differences in the composition or abundance of demersal fisheries resources over time.

6.4 SAMPLING DESIGN

6.4.1 Biomonitoring of Contaminants

Samples of the target species should be collected twice per year (July / August in the wet season and January / February in the dry seasons) specifically from two stations, one located north of Lung Kwu Chau as a reference area (TNA) and the other located on the northern edge of Pit A (INA) (*Figure 6.4a*). However, in order to obtain sufficient tissue and whole body samples from impact and reference stations, samples collected at different impact and reference stations (eg INA and INB, and TNA and TNB) will be combined where necessary.

The precise location of the sampling stations should be confirmed in advance of the commencement of the disposal activities and agreed with EPD

Due to concerns regarding the collection of sufficient quantities of target species, catch from the first trawl survey of each season (trawl for catch characterisation) should be retained in a frozen state for joint processing with the biomonitoring samples in the following month.

Five replicate tows should be conducted at each station and composite samples prepared from all nets and tows at each station during each of the sampling events. Replicate data points should be obtained whenever the abundance of target species allows laboratory analysis of more than one tissue / whole body sample for each target species at each station. The design to be developed should address the following key issues:

- Rigour of the dataset to allow for statistical testing of observed differences;
- Data required for the risk assessment;

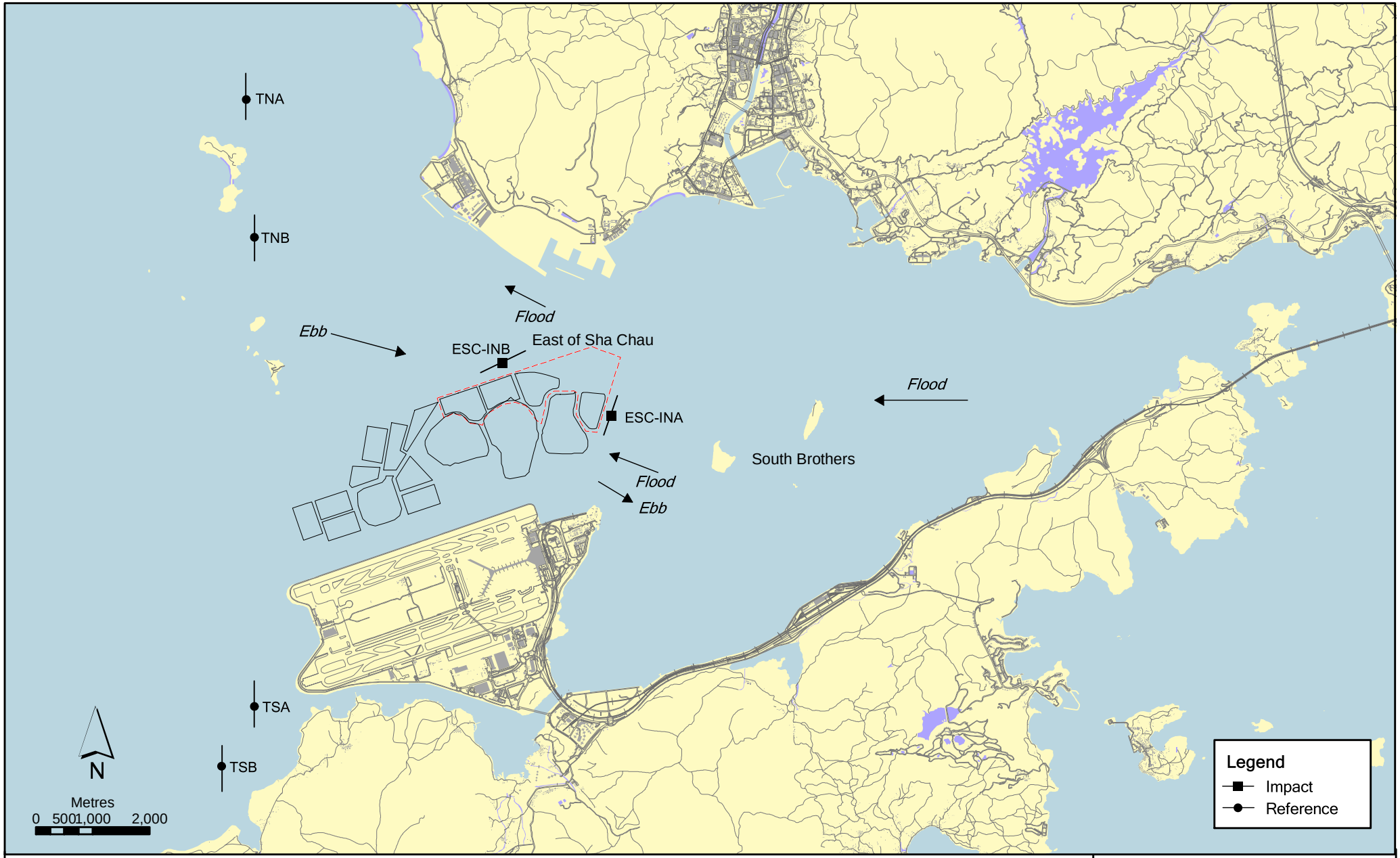

Figure 6.4a

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Date: 02/02/2005

MARINE BIOTA MONITORING STATIONS
WHEN EAST SHA CHAU FACILITY IS ACTIVE

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- Composite samples to minimise the variance between fish and improve the reliability of detecting any significant trends; and,

- Analysing replicate samples, whenever possible, to provide cost effective statistical rigour.

6.4.2 Trawling, Sorting & Analysis

The design of the sampling programme should encompasses the following key issues:

- Temporal variation in fisheries assemblages; and,

- Spatial variation of mobile assemblages of demersal fisheries resources.

Samples should be collected for analysis four times each year (twice in the dry season and twice in the wet season) to account for temporal variation in the fisheries assemblages. The samples should be collected from 5 replicate trawls (each with 6 nets) undertaken along a transect. Two replicate transects should be sampled at each site. Two sites should be located in each of two areas (impact areas and reference areas) (*Figures 6.4a* and *6.4b*). The exact position of the sampling locations should be confirmed prior to the commencement of the disposal activities and agreed with EPD.

Target species should be identified in advance of the commencement of disposal activities. The species list should be devised with reference to the previous biomonitoring programmes for the East Sha Chau CMPs. The species list should also include alternative species such that in case sufficient samples of target species cannot be obtained, analysis of the alternative species should be carried out.

6.5 STATISTICAL TREATMENT OF DATA

6.5.1 Biomonitoring of Contaminants

The data should be analysed using analysis of variance techniques to test for differences between the two sampling sites. Once a time series of data (sequential sampling events) has been gathered, differences should be tested between the stations and between the different sampling events to examine any temporal trends in contaminant levels in the target species.

6.5.2 Trawling, Sorting & Analysis

Catch composition should be analysed using partially nested analysis of variance techniques to account for changes in catches between and within sites in the North Lantauregion and between different sampling times. As with the previous examples, any significant differences should be further tested through the use of multiple comparison tests.

6.6 USE OF DATA

If significant increases are detected in the levels of contaminants in fisheries resources in this programme it will indicate that bioaccumulation is occurring. However, as demersal fisheries resources are generally mobile (except burrowing species such as the gobies *Trypauchen* and *Oxyurichthys*), increases may not necessarily be due to disposal at the disposal facility. Other contaminant sources such as discharges from the Pearl River, the local sewage outfalls or non point source pollution may cause such increases. To account for these confounding effects, the results from this Project's sediment and water chemistry programmes along with the most recent sediment toxicity test results so that the sources of any increases can be identified. Should there be evidence that effects are due to the active facility, the monitoring and disposal programme shall be reviewed and revised where necessary as agreed with CEDD / EPD.

6.7 DATA COLLECTION PARAMETERS

6.7.1 *Biomonitoring of Contaminants*

The contaminants of concern for this project should be measured separately, firstly in tissue samples (soft tissue) and secondly in whole body samples obtained from the species list established for this project. The species to be examined should be chosen based on two criteria:

- The degree to which the organisms are exposed to contaminants in the sediments; and,
- The position of the organisms in the food chain and the trophic level of their predators (ie, humans or Indo-Pacific Humpback Dolphin).

In the laboratory, each sample should be analysed for species composition, number of species, abundance and biomass. Each biomonitoring sample should be sorted for target species; target species selection should be based on the abundance and potential sample mass available for each species captured. In preparing samples for analysis, different species will not be mixed. Each tissue sample for laboratory analysis should consist of three or more organisms, with priority given to larger individuals with no more than 2 fold difference in length. Length and weight of all individual organisms represented by the composite sample shall be recorded and individuals for tissue sample analysis dissected with a sterilised (with hexane) titanium knife and a composite sample prepared. Frozen composite samples of at least 55 g wet weight (5 g for metal analysis, 30 g for organic analysis, 20 g for TBT analysis) should be sent to the laboratory for analysis.

The analytical parameters for tissue and whole body testing are given below.

(a) Inorganic Contaminants;

(b) Polycyclic Aromatic Hydrocarbons (PAHs);

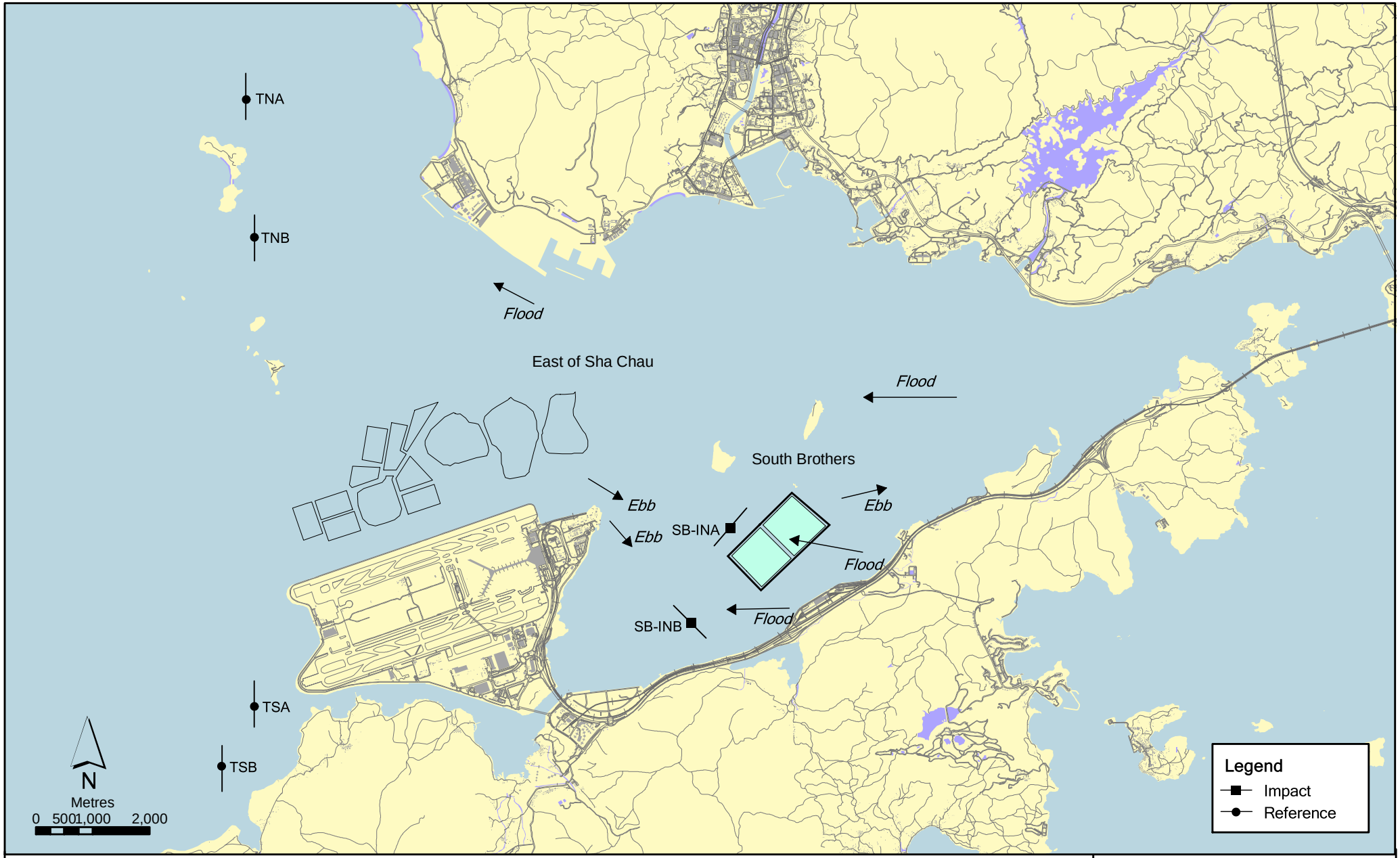

Figure 6.4b

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Date: 02/02/2005

MARINE BIOTA MONITORING STATIONS
WHEN SOUTH BROTHERS FACILITY IS ACTIVE

Environmental
Resources
Management

ERM

(c) Total Polychlorinated Biphenyls (PCBs);

(d) Organochlorine Pesticides (DDE & DDT); and,

(e) Tributyltin (TBT).

Moisture content of the tissue and whole body samples will also be measured.

6.7.2 Trawling, Sorting & Analysis

Catches from the trawl vessel should be processed to record the number and abundance of individuals of commercial fisheries resources in the samples as well as the number of species present.

6.8 SAMPLING PROCEDURE AND EQUIPMENT

Trawl sampling should be conducted by a shrimp trawler equipped with a GPS system to ensure accurate positioning of each trawl. Five replicate trawls, with six nets deployed in each, should be conducted for 10 minutes at each station. If more than one of the six nets are retrieved in a damaged condition, the samples should be rejected and the trawl repeated. To ensure the maximum quality of the benthic trawl samples, several control measures have been incorporated into the sampling programme, including:

- no more than three consecutive trawls should be conducted at a station and resampling should only occur after a minimum of two hours has elapsed;
- subsequent trawls at each station should be shifted to avoid repetitive sampling over the same area of seabed; and,
- the first station sampled in each survey should be selected at random to minimise the diurnal influences on catches.

Catches from all six nets in each trawl should be combined to form one sample. Each sample should be immediately washed and stored in sterilised (with hexane) glass jars. All samples should be chilled to $4^{o}C$ and transported to the laboratory for further sorting and analysis.

7 HUMAN HEALTH AND ECOLOGICAL RISK ASSESSMENT

7.1 BACKGROUND

The waters north of Lantau have historically been important fishing grounds and are presently fished by shrimp and hang trawlers based primarily at Castle Peak. These fishermen's catches comprise mainly shrimps and crabs, as well as fish species of relatively low commercial value such as pony fish, puffer fish and gobies (1). The North of Lantau area also is recognized as the primary habitat of the Indo-Pacific Humpback Dolphin (*Sousa chinensis*) within Hong Kong waters. This species, which is listed in Appendix 1 of the Convention on International Trade in Endangered Species (CITES), has a limited distribution in Hong Kong waters due to its preference for shallow, coastal estuarine habitat and is thought to be threatened by continuing development in the Pearl River Delta.

Disposal operations at the facility will be designed to minimize the dispersion of contaminated sediments during disposal and to prevent the long-term migration of contaminants through placement of a clean sand and mud cap. However, as losses of contaminated sediment will nevertheless occur during placement, and as the area serves as habitat for marine species which may be consumed by humans and/or the Indo-Pacific Humpback Dolphin, the risk of adverse impacts must be addressed by the monitoring programme. Pathways of contaminant release to sensitive receivers (ie humans and dolphins) include ingestion of contaminated sediment, ingestion of dissolved and suspended contaminants in water, and ingestion of organisms with contaminant residues.

The EIA has indicated that the consumption of seafood collected within the vicinity of the pits does not pose an unacceptable public health risk to any of the sub-populations of concern. In order to verify the predictions of the EIA a programme of monitoring the concentration of contaminants of concern in seafood is recommended. The data from such a programme would also be of value to determining the risks to the Indo-Pacific Humpback Dolphin.

Consequently, a risk assessment should be performed at least on an annual basis to verify that no unacceptable risk are occurring to either human health or marine mammals as a result of consuming prey species from the waters in the vicinity of the pits of North Lantau. The details of the EM&A programme for assessing hazard to health of humans and marine mammals are presented below.

(1) ERM (1997) Fisheries Resources and Fishing Operations in Hong Kong Waters. Draft Final Report prepared AFD.

7.2 *OBJECTIVE*

The objective of the risk assessment component of the monitoring programme is to determine whether disposal operations at the active pits are posing an unacceptable risk to humans and dolphins through consumption of seafood / marine prey species from the North Lantau area. This objective should be addressed through a standardized risk assessment methodology which cost effectively builds on existing risk assessment methodologies and databases and overcomes some of the previous studies' limitations.

7.3 *HYPOTHESIS*

Given the above discussion of objectives, the impact hypotheses for this component of the monitoring programme are defined as follows:

For Human Health:

IH_1: *Risks to human health from consumption of commercial species captured adjacent to the active pits are no greater than risks associated with consumption of species remote from the active pits;*

AND

IH_2: *Risks to human health from consumption of commercial species captured adjacent to the active pits are below the screening risk criterion (see Section 7.5).*

For Dolphins:

IH_1: *Risks to dolphins from consumption of prey species captured adjacent to the active pits are no greater than risks associated with consumption of prey species remote from the active pits;*

AND

IH_2: *Risks to dolphins from consumption of prey species captured adjacent to the active pits are below the screening risk criterion (see Section 7.5).*

7.4 *SAMPLING DESIGN*

Data required for the risk assessment should consist of:

- contaminant concentrations in commercial / prey species collected from stations adjacent to and remote from the active pits;
- toxicology data for humans and dolphins;
- gastro-intestinal tract absorption factors;
- literature-derived human consumption rates and patterns for seafood;
- literature-derived data on exposure of humans from other food groups;

- literature-derived data on contaminant levels in marine mammals;
- data collected by the Swire Institute of Marine Science (SWIMS) and AFCD on contaminant levels in stranded *Sousa chinensis* carcasses; and,
- existing natural history information for the Indo-Pacific Humpback Dolphin and related species (eg diet composition and feeding range).

The primary data input to the risk assessment should derive from the bi-annual trawl (ie tissue collection) monitoring events. The risk assessment shall be performed on an annual basis.

7.5 USE OF DATA

The risk assessment shall follow the guidelines of the US Environmental Protection Agency [1] [2] and shall incorporate a four-step approach involving problem formulation, estimation of exposure, characterization of ecological or human health effects (injury), and risk characterization. Each of these steps is described below with reference to how each applies to both human health and ecological risk assessment.

Problem Formulation: Also known as hazard definition [3], the problem formulation will describe the sensitive populations (eg the general Hong Kong population, subsistence fishermen, the Indo-Pacific Humpback Dolphin) and identify biological effects of concern potentially associated with the CMP operations at the active facility. Identification of these effects should include a discussion of contaminants of concern, measurement endpoints and a conceptual model embodying the mechanisms of contaminant migration.

Estimation of Exposure: The purpose of the exposure estimation is to determine the intake of each contaminant of concern by potentially exposed individuals. This step shall consider the various routes of contaminant release and their migration from the site to sensitive receivers. Factors such as fate and transport processes, the concentrations in the ambient environment, and the maximum short-term or average lifetime doses should be assessed.

For human populations exposure factors presented in previous reports [1] [2] shall be critically evaluated to determine if further modification is necessary. These factors, which include amounts of seafood consumed, origin of seafood products, and methods of preparation (eg raw versus cooked, whole body vs

(1) U.S. Environmental Protection Agency. 1992. Framework for Ecological Risk Assessment. EPA/630/R-92/001. Risk Assessment Forum, U.S. EPA, Washington, DC.

(2) U.S. Environmental Protection Agency. 1996. Ecological Risk Assessment Guidance for Superfund: Process for Designing and Conducting Ecological Risk Assessments (Draft). U.S. EPA.

(3) Suter, G W II. (1993). Ecological Risk Assessment. Lewis Press, Boca Raton, FL, 538 pp.

(4) Shaw, B (1995) Evaluation of risks to human health in Hong Kong from consumption of chemically contaminated seafood: A risk assessment approach, MSc thesis, Environmental Management Programme, University of Hong Kong.

(5) EVS (1996) Contaminated Mud Disposal at East Sha Chau: Comparative Integrated Risk Assessment. Prepared for CED.

tissue only) shall be evaluated for the general population and any sensitive subpopulations (eg subsistence fishermen fishing in the East of Sha Chau area).

Characterization of Effects: The effects assessment is designed to quantify the relationship between the degree of exposure to a substance and the extent of toxic injury or disease. This step in the assessment shall use data derived from dose response studies on laboratory animals or, less frequently, on exposed human populations and clinical trials. For non-carcinogenic substances, once the relationship between doses and responses is established, a threshold which represents the highest contaminant concentration that is not expected to result in an adverse effect, ie the reference dose (RfD) or a No Observed Adverse Effect Level (NOAEL) can be established. This threshold shall then compare to the dose derived from the exposure assessment above to produce the risk characterization.

For humans, dose-response relationships must be considered separately for carcinogens and non-carcinogens. When dealing with carcinogens, a cancer potency factor (CPF) or Slope Factor (SF) for each contaminant of concern shall be used. For non-carcinogens, the NOAEL or LOAEL (lowest observed adverse effect level) shall be used as the threshold value. Data on CPFs, and NOAEL/LOAEL values are available through the U.S. EPA's IRIS (Integrated Risk Information System) and HEAST (Health Effects Assessment Summary Tables) databases. The relationship between contaminant concentrations in toothed cetacean tissues and the concentrations in their prey items will be assessed in this programme.

Risk Characterization: The risk characterization shall integrate the results of the exposure and effects assessments to estimate the risks and consequences of contaminant exposures. In this step, the estimated exposure should be divided by the threshold value to obtain a Hazard Quotient (HQ). Generally HQ values below 1 are considered to represent a very low risk of adverse effects, whereas HQ values above 10 indicate a moderate to high level of risk.

For human populations, the general approach to evaluating HQs can be applied to this Project. However, the human health risk characterization produced for this Project should be updated through the use of continually collected tissue and other environmental monitoring data to reflect current conditions. This Study's human health risk assessment will improve the robustness of previous studies through a careful reconsideration of all exposure and effects parameters, with particular focus on background doses and seafood consumption patterns.

8 BENTHIC RECOLONISATION

8.1 BACKGROUND

The EIA conducted for this Project has indicated that benthic fauna are expected to recolonise the pits following capping with uncontaminated mud. It is expected that recolonisation of the natural benthic assemblage will occur and eventually the benthic assemblage will resemble that of the surrounding areas. Recolonisation may be achieved by larval recruitment, influx of juveniles or adults carried in water currents, or through the active swimming or crawling of individuals. However, other natural (eg storm events, hypoxia, salinity fluctuations) or anthropogenic (eg pollution, dredging activities and fisheries operations) activities may hinder recolonisation of capped pits. As a result, the factors contributing to the composition of the benthic assemblage may be difficult to determine. It is also important for any recolonisation studies to be aware of any cap maintenance (or "topping up") activities which may also impact the resident benthic assemblages.

In order to verify the recolonisation of marine biota on the capped pits, a benthic recolonisation programme is recommended. The full details of the EM&A programme for benthic recolonisation are presented in the following sections.

8.2 OBJECTIVE

The objective for this component of the Study is to monitor and report on the benthic recolonisation of the capped pits including the previous ones and specifically to determine the difference in infauna between the capped pits and adjacent sites.

8.3 HYPOTHESIS

The impact hypothesis for this task is as follows:

Recolonisation is occurring at the capped pits such that assemblages at the capped pits become more similar to reference assemblages as time since capping increases.

The null hypothesis to be tested for this work component is as follows:

H_0 There is no difference in the structure of benthic infaunal assemblages found at the capped pits at the active facility and adjacent reference areas.

8.4 SAMPLING DESIGN

The sampling design of this task involves two treatments: capped pits and reference areas (*Figures 8.4a* and *8.4b*). The capped pit treatment shall involve collection of samples from the capped mud pits at the active facility. The pits are anticipated to be capped at different times. The number of samples to be collected at each station, the number of impact stations and their locations should be confirmed prior to the commencement of capping activities and agreed with EPD based on the detailed design of the disposal facility.

The second treatment shall involve sampling at different reference sites where the number of sample stations and the exact position of the sampling sites should be determined prior to the commencement of the capping activities and agreed with EPD based on the detailed design of the disposal facility. The reference sites should be chosen to improve the balanced nature of the design (ie the number of reference sites should be the same as the impact sites). Using multiple controls is an effective way of ensuring that the extremely variable nature of Hong Kong's marine benthos from one site to another does not overly influence or alter the results. Current ecological theory suggests that the use of multiple control sites in sampling designs are statistically more robust and hence the conclusions more reliable [(1) (2)].

One grab sample shall be taken at each of the different stations clustered within each site. The analysis (Cumulative Running Mean Test to determine optimum sample size for stabilising mean and standard error values) revealed that 12 samples would be the optimum number. The technique of clustering stations within one site has been proven to be an effective way of testing hypotheses and removing the confounding effects of spatial variation from the interpretation. The number of samples to be collected at each site and the exact locations of the sampling stations should be determined prior to the commencement of capping activities based on the detailed design of the disposal facility.

8.5 STATISTICAL TREATMENT OF DATA

The data collected during the monitoring programme shall be analysed using two different but complementary approaches as detailed below.

8.5.1 Univariate Analyses

ANOVA & MANOVA: Simple, univariate measures shall be tested using an Analysis of Variance (ANOVA), and multivariate measures of community structure shall be tested using the Multiple Analysis of Variance (MANOVA). Both ANOVA and MANOVA test the same null hypothesis using similar methods. The method is essentially a comparison of the variability within a site to the variability between sites. If the ratio of these two variances (that is,

(1) RJ Schmitt & CW Osenberg(1996) Detecting Ecological Impacts: concepts and applications in coastal habitats. Academic Press.

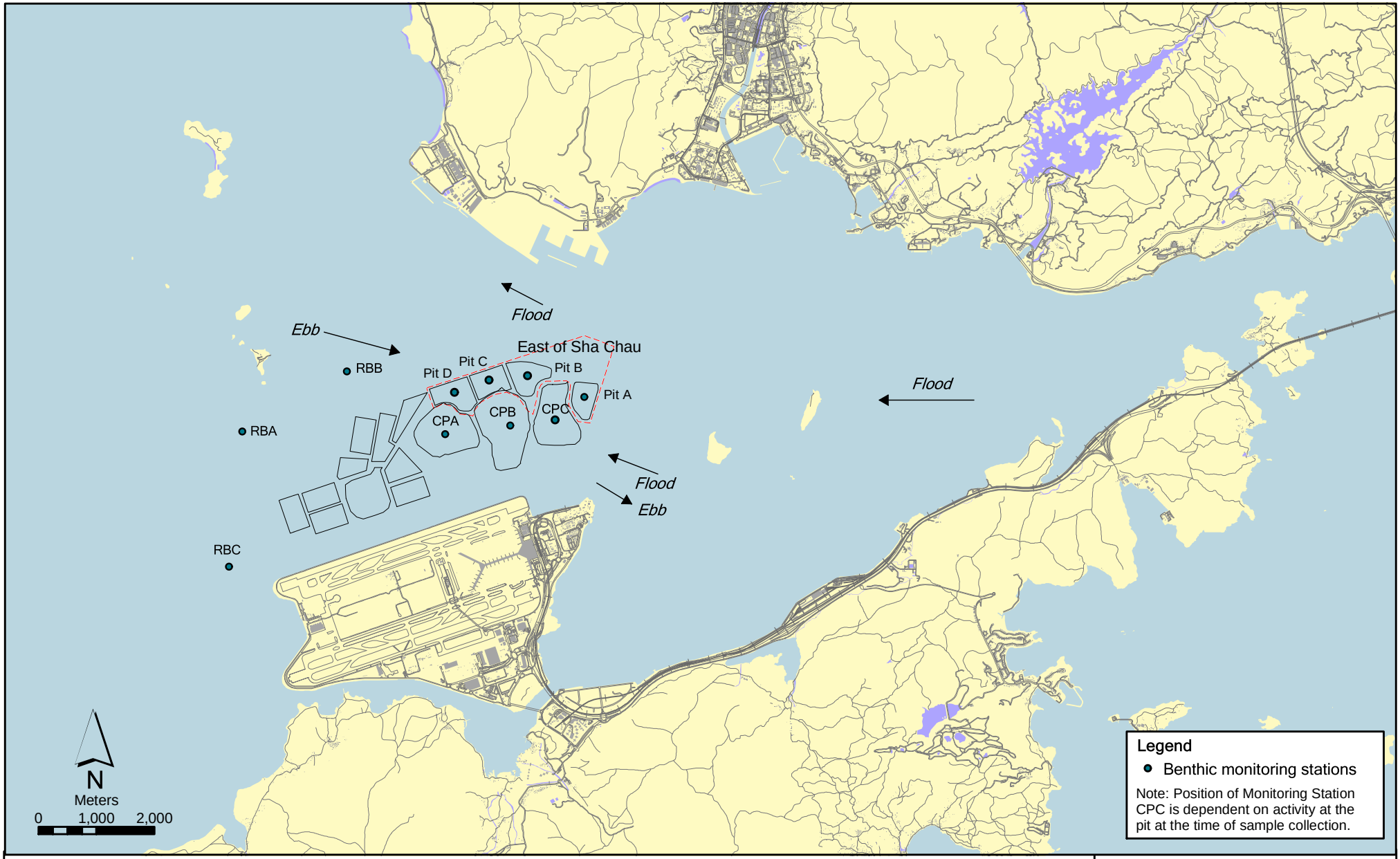

Figure 8.4a

BENTHIC MONITORING STATIONS
WHEN EAST OF SHA CHAU FACILITY IS ACTIVE

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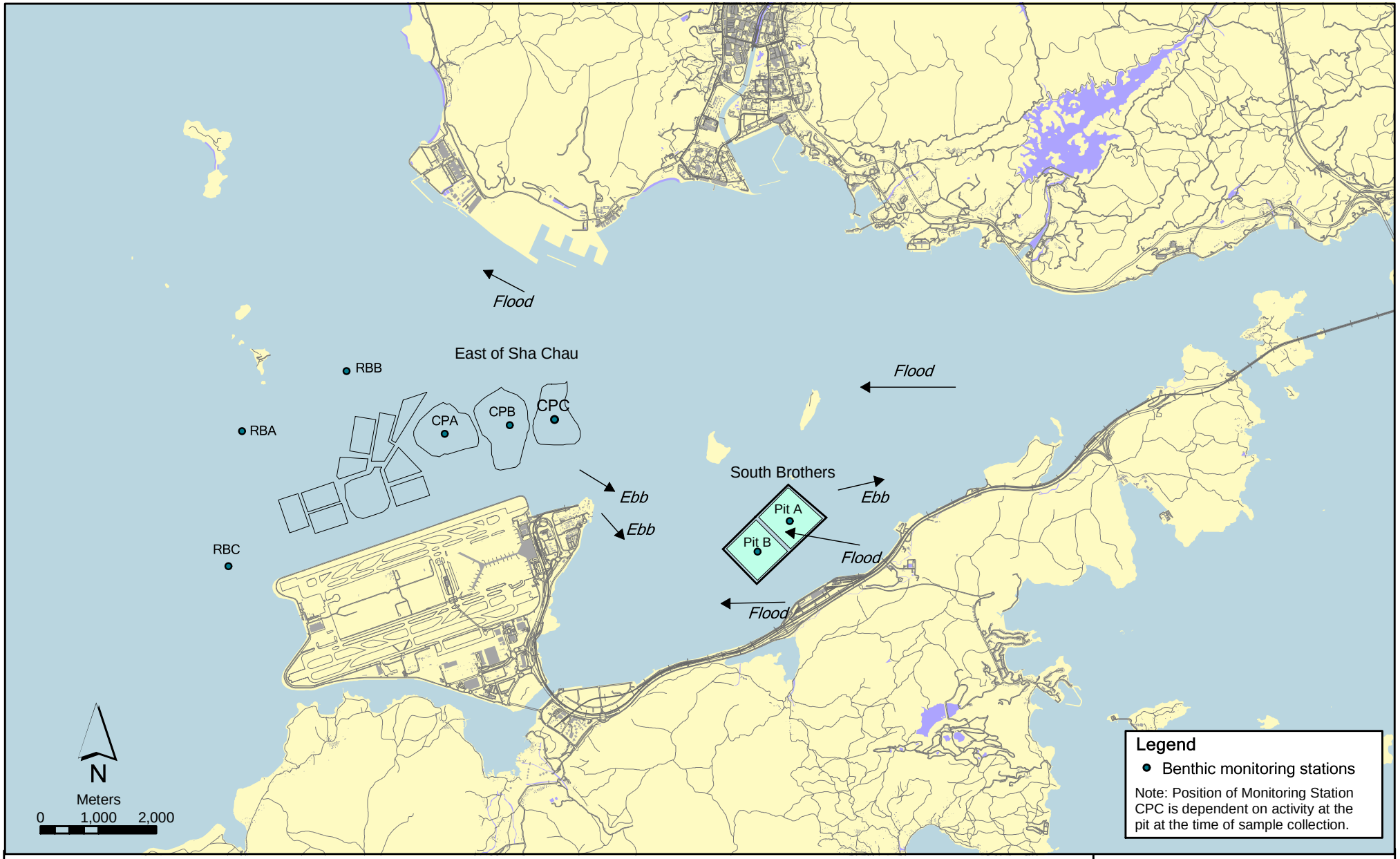

Figure 8.4b

BENTHIC MONITORING STATIONS
WHEN SOUTH BROTHERS FACILITY IS ACTIVE

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Date: 02/02/2005

Environmental Resources Management

ERM

the between-group-variance over the within-group-variance) is large enough, then any differences observed are due to true differences that exist between the groups and not just to random variation. ANOVA and MANOVA tests are based on several assumptions related to the underlying distribution of the data being analysed (ie normality, homogeneity of variances). If the data deviate significantly from these assumptions, then these tests are considered to be inappropriate. If this situation arises, alternative procedures (ie parametric tests with rank transformed data or nonparametric analogues such as Kruskal Wallis) which address similar hypotheses but do not require such stringent assumptions shall be adopted. Observed differences between the sites and / or areas shall be tested using multiple comparison procedures such as the Student Newman Keuls (SNK) or Tukey test.

8.5.2 Multivariate Analyses

Multi Dimensional Scaling (MDS): Multi dimensional scaling (MDS) shall also be used to depict the similarities between stations based on their benthic assemblages. MDS is a method for creating a low dimensional picture of the relationships between stations in a complex, multi dimensional problem. The Bray-Curtis distance metric shall be used for both the clustering techniques and the MDS. The dendrogram from the cluster analysis, and the MDS ordination plot will provide complementary views of the same similarity information. The data for MDS and cluster analyses should be standardised prior to analysis, to ensure that bias resulting from including data in different forms (eg percent data for silt clay composition, numerical data for abundances and biomass data in mg) does not occur.

8.6 USE OF DATA

The detailed statistical analyses described above shall be used to comprehensively explore the benthic assemblage patterns in the area of the active pits. This exploration should lead to conclusions regarding the effectiveness of the cap material in promoting post-dredging benthic assemblages. This information can be used to reassess the choice of capping materials or revise the procedures for placing the caps at the active facility.

8.7 DATA COLLECTION PARAMETERS

The benthic sediment samples collected during this task will be analysed for the following parameters:

- Percentage of silt / clay in the sediments;
- Faunal Abundance;
- Faunal Biomass;
- Species Composition; and,
- Trophic Structure.

(1) AJ Underwood (1997) *op cit.*

8.8 SAMPLING PROCEDURE AND EQUIPMENT

The sampling team and vessel will be deployed and accurate positioning attained as described in *Section 4*. The vessel will be equipped with adequate fixed sieve stations to facilitate rapid processing of samples and ensure the maximum number of samples are collected in each survey. At each of the designated benthic sampling stations, seafloor sampling will be carried out with a modified Van Veen grab sampler (dimensions 30 cm H 30 cm H 30 cm) or similar instrument approved by EPD / AFCD. One subsample of approximately 1 kg sediment shall be collected from each sample for analysis of particle size. The remaining sediment from each sample shall be used for sorting. Samples will be labelled and sieved through a 1 mm and 0.5 mm sieve and all residues and organisms retained, double-bagged and preserved in 4% buffered formalin in seawater. A vital stain (eg Rose bengal) will be added to distinguish organic materials and organisms from other non-living residues. The grab and utensils will be washed thoroughly with seawater after each deployment to avoid cross-contamination between samples. On completion of the survey all samples will be transferred to the laboratory for sorting and identification. All sediment sieving will be conducted by qualified marine scientists who will oversee and coordinate all field operations.

8.9 LABORATORY PROCEDURES

Upon arrival at the laboratory, all benthic samples should be re-inventoried and checked against chain-of-custody forms. Sample rescreening should be performed after the samples have been held in formalin for a minimum of 24 hours to ensure adequate fixation of the organisms. Individual samples from the 500 µm and 1 mm^2 mesh sieves will be gently rinsed with fresh water into a 250 µm sieve to remove the formalin from the sediments. Sieves will be partially filled while rinsing a specific sample to maximize washing efficiency and prevent loss of material. All material retained on the 250µm sieve is placed in small fractions into a labelled petri dish and preserved with 70% ethanol. The material is lightly agitated to ensure complete mixing of the alcohol with the sediments. The sediment is then sorted to remove all animals and fragments. Original labels will remain with the rescreened sample material.

Standard and accepted techniques shall be used for sorting organisms from the sediments (1). Small fractions of a sample will be placed in a petri dish under a 10-power magnification dissecting microscope. The petri dish will be scanned systematically and all animals and fragments removed using forceps. Each petri dish will be sorted at least twice to ensure removal of all animals. Organisms representing major taxonomic groups including Polychaeta, Arthropoda, Mollusca, and miscellaneous taxa will be sorted into

(1) Holme, N. A. and A. D. McIntyre (eds) (1984) Methods for the study of marine benthos. Blackwell Scientific Publications, Oxford (UK).

separate, labelled vials containing 70 percent ethanol. All sorted samples will be systematically checked to ensure compliance with QA / QC program requirements before proceeding to the taxonomic identification, enumeration, and biomass determination phases of the analysis.

Taxonomic identifications will be performed by regional taxonomic experts using stereo dissecting and high-power compound microscopes, to the family level except for dominants, which will be identified, where possible, to species. The careful sampling procedure employed in the Study will minimise fragmentation of organisms, however should breakage of soft-bodied organisms occur, only anterior portions of organism fragments will be counted. All fragments will be retained and weighed during biomass determinations, described below. Rare or questionable taxa will be compared against reference collection specimens for confirmation and consistency of identification. The nomenclature used in all reference collections referred to in this study should be cross checked and differences or discrepancies should be noted. Biomass determinations will be made by taking the blotted wet mass of each taxonomic fraction.

8.10 BENTHIC MACRO-INFAUNA AND TAXONOMIC IDENTIFICATION

Sorting QA / QC will be performed using 25-power magnification by someone other than the original sorter. Twenty percent of each sorted sample should be resorted to ensure 95 percent sorting efficiency. A sample passes QA / QC if the number of organisms found during the QA / QC check does not represent more than 5 percent of the total number of organisms found in the entire sample. If the number of organisms found is greater than 5 percent of the total number, the entire sample will be resorted. Any samples where the identification of taxa is questionable will be sent out for independent reidentification by a qualified regional expert. Reference collections developed during previous seabed and benthic studies in Hong Kong should be consulted as necessary.

9 IMPACTS OF MAJOR STORMS

9.1 BACKGROUND

Based on the previous experience with the development and approval for CMP IV at East of Sha Chau for use as a confined disposal facility for contaminated mud, monitoring of the dispersion of uncapped sediments during major storm events, such as typhoons of signal 8 or higher, is considered as an important objective of the study. It is therefore considered necessary to include this post-storm monitoring as part of the EM&A programme for the mud disposal facility.

9.2 SAMPLING DESIGN

The main design objective of the post-storm monitoring programme is to determine whether there are any detectable changes in sediment quality in the active pit area after a major storm. The post-storm monitoring programme will be mobilized within one week of a major storm event (ie a minimum Typhoon Signal of No 8) and will consist of regional sediment sampling as described in *Section 4*. However, in order to be cost-effective, only the inorganic contaminants will be analysed. Should any sediments have eroded from the pits during a storm then the inorganic "fingerprint" will be detected. This therefore, removes the need for extra testing of the organic contaminants. As it is unlikely that water column effects associated with any dispersion of sediments from the pit during the storm could be observed, water column monitoring is not proposed. Similarly, trawl sampling and tissue collection is not proposed due to the length of time required for community structure or body burden effects to manifest themselves after the storm event.

The regional sediment sampling programme (*Section 4.7.2*) has several key features which are particularly applicable to addressing concerns associated with major storms. The regional programme contains stations on previously capped pits for the purpose of attributing whether any identified contaminants are emanating from the previously capped pits. As the regional programme will be routinely conducted twice in the wet and dry seasons, pre-storm (ie pre-impact) data is likely to be available for all of the sampling stations. This will allow a statistical comparison of pre- and post-storm datasets for the contaminants of concern using statistical methods described in *Section 4.5* and an assessment of the effects of the storm on ambient sediment quality. In addition, through analysis of pre-storm near field sediment datasets, it may prove possible to derive a "fingerprint" or profile of sediment contamination originating from the active pits. If so, using information on the magnitude and direction of the storm, examination on whether patterns of sediment contamination after the storm can be attributed to the active pits should be conducted.

The field, laboratory and QA / QC procedures for sediment sample collection after major storm events will be identical to those used for the Regional Monitoring of Sediment Quality (*Section 4*).

10 REPORTING

10.1 GENERAL

Reports shall be provided in both hard copy and electronic version upon agreeing the format with EPD. This would enable a transition from a paper / historic and reactive approach to an electronic / real time proactive approach. All the monitoring data should also be submitted on diskettes.

10.2 REPORTS

The following documents shall be submitted to CEDD for the EM&A:

- Inception Report:
- Environmental Monitoring and Audit Manual;
- Operations Manual;
- Reports on Dredging and Capping Operations;
- Monthly Progress Reports;
- Quarterly EM&A Reports;
- Annual Review Report;
- Annual Risk Assessment Report;
- Draft Final Report;
- Executive Summary Report; and
- Final Report.

Monthly Progress Reports will be required for the duration of the programme period and shall be submitted to CEDD by the 10th of each month. Each report shall contain:

- A list of the activities, tests, analyses and assessments performed in the month according to that detailed in the Monitoring and Audit Manual for the purpose of reporting any significant findings resulting from monitoring and audit activities;
- a list of outstanding activities, tests, analyses and assessments as well as the schedule for completing these outstanding items; and,
- a list of previously outstanding activities, tests, analyses and assessments that are completed in the month.

Quarterly EM&A Reports will be required for the duration of the programme period and shall be submitted within 60 days from the end of every quarterly monitoring period. Each report shall:

- confirm that all activities, tests, analyses, assessments etc. have been carried out as stated in this EM&A Manual;
- report on the auditor's findings on the field events and laboratory tests and analysis;
- report on any trends resulting from disposal, dredging and capping activities at the active facility.

An Annual Review Report shall be submitted within 30 days from availability of the test results for every yearly monitoring period. Each report shall:

- make a clear statement on the acceptability of environmental impacts by reference to the impact hypotheses;
- state how successful the monitoring programme has been in addressing the objectives of the Assignment;
- make recommendations for revisions to the monitoring programme and disposal operation, as necessary, to ensure that the objectives are fully met in a cost effective manner; and
- summarise the monitoring results to illustrate whether any change or trend resulting from the disposal, dredging and capping activities is detected or not.

A **Risk Assessment Report** shall be prepared within 30 days from availability of the test results for every yearly monitoring period. Each report shall address the risk to the human health and dolphin of eating seafood taken in the marine area around North Lantau area due to disposal of contaminated marine sediments in the active pits.

A **Draft Final Report** shall be prepared within 14 days of receipt of the final results of the EM&A programme. It shall address how each objective of the assignment has been met and should will included a final version of the EM&A Manual as an appendix.

A **Final Report** shall be prepared within 21 days of receipt of comments on the Draft Final Report.

An English and Chinese **Executive Summary Report** shall be prepared within 21 days of receipt of comments on the Draft Final Report. It should highlight any issues of concern and the acceptability of the dredging, backfilling and capping operations at the active pits.

Annex A

Implementation Schedule

1 IMPLEMENTATION SCHEDULE

This *Annex* provides a consolidation of the mitigation measures recommended for the Project. The Implementation Schedule has the following column headings:

EIA Ref

This denotes the section number or reference from the EIA Report Main text.

EM&A Log Ref

This denotes the sequential number of each of the recommended mitigation measures specified in the Implementation Schedule.

Environmental Protection Measures

This denotes the recommended mitigation measures, courses of action or subsequent deliverables that are to be adopted, undertaken or delivered to avoid, minimise or ameliorate predicted environmental impacts.

Objectives

This denotes the objectives of the recommended mitigation measures and main concerns to address.

Location/Duration of Measures/Timing of Completion of Measures

This indicates the spatial area in which the recommended mitigation measures are to be implemented together with details of the programming or timing of their implementation.

Implementation Agent

This denotes where the responsibility lies for the implementation of the recommended mitigation measures.

Implementation Stage

This denotes the stage at which the recommended mitigation measures are to be implemented either during the Design, Construction, Operation or Decommissioning.

Relevant Legislation

This section defines the controlling legislation that is required to be compiled with.

IMPLEMENTATION SCHEDULE

EIA* Ref.	EM&A Log Ref	Environmental Protection Measures	Objectives	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage**				Relevant Legislation & Guidelines
						Des	C	O	Dec	
		WATER QUALITY								
Section 2.4 of Part 3	1	Although there is no requirement for constraints on timing or sequencing apparent from the assessment, as all scenarios have been demonstrated to be acceptable with the required mitigation measures in place. The following operational constraints shall be implemented to ensure no unacceptable water quality impacts.								
Section 2.4 of Part 3		• Dredging operations within the East of Sha Chau Facility do not exceed 100,000 m^3 $week^{-1}$.	To avoid unacceptable water quality impacts during dredging	At the East of Sha Chau work site, throughout the whole duration of the construction period	Contractor		✓			*Water Pollution Control Ordinance*
Section 2.4 of Part 3		• Backfilling operations within the East of Sha Chau Facility do not exceed a disposal rate of 26,700 m^3 day^{-1}.	To avoid unacceptable water quality impacts during backfilling	At the East of Sha Chau work site, throughout the whole duration of backfilling	Contractor			✓		*Water Pollution Control Ordinance*
Section 2.4 of Part 3		• Capping operations within the East of Sha Chau Facility do not exceed a disposal rate of 26,700 m^3 day^{-1}.	To avoid unacceptable water quality impacts during capping	At the East of Sha Chau Facility work site, throughout the whole duration of capping	Contractor			✓		*Water Pollution Control Ordinance*
Section 2.4 of Part 3		• No overflow is permitted from the trailer suction hopper dredger but the Lean Mixture Overboard (LMOB) system will be in operation at the beginning and end of the dredging cycle when the drag head is being lowered and raised.	To avoid unacceptable water quality impacts during dredging	At the East of Sha Chau work site, throughout the whole duration of the construction period	Contractor		✓			*Water Pollution Control Ordinance*

EIA* Ref.	EM&A Log Ref	Environmental Protection Measures	Objectives	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage**				Relevant Legislation & Guidelines
Section 2.4 of Part 3		• Dredged marine mud shall be disposed of in a gazetted marine disposal area in accordance with the *Dumping at Sea Ordinance* (*DASO)* permit conditions.	To avoid unacceptable water quality impacts during dredging	At the East of Sha Chau work site, throughout the whole duration of the construction period	Contractor		✓			*Water Pollution Control Ordinance*
Section 2.4 of Part 3	2	The following good practice measures shall apply at all times: • All disposal vessels should be fitted with tight bottom seals in order to prevent leakage of material during transport.	To prevent leakage of material during transport	At the East of Sha Chau work site, throughout the whole duration of the disposal period	Contractor			✓		*Water Pollution Control Ordinance*
Section 2.4 of Part 3		• All barges 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.	To ensure that material does not spill over during transport and the decks are not washed by wave action	At the East of Sha Chau work site, throughout the whole duration of the construction and operation period	Contractor		✓	✓		*Water Pollution Control Ordinance*
Section 2.4 of Part 3		• After dredging, any excess materials should be cleaned from decks and exposed fittings before the vessel is moved from the dredging area.	To avoid potential adverse water quality impacts associated with dredging	At the East of Sha Chau dredging sites, throughout the dredging period	Contractor		✓			*Water Pollution Control Ordinance*
Section 2.4 of Part 3		• 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 dredging site.	To avoid potential adverse water quality impacts associated with dredging	At the East of Sha Chau dredging sites, throughout the dredging period	Contractor		✓			*Water Pollution Control Ordinance*
Section 2.4 of Part 3		• If installed, degassing systems should be used to avoid irregular cavitation within the pump.	To avoid adverse water quality impacts due to irregular cavitation within the pump	At the East of Sha Chau work site, throughout the whole duration of the construction and operation period	Contractor		✓			*Water Pollution Control Ordinance*

EIA* Ref.	EM&A Log Ref	Environmental Protection Measures	Objectives	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage**				Relevant Legislation & Guidelines
Section 2.4 of Part 3		• Monitoring and automation systems should be used to improve the crew's information regarding the various dredging parameters to improve dredging accuracy and efficiency.	To improve dredging accuracy and efficiency	At the East of Sha Chau dredging site, throughout the dredging period	Contractor		✓			*Water Pollution Control Ordinance*
Section 2.4 of Part 3		• Control and monitoring systems should be used to alert the crew to leaks or any other potential risks.	To alert the crew to leaks or any other potential risks	At the East of Sha Chau work site, throughout the whole duration of the construction and operation period	Contractor		✓	✓		*Water Pollution Control Ordinance*
Section 2.4 of Part 3		• When the dredged material has been unloaded at the disposal areas, any material that has accumulated on the deck or other exposed parts of the vessel should be removed and placed in the hold or a hopper. Under no circumstances should decks be washed clean in a way that permits material to be released overboard.	To prevent release of dredged materials overboard	At the East of Sha Chau dredging sites, throughout the dredging period	Contractor		✓			*Water Pollution Control Ordinance*
Section 2.4 of Part 3		• All dredgers should maintain adequate clearance between vessels and the seabed at all states of the tide and reduce operations speed to ensure that excessive turbidity is not generated by turbulence from vessel movement or propeller wash.	To ensure that under-vessel turbidity is not generated by turbulence from vessel movement or propeller wash	At the East of Sha Chau dredging sites, throughout the dredging period	Contractor		✓			*Water Pollution Control Ordinance*
Section 3 of Part 4	3	Water quality monitoring will be required for the following activities at the East of Sha Chau Facility: • Dredging of each pit; • Backfilling of each pit with contaminated mud; and • Capping of each pit with uncontaminated Mud.	To avoid impacts to water quality during dredging, backfilling and capping	At the East of Sha Chau work sites, throughout the dredging, backfilling and capping period	Contractor		✓			*Water Pollution Control Ordinance*

EIA* Ref.	EM&A Log Ref	Environmental Protection Measures	Objectives	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage**				Relevant Legislation & Guidelines
Section 3 of Part 4	4	Sediment quality monitoring will be required for the backfilling activities at the East of Sha Chau Facility.	To avoid impacts to water quality during backfilling	At the East of Sha Chau work sites, throughout the backfilling period	Contractor		✓			*Water Pollution Control Ordinance*
		MARINE ECOLOGY								
Section 3 of Part 3	5	In accordance with the guidelines in the *EIAO-TM*, the general policy for mitigating impacts to marine ecological resources shall be applied in order of the following priority: • **Avoidance:** Potential impacts should be avoided to the maximum extent practicable by adopting suitable alternatives; • **Minimisation:** Unavoidable impacts should be minimised by taking appropriate and practicable measures such as constraints on the intensity of works operations (eg dredging rates) or timing of works operations; and • **Compensation:** The loss of important species and habitats may be provided for elsewhere as compensation. Enhancement and other conservation measures should always be considered whenever possible.	To avoid potential impacts to marine ecology	During project planning and design	Design Team	✓				*EIAO-TM*
Section 3 of Part 4	6	Sediment toxicity monitoring will be conducted to assess the potential toxicity impacts to marine life due to disposal activities.	To avoid impacts to marine life due to disposal activities	At the East of Sha Chau Facility, throughout the backfilling period	Contractor			✓		

EIA* Ref.	EM&A Log Ref	Environmental Protection Measures	Objectives	Location/Duration of Measures/Timing of Completion of Measures	Implementation Agent	Implementation Stage**				Relevant Legislation & Guidelines
	7	Benthic recolonisation monitoring will be required to assess the recolonisation status of benthic fauna on capped pits.	To assess the recolonisation status of benthic fauna on capped pits	At the East of Sha Chau Facility, after capping of mud pits	Contractor			✓		
		HAZARD TO HEALTH								
Section 3 of Part 4	8	A risk assessment to verify that no unacceptable risk are occurring to either human health or marine mammals as a result of consuming prey species from the waters in the vicinity of the pits will be required.	To assess hazard to health of humans and marine mammals	In the vicinity of the East of Sha Chau Facility, throughout the disposal period	Contractor			✓		
		CULTURAL HERITAGE								
Section 7 of Part 2	9	A watching brief by a qualified archaeologist to be conducted during dredging in the areas of identified anomalies in the South Brothers pit B, in the event that the South Brothers Pits are needed.	To establish the archaeological potential of the anomalies.	At the South Brothers Facility if it is to be used, during the construction works	Contractor	✓				*AMO Marine Archaeological Investigation Guidelines*

Annex B

Complaints Proforma

COMPLAINTS PROFORMA

REPORT FORM FOR COMPLAINTS `	SHEET ____ OF ____ UNIT REFERENCE _____

RECIPIENT

NAME: LOCATION: TEL.:

COMPLAINANT

NAME: TEL.: FAX:

ADDRESS:

COMPLAINT

TYPE: Water Quality/Other

DATE: TIME: Location:

DESCRIPTION:

COPY FAX TO: DATE:	ORIGINAL TO: DATE:

REVIEW RESULTS

SIGNED: DATE:

RECOMMENDATIONS

SIGNED: DATE:

ATTACHMENTS

COPY TO: DATE/TIME:

CED: DATE: TIME:

INDEPENDENT ENVIRONMENTAL CHECKER DATE: TIME.:

Annex C

Method Statement for Public Fill Capping at East of Sha Chau

Proposal to Use Excavated Soil among Public Fill in Capping Layer of Contaminated Mud Pits at East Sha Chau (ESC)

Method Statement

The methodology of implementing the capping works through using excavated soil among public fill is summarised in paragraphs below:

At Public Fill Reception Facilities (e.g. Barging Point)

1. All incoming trucks would be visually inspected by site supervisory staff of the Civil Engineering and Development Department (CEDD) at the reception point of the public fill reception facilities. Visual inspection will be conducted by a staff who is positioned high enough to overlook truckloads. Truckloads with unsuitable materials will not be diverted to ESC. Among the public fill[1], only the excavated soil with size below 200 mm and have no abnormal colour or odour which signifies contamination could be used for forming the inner capping layer at ESC Pit IV.

2. CEDD will conduct spot checks on those truck loads considered to be visually suitable for capping, aided by a grab, to the inner portion for ensuring the homogeneity of the materials. Grab inspection to reveal underlying materials will be conducted 1 day in a week and on about 20% of the truckloads for that day

3. For incoming materials generated from identifiable projects, CEDD will implement a trip-ticket system, involving issue of Delivery Form at sources and receiving of the Form at the public fill reception facilities. CEDD will ensure the Delivery Forms will be vetted on entry of the truck concerned and cross-compared with a list of Acceptable Work Sites (see para. for the list). Truckloads from work sites not on the list will be considered not acceptable for ESC capping. If these materials satisfy the requirements as mentioned in paragraphs 1 and 23, they can be used for capping at ESC Pit IVa, Pit IVb and Pit IVc. The list of Acceptable Work Sites will be updated and provided by CEDD

[1] Public fill – The main constituents include soil, broken rock, building debris, concrete etc. which are generated from construction and demolition activities of the construction industry. Public fill shall be uncontaminated materials and free from household refuse, plastic, metal, industrial and chemical waste, animal and vegetable matter.

Notes: The paragraphs in "italic" together with Appendix B can be adapted to form the method statement under the permit to be issued under DASO.

from time to time.

4. For those materials generated from non-identifiable projects, the truck vehicle number, arrival time, type of material and district of the source, will be recorded in a computer database at the public fill reception facilities. If these materials satisfy the requirement as mentioned in paragraphs 1 and 22, they can be used for capping at ESC Pit IVb and Pit IVc only.

5. No materials shall be coming from the "Decommissioning Projects" under the EIAO. A letter or memo would be sent to the concerned project offices and private clients to remind them not to deliver these materials to the public fill reception facilities.

6. CEDD has installed CCTV surveillance system at each of the public fill reception facilities for recording all the image of every incoming truck and the materials contained in its hopper. CCTV cameras are positioned at positions to view and visually record truckloads, truck license plates, unloading from trucks of materials to ESC vessel. CEDD will deploy at all time a staff to supervise the unloading activity at the tipping hall to ensure only those trucks loads defined as suitable material for capping after visual screen would be unloaded into the right barge for transportation to ESC.

7. For the truckloads diverted to ESC, CEDD will ensure records be kept about truck licence plates, time-in to and time-out from facilities and sources of material (for identifiable projects) or district of material generation (for non-identifiable projects).

Transportation of Suitable Material to ESC

8. Material that passes process in para 1,2, 3 and 6 and confirmed to be from acceptable work sites would be directed by CEDD to be off-loaded from trucks onto the derrick lighter destined to ESC Pit IVa, Pit IVb or Pit IVc. Materials that passes process in para 1,2, 3 and 6 and confirmed to be from non-identifiable source would be directed by CEDD to be off-loaded from trucks onto the derrick lighter destined to ESC at Pit IVb and Pit IVc separately. At present, the Kai Tak

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Barging Point (KTBP) is receiving public fill only from identifiable sources. The excavated soil received at KTBP, subject to the aforesaid relevant processes, would be disposed of at Pit IVa, Pit IVb and Pit IVc. The other public fill reception facilities are receiving public fill from identifiable and non-identifiable sources, their received excavated soil suitable for capping would, subject to the aforesaid relevant processes, be disposed of at Pit IVb and Pit IVc only. If these public fill reception facility can be provided with two tipping halls for unloading of materials onto barges, suitable material from identifiable sources would be disposed of at Pit IVa and non-identifiable source would be disposed of at Pit IVb and Pit IVc separately.

9. The material considered to be not suitable for capping at ESC would be loaded into another barge or stockpiled on land, for subsequent transportation to Fill Banks.

10. *Only derrick lighters equipped with Automatic Self Monitoring System would be used to receive excavated soil from trucks for capping.* As the bottom of derrick lighters cannot be opened for dumping, illegal dumping or leakage of materials during the transportation of the material to ESC would unlikely happen.

At ESC

11. *All derrick lighters shall report to the management team of ESC contaminated mud pits upon arrival at ESC and conduct works at ESC in accordance with the Site Management Scheme for Capping to ESC Contaminated Mud Disposal Facility.*

12. *The derrick lighter operator shall follow the instructions of the management team of ESC contaminated mud pits to position their barge at designated area within the pits.*

13. *The excavated soil among public fill shall be placed on the prevailing seabed level by using grab method. Any incidental unsuitable material loaded into the derrick lighter will not be grabbed for deposition into the capping layer. Also, the grab shall be lowered below sea level for releasing the excavated soil evenly layer by layer to prevent concentrated load acting on the underlying layers.*

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14. *To minimize any floating refuse that may arise during the placement of materials, floating refuse boom would be installed for enclosing the disposal spot for each derrick lighter.*

15. *Refuse collection boat(s) will be provided at ESC for picking up occasional floating refuse arising from the placement of excavated soil among public fill for capping. In case where the refuse boom and the refuse collection boat(s) could not control the spread of floating refuse (possibly due to severe wave conditions etc), MD's VTC and EPD would be notified immediately.*

Site Supervision

16. The whole operation at the public fill reception facilities and at ESC dumping ground would be supervised/monitored by the site staff of CEDD. In fact, a team of site supervisory staff stationed on a floating office is already in place at ESC for monitoring the contaminated mud disposal activities and capping works.

17. An operation guideline for the site supervisory staff to control of the quality of the capping works at different stages is attached in Appendix A.

Environmental Monitoring

18. Since the contaminated mud Pit IV was put into operation for receiving contaminated mud in December 1997, a comprehensive EM&A programme which covers the whole area of the pits has been in place. It comprises 5 major components, namely sediment quality monitoring, sediment toxicity, water quality monitoring, benthic infauna sampling and identification, and trawling and tissue analysis of demersal fauna. An independent environmental consultant, under the Consultancy Agreement No. CE 64/99, and a contractor are being employed for implementing the EM&A programme and associated field sampling and testing works. The EM&A programme is overseen by a Working Group comprising representatives from EPD, CEDD and AFCD. Findings from the EM&A have been regularly reported to the ACE.

19. In view of that the capping work will render no environmental change nor cause

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more adverse environmental effect, it is considered that the present EM&A programme is sufficient for monitoring the environmental impact even when the subject proposed capping work is implemented.

20. As a prudent approach, water quality monitoring including suspended solid, temperature, dissolved oxygen, salinity and turbidity could be stepped up from a monthly basis to weekly basis at the initial four months of the capping work to ascertain any impact. The water quality monitoring will be carried out by the existing independent environmental consultant and the independent field sampling and testing contractor referred in paragraph 17 above. Details of the monitoring programme is to be worked out by the independent environmental consultant under the Consultancy Agreement No. CE 64/99 and endorsed by EPD (WP).

21. As detailed in Appendix B, *If the suspended solid parameter reaches the respective levels of concern level, the Contractor would be instructed by the management team to implement the mitigation/remedial actions accordingly including slowing down the capping or stopping.*

Statistical Checking of Project Activities

22. For non-identifiable projects, a statistically random sampling exercise will be carried out to verify that the likelihood of excavated soils from unknown origins being contaminated will be acceptably low. The methodology of this sampling exercise will be as follows:

(a) In accordance with the Building Ordinance, the AP/Engineer of the private projects need to provide submissions to Building Department (BD). If the project is related to soil works, the AP/Engineer should also provide geotechnical submissions to Geotechnical Engineering Office (GEO) of this Department. As the active private projects list maintained by BD will include building & super-structure projects which would seldom produce excavated soil for disposal, the active private projects list from GEO which cover most of the soil related private construction projects in Hong Kong seems to be more appropriate for use in our survey. Based on this active projects list, about 30% or 60 numbers of these projects/contracts, whichever is the less, would be randomly selected to carry out a site survey

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in order to check whether previous activities taken place at the work sites would have likely caused land contamination. A list of these activities which is provided by EPD would be used as the basis for forming the checklist to assist in the site survey. As the change of the active private projects in the list is not frequent, such statistically random sampling survey would be carried out on a half-yearly basis.

(b) In view of that some of the small private projects may not be required for submission to BD and thus not included in the GEO's active projects list, a random selection of some incoming trucks at the facilities to trace the source of the materials and then carry out the site visit as mentioned in sub-paragraph (a) above by our survey team. Such survey would be carried out on two consecutive days on a quarterly basis.

23. For identifiable projects, a desk-top exercise would be carried out, based on the submitted projects/contracts information, to compile a list of projects/contracts which are suitable for providing materials to form the inner capping layer at ESC. In addition, we will randomly select some projects/contracts from the above list to conduct a similar site visit as mentioned in paragraph 21(a) above in order to supplement the accuracy of the compiled list.

Fill Management Division

Civil Engineering and Development Department

January 2005

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