Appendix 10.4
Sediment Sampling and Testing Plan and Approval Letter from EPD

H20067

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13 March 2013
(Fax No: 2182 7708)

General Manager, Environment
Airport Authority Hong Kong, HKIA Tower
1 Sky Plaza, Hong Kong International Airport
Lantau, Hong Kong

Attn: Mr Peter LEE

Dear Mr Lee,

Expansion of Hong Kong International Airport into a Three Runway System
Submission of Sediment Sampling and Testing Plan

I refer to the letter of your consultant (Mott MacDonald HK Ltd.) dated 18.2.2013 enclosing the subject plan for our agreement as per the requirement of the EIA Study Brief (No. ESB-250/2012), Appendix E1, para. 3(i).

Please note that we have no further comment on the subject plan.

Should you have any query on the above, please feel free to contact the undersigned.

	To	Action	Info/Mail	Copy	Sign	Date
1	BFK					
2	GC					
Rec'd		13 MAR 2013				
3	DC					
4	AdW					
File No. T30883/02/01/04						

Yours faithfully,

(Kenny LEUNG)
Environmental Protection Officer
for Director of Environmental Protection

c.c. Mott MacDonald HK Ltd. (Attn: Mr Eric CHING) Fax No: 2827 1823

Internal
E(RA)23 E(WP)34
Annex (44) to EP2/N9/19

[20130313.001]

Expansion of Hong Kong International Airport into a Three-Runway System (3rd Runway Project)

Sediment Sampling and Testing Plan (Rev D)

February 2013

Airport Authority Hong Kong

Expansion of Hong Kong International Airport into a Three-Runway System (3rd Runway Project)

Sediment Sampling and Testing Plan (Rev D)

February 2013

Airport Authority Hong Kong

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Content

Drawing No. MCL/P132/EIA/3-003 Proposed Grab sample Locations for Submarine Cable Option C1
Drawing No. MCL/P132/EIA/3-004 Proposed Vibrocore Locations for Submarine Cable Option C1
Drawing No. MCL/P132/EIA/4-001 Proposed Vibrocore Locations for Reclamation Area in the CMPs
Drawing No. MCL/P132/EIA/5-001 Gelogical Profile

1. Introduction

1.1 General

Mott MacDonald Hong Kong Limited (MMHK) received instruction from Airport Authority Hong Kong (AAHK) dated 28 March 2012 to commence the Environmental Impact Assessment (EIA) for the Expansion of Hong Kong International Airport (HKIA) into a Three-Runway System (hereafter referred to the Project).

1.2 Project Background

As part of the AAHK's Airport Master Plan 2030, studies were undertaken to identify the preferred airport expansion scheme and to prepare preliminary design and environmental assessments to compare the identified airport expansion options. The findings of the assessments were used to support the AAHK's public consultation of the Hong Kong International Airport (HKIA) Master Plan 2030 between 3 June 2011 and 2 September 2011.

Following the completion of the public consultation, on 20 March 2012, the Government of HKSAR approved the adoption of Option 2 (three-runway system) as the future development option for HKIA for planning purposes, and for the AAHK to proceed with the statutory EIA process.

The Project Profile was prepared for application for EIA Study Brief and submitted to Environmental Protection Department (EPD) on 28 May 2012. Following the statutory public inspection, a request for further information under Section 5(4) of the EIA Ordinance (EIAO) was issued by EPD on 13 June 2012. The further information requested by EPD for the Project Profile was submitted to EPD on 29 June 2012. The EIA Study Brief (No. ESB-250/2012) for the Project was formally issued on 10 August 2012.

1.3 Scope of Work

Proposed reclamation area

The Project covers mainly an area of reclamation of approximately 650 ha to the north of the existing Airport Island and other relevant modifications due to this future development. The extent and configuration of this reclamation area has been refined from extensive alignment and layout option studies undertaken as part of the HKIA Master Plan 2030.

Subject to the Reclamation Scheme Design which is underway, the following three components of the Project would be constructed by non-dredged methods:

- Proposed reclamation in the Contaminated Mud Pit (CMP) area by Deep Cement Mixing (DCM);
- Proposed reclamation in the non-CMP area by Prefabricated Vertical Drain (PVD); and
- Proposed seawall of the reclamation in the non-CMP area by Stone Columns.

In 2008, AAHK had undertaken an Initial Land Formation Engineering Study. The non-dredged methods as described above had been reviewed. Sediment removal is not required for non-dredged methods including DCM and PVD etc.

A trial of the DCM method for reclamation in the CMP area had been conducted in February 2012. The comprehensive water quality monitoring results obtained from the DCM trial had demonstrated that the DCM column installation process would not result in any cement slurry leakage or contaminant release from the CMP, and the key environmental concerns would be limited to the suspended solids and turbidity,

particularly during both mobilization and demobilization processes. Details of the monitoring results are documented in a separately prepared DCM Environmental Monitoring Report, which has been submitted to EPD for review and comment. The release of pore water from marine sediment due to PVD and Stone Column, although could be well diluted upon the release into the water column, should be further studied To allow for study on release of contaminant, if any in the non-CMP area, ground investigation (GI) is proposed in the reclamation in the non-CMP area and is discussed in this Plan.

Diversion of submarine fuel pipeline

As part of the Reclamation Scheme Design and illustrated in **Drawing No. MCL/P132/EIA/1-001**, the following two options are under consideration for diversion of the submarine fuel pipeline:

Option P1: Diversion of submarine fuel pipeline by horizontal directional drill (HDD) method

- Horizontal Directional Drilling (HDD) is a trenchless installation technique that involves the installation of pipes, conduits, and cables in a shallow arc using a surface-launched drilling rig and a steerable down hole system commonly used in drilling oil and gas wells. The HDD method will be deployed to install the pipeline directly from the existing Airport island to Sha Chau by underground drilling (mostly at sub-seabed rock level) without any disturbance to the seabed.

Option P2: Diversion of submarine fuel pipeline by direct lay method

- The direct lay method will involve removal of marine sediments from the seabed to form a trench (roughly 100m in width and 10 -12m in depth) into which the proposed fuel pipeline is laid.
- The proposed pipeline will run from the existing Airport island to Sha Chau in a “S-shape” alignment in order to avoid encroaching into the Sha Chau and Lung Kwu Chau (SCLKC) Marine Park as far as practicable.

Selected Option

Option P2 would result in release of sediments into water column during excavation of marine sediments from the seabed and require subsequent disposal of a large quantity of the removed sediments. Option P1 does not require any removal of marine sediments from the seabed, but only involves generation of inert materials by drilling through the sub-seabed rock layer. Therefore, Option P1 is obviously more desirable than Option P2 from the environmental perspective. Hence, Option P1 has been selected as the preferred construction method for diversion of the submarine pipeline.

Diversion of 11kV submarine cable

As part of the Reclamation Scheme Design and illustrated in **Drawing No. MCL/P132/EIA/1-002**, the following four options are under consideration for diversion of the 11kV submarine cable:

Option C1: Diversion of submarine cable from Airport to the south of SCLKC Marine Park by water jetting method with field joint

- The proposed cable will be laid by water jetting method from west side of the existing Airport island near South Perimeter Road to the south of SCLKC Marine Park where the proposed cable will be connected to the existing cable via a field joint. The cable will be buried about 5m below seabed.
- At the field joint area which is proposed to be over 500m outside the SCLKC Marine Park boundary, excavation of a seabed area of 120m in length, 32m in width and 5m in depth will need to be carried out to expose the existing cable, which will then lifted up to a barge for forming the field joint.

- It is estimated that about 10,200m^3 of sediment would be generated during diversion of 11kV submarine cable under Option C1. Estimation of the sediment quantity is shown in **Appendix A**.

Option C2: Diversion of submarine cable by HDD method

- The proposed diversion of submarine cable will be constructed using HDD method. The cable will be laid in an alignment similar to that of the Option P1 for submarine pipeline mentioned above, except that the ending point of the submarine cable will be different from that of the pipeline.

Option C3: Diversion of submarine cable from Airport to the east of Sha Chau by water jetting method

- The construction method is the same as Option C1, but the alignment will run from the west side of the existing Airport island near South Perimeter Road to east of Sha Chau in a "S-shape" alignment in order to avoid encroaching into the SCLKC Marine Park as far as practicable. The length of this alignment is approximately double that of Option C1.

Option C4: Diversion of submarine cable from Tuen Mun to the east of Sha Chau by water jetting method

- The construction method is the same as Option C1, but the alignment will run from southwest Tuen Mun near the Lung Kwu Tan Road to the east of Sha Chau. The length of this alignment is similar to that of Option C1.

Selected Option

In all options above exception Option C2, water jetting would be employed, which is a non-dredged method without the need for trench excavation. However, it is expected that seabed sediment would be released close to the seabed when using the water jetting method, which would be settled relatively quickly and thus release of sediment in suspension would be in short duration. Among these Options C1, C3 and C4, Option C3 is obviously the least environmentally desirable because of its longest alignment and accordingly the largest extent of seabed to be affected by water jetting. Therefore, Option C3 will not be adopted.

For Option C2, while the HDD method does not involve any work at the seabed, this method is yet to be confirmed as technically feasible. This is because pulling a long length of the cable (about 4.47km) through the drilled hole would exert such a high tension on the cable that will damage it, unless a specially designed and fabricated cable to withstand the high tension can be identified. As a result, Option C2 will not be selected.

When comparing Options C1 and C4, both Options are of similar alignment lengths, i.e., requiring similar extent of water jetting works. However, Option C4 requires a small portion of the water jetting works at the seabed within SCLKC Marine Park whereas all the works of Option C1 will be outside the Marine Park. As a result, Option C1 has been selected as the preferred construction method.

Periodical maintenance dredging of the navigation channel to the north of the proposed reclamation area

While the need and scale of the periodical maintenance dredging of the navigation channel to the north of the reclamation is yet to be confirmed by the Engineering Design Consultant, it is required in the EIA Study Brief to assess the water quality impact associated with the maintenance dredging work. To allow for study on release of contaminant, if any along the navigation channel during periodical maintenance dredging, GI is proposed for the realignment of the navigation channels and is further discussed in this Plan. Should periodical maintenance dredging of the navigation channel to the north of the proposed reclamation area is confirmed to be required and the dredging volume is above the requirement as specified in Technical

Circular ETWB TC(W) No. 34/2002 Management of Dredged/ Excavated Sediment or Practical Note PNAP ADV-21 Management Framework for Disposal of Dredged/ Excavated Sediment in which the sediment sampling and testing requirements can be waived, guidelines for sediment assessment including sediment sampling and testing would be followed for application for marine dumping permit prior to the disposal of dredged/excavated sediment. A supplementary SSTP should also be submitted for further sediment sampling and testing at the maintenance dredging area as appropriate to seek the agreement from EPD.

1.4 Purpose of the Plan

According to the Technical Circular ETWB TC(W) No. 34/2002 and Practical Note PNAP ADV-21, a proposal for Sampling and Testing of Sediment should be prepared and submitted to Director of Environmental Protection (DEP) for approval. The proposed GI work associated with the diversion of submarine fuel pipeline and 11kV cable will be undertaken to determine the properties of the dredged or excavated sediment. The results of sampling and testing would be used to support future dumping permit application for dredged sediment. Upon the completion of the sampling and chemical and biological testing, a Sediment Quality Report (SQR) will be submitted to DEP for approval.

As part of the Project scope, in accordance to the requirements of EIA Study Brief of the Project (ESB-250/2012), the scope of GI works should also cover the requirement of Waste Management Implication as stipulated in Appendix E1 Section 3 of the EIA Study Brief.

The purpose of this Sediment Sampling and Testing Plan is therefore to seek the agreement from EPD on the following as specified in Appendix E1 Section 3 of the EIA Study Brief:

- The range of parameters to be analyzed;
- The number, type and methods of sampling;
- Sample preservation; and
- Chemical and biological laboratory test methods to be used.

Details of the above are presented in **Sections 3** and **4** of this Plan.

2. Review of Historical Data

2.1 Routine Monitoring by EPD

Based on the data from EPD's publication *Marine Water Quality in Hong Kong in 2011*, one of the EPD reference marine sampling points at Outer Port Shelter (PS6) can be used as the reference station for the Project. The most recent available test results from EPD on the recovered sediments at sampling point PS6 indicated that the sediments are with all contaminant levels not exceeding the Lower Chemical Exceedance Level (LCEL), as defined in ETWB TC(W) No. 34/2002 and PNAP ADV-21, which means the sediment could be classified as Category L. Excerpts of the published marine sediment testing results at PS6 are given in **Appendix B**.

2.2 Previous Non-statutory Monitoring

HKIA was opened for commercial operations in 1998. The Airport was built on a large reclaimed land. EPD conducts routine monitoring on sediment quality within the Hong Kong waters. AAHK subsequently commissioned three rounds of non-statutory marine environmental monitoring studies in 1999 (Contract 194), 2002 (Contract M829) and 2005 (Contract E007) respectively. According to the findings of these studies, there was no significant deterioration in sediment qualities in areas adjacent to the HKIA that could be attributable to the operation of the airport.

In 2009, the AAHK commissioned MMHK to carry out the Non-Statutory Marine Environmental Monitoring Update for 2009/2010 in order to update the findings of the previous studies. Sediment quality parameters including metals (Cadmium, Chromium, Copper, Mercury, Nickel, Lead, Silver and Zinc), metalloid (Arsenic), organic PAHs, Low molecular weight PAH, high molecular weight PAH, organic non-PAHs (PCBs) and organochlorine pesticides were measured at monitoring stations around the Airport island as shown in **Drawing No. MCL/P132/EIA/2-001**. Spatial variations of the contaminant concentrations were recorded but the differences were small. The results in 2009/2010 are similar to those obtained from the previous studies in 1999, 2002 and 2005. There was no trend of increasing contaminants over time.

Based on the MMHK monitoring results and findings in 2009/2010, the tested parameters of all sediment samples did not exceed their corresponding LCEL, with the exception of arsenic which exceeded its LCEL. Therefore, all the sediment samples are classified as Category M based on the criteria of ETWB TC(W) No. 34/2002 and PNAP ADV-21. However, the average arsenic level recorded by EPD at NS6 between 1999 and 2009 was 11.9 mg/kg dry weight, which is close to the LCEL suggesting that the background arsenic level surrounding the HKIA area was generally high. The exceedance of arsenic would unlikely be a reflection of anthropogenic pollution or impact from the HKIA. Excerpts of the relevant sediment testing results are given in **Appendix C**.

2.3 Environmental Monitoring and Audit for Contaminated Mud Pit at Sha Chau

The sediment monitoring results of the Environmental Monitoring and Audit for Contaminated Mud Pit at Sha Chau (2009-2013) – Investigation Study were also reviewed. The environmental monitoring and audit (EM&A) data of the sediment monitoring stations located around but outside the CMPs as shown in **Drawing No. MCL/P132/EIA/2-001** were reviewed. According to the Monthly Progress Reports for Contaminated Mud Pits at Sha Chau, there are two sets of sediment monitoring data for separate purposes:

- Pit Specific Monitoring of Sediment Quality – conducted to examine near field impacts of backfilling operations at CMP 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.
- Cumulative Impact 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.

Sediment quality parameters monitored include all heavy metals (cadmium, chromium, copper, mercury, nickel, lead, silver, zinc and arsenic), total organic carbon (TOC), tributyltins (TBTs) , total polychlorinated biphenyls (PCBs), low molecular weight PAHs and high molecular weight PAHs, total dichlorodiphenyltrichloroethane (DDT) and 4,4"-dichlorodiphenyldichoroethylene (4,4"-DDE).

According to the recent available EM&A data undertaken during February to March 2012 detailed in the 33rd Monthly Progress Report for Contaminated Mud Pits at Sha Chau – March 2012, the heavy metal concentrations of pit specific monitoring sediment did not exceeded the LCEL as defined in ETWB TC(W) No. 34/2002 and PNAP ADV-21, except the concentration of arsenic, which exceeded the LCEL for both months in some monitoring stations. However, the natural levels of arsenic are relatively high in Hong Kong's marine sediments. Therefore, the slight exceedance of LCEL for arsenic is acceptable. For the concentrations of organic contaminants, including PCBs, low and high molecular weight PAHs, they were below the reporting limit at all stations during February and March 2012. However, the concentrations of DDT and 4,4''-DDE were higher than the reporting limit for both months.

The result of cumulative impact sediment monitoring indicated that the concentrations of all heavy metals, except arsenic, did not exceed the LCEL. Therefore, the sediment samples, including those in the navigation channel to the north of the proposed reclamation area, are classified as Category M based on the criteria of ETWB TC(W) No. 34/2002 and PNAP ADV-21. However, due to the relatively high natural levels of arsenic in Hong Kong's marine sediment, the exceedance of arsenic is considered as acceptable. According to the EM&A data, the concentrations of DDT and 4,4"-DDE were comparatively high at one station near Pak Chau. All the organic contaminants, TOC and TBTs were found to be below the reporting limit for all stations. Excerpts of the relevant sediment testing results are given in **Appendix D**.

2.4 Previous GI Results

Extensive GI has been carried out for the existing airport platform and the surrounding area. The earliest GI reports for the existing runway date back to the 1970s, with most of the data having been collected in '80s and early '90s. The early GI work was carried out before the establishment of the current standards and controls on GI site supervision. Consequently, the quality of some of the early logging and in-situ testing lacks an adequate level of assurance and can lead to anomalous conclusions. A number of GI works have been carried out within the proposed third runway footprint or within a 100m of the boundary of the footprint. The investigations are summarised below:

- Chek Lap Kok New Airport Marine Investigation (GMH Series)1991
- Chek Lap Kok New Airport, Marine Investigation at East Sha Chau (ESC Series) 1991
- Marine Investigation along North Runway (256 Series) 1994
- Site Investigation for SPC Works Area H, Including Northern Runway (607 Series) 1994
- Hong Kong International Airport Contract P398 - Marine Site Investigation Works (1-1, P, M Series) 2008
- Hong Kong International Airport Contract P398 - Marine Site Investigation Works (DH/P132/03) 2009
- Site Investigation for the aviation fuel pipeline to Sha Chau Island (609 Series) 1994
- Marine Site Investigation Works of Chek Lap Kok Airport, P541 (DH Series) 2011

There is no existing outfall around the Airport island. There is an existing submarine outfall from Pillar Point Sewage Treatment Works but is located far away from the proposed dredging or excavation area. Therefore, the dredging or excavation area would not fall into the protection boundary of the outfall.

3. Sediment and Sampling Testing

3.1 Review of Exiting Information for Site Contamination Assessment (Tier I)

According to the available information of the marine sediment quality as reviewed in **Section 2**, the marine sediment at the EPD marine sediment sampling point PS6 is categorised as Category L. However, the results obtained from the sediment monitoring stations located around but outside the CMPs in the Environmental Monitoring and Audit for Contaminated Mud Pit at Sha Chau (2009-2013) – Investigation Study showed that the marine sediment was categorised as Category M due to the exceedance of arsenic. The results and findings in the AAHK's Non-Statutory Marine Environmental Monitoring Update 2009/2010 Study indicated that while the sediment samples around the Airport island were classified as Category M, only arsenic was found to exceed the LCEL. Due to the relatively high natural levels of arsenic in Hong Kong's marine sediment, the exceedance of arsenic is considered as acceptable. However, more comprehensive information should be obtained in order to support such a conclusion for all the concerned areas of the Project. Therefore, according to the ETWB TC(W) No. 34/2002 and PNAP ADV-21, Tier II Chemical Screening are proposed as follows.

3.2 Chemical Screening (Tier II)

The proposed marine GI works is presented in **Drawing No. MCL/P132/EIA/3-001, MCL/P132/EIA/3-002, MCL/P132/EIA/3-003 and MCL/P132/EIA/3-004**. Marine sediment samples will be taken at the following intervals:

- Vibrocore sampling at the proposed reclamation area in the non-CMP area with a grid size of 600m by 600m (**Drawing No. MCL/P132/EIA/3-001**) as the purpose of sampling in this area is to study the potential release of contaminants due to the use of non-dredged methods and a grid size of 600m by 600m could provide sufficient number samples for evaluation of a worst case condition of source concentrations for prediction of water quality impact;
- Grab sampling at the navigation channel to the north of the proposed reclamation area with a grid size of 600m by 600m (**Drawing No. MCL/P132/EIA/3-002**) as the purpose of sampling in this area is to study the release of contaminants due to periodical maintenance dredging and a grid size of 600m by 600m could provide sufficient number of samples for evaluation of sediment quality and a worst case condition of source concentrations for prediction of water quality impact;
- Grab sampling at the tentative corridor of Option C1 for diversion of submarine cable with a grid size of 200m by 200m (**Drawing No. MCL/P132/EIA/3-003**) as the expected contamination level in this area is low; and
- Vibrocore sampling at the tentative field joint area of Option C1 for diversion of submarine cable with a grid size of less than 100m by 100m (**Drawing No. MCL/P132/EIA/3-004**), although the expected contamination level in this area is low (except that arsenic would exceed the LCEL based on historical monitoring results as detailed in **Section 2**). It should be noted in **Drawing No. MCL/P132/EIA/3-004** that the proposed vibrocore sampling locations are at about 120 m away from the existing cable location, which is the buffer distance recommended by CLP to safeguard the existing cable from any potential damage by the vibrocore sampling work. Moreover, the sampling locations are on the east side of the existing cable because of the need to avoid the risk of damaging the existing submarine pipeline which is adjacent to the existing cable on the west side.

In this respect, and with reference to ETWB TC(W) No. 34/2002 and PNAP ADV-21, all vibrocores and grab samples analytical method used for detecting all the contaminants will be in accordance with the methodology stated in the references. Vibrocore samples will be taken continuously, the top level of the

sub-samples will be started from the seabed, 0.9 down, 1.9 down, 2.9 down and then every 3m to the bottom of the sediment layers. Grab samples from Location PS6 in Outer Port Shelter WCZ will also be obtained as the same time as a Reference Sediment for laboratory testing. The proposed locations of the vibrocores and grab samples are shown in **Appendix E.**

On recovery of the vibrocores and grab samples, the required sub-samples would be taken, bagged, labelled and stored as set out in ETWB TC(W) No. 34/2002 and PNAP ADV-21. Tier II Chemical Screening will be undertaken for the parameters using the analytical methods and reporting limits described in **Table 3.1**.

Table 3.1: Parameters Proposed for Tier II Chemical Screening for Sediment Samples

Parameters	Preparation Method US EPA Method	Determination Method US EPA Method	Reporting Limit
Metals (mg/ kg dry wt.)			
Cadmium (Cd)	3050B	6020A or 7000A or 7131A	0.2
Chromium (Cr)	3050B	6010C or 7000A or 7190	8
Copper (Cu)	3050B	6010C or 7000A or 7210	7
Mercury (Hg)	7471A	7471A	0.05
Nickel (Ni)	3050B	6010C or 7000A or 7520	4
Lead (Pb)	3050B	6010C or 7000A or 7420	8
Silver (Ag)	3050B	6020A or 7000A or 7761	0.1
Zinc (Zn)	3050B	6010C or 7000A or 7950	20
Metalloids (mg/ kg dry wt.)			
Arsenic (As)	3050B	6020A or 7000A or 7061A	1
Organic- PAH (µg/kg dry wt.)			
Low Molecular Weight PAHs+	3550B or 3540C and 3630C	8260B or 8270C	55
High Molecular Weight PAHs++	3550B or 3540C and 3630C	8260B or 8270C	170
Organic-non-PAH (µg/kg dry wt.)			
Total PCBs+++	3550B or 3540C and 3665A	8082	3
Organometallics (µg TBT/L in interstitial water)			
Tributyltin	Krone et al. (1989)*- GC/MS UNEP/ IOC/ IAEA**	Krone et al. (1989)*- GC/MS UNEP/ IOC/ IAEA	0.015

Note:

(i) The reporting limits shown in this table are the most stringent limits which will be specified by Director of Environmental Protection (DEP). Project proponents should consult DEP on the required limits in the preparation of proposals for sampling and chemical testing of the sediments.

(ii) Other equivalent methods may be used subject to the approval of DEP.

\+ Low molecular weight PAHs include acenaphthene, acenaphthylene, anthracene, flouroene, naphthalene, and phenanthrene

++ High molecular weight PAHs include benzo[a]anthracene, benzo[a]pyrene, chrysene, dibenzo[a,h]anthracene, floranthene, pyrene, benzo[b]fluroanthene, benzo[k]fluoranthen, indeno[1,2,3-c,d]pyrene and benzo[g,h,i]perylene

+++ The reporting limit is for individual PCB congeners. Total PCBs include 2,4' diCB, 2,2',5 triCB, 2,4,4'triCB, 2,2'3,5'tetraCB, 2,2',5,5'tetraCB, 2,3',4,4'tetraCB, 3,3',4,4'tetraCB, 2,2',4,5,5'pentaCB, 2,3,3',4, 4'pentaCB, 2,3',4,4',5 pentaCB, 3,3',4,4',5 pentaCB, 2,2',3,3',4,4' hexaCB, 2,2',3,4,4',5' hexaCB, 2,2',4,4',5,5' hexaCB, 3,3',4,4',5,5' hexaCB, 2,2',3,3',4,4',5 heptaCB, 2,2',3,4,4',5,5' heptaCB, 2,2',3,4',5,5',6 heptaCB (ref: the "summation" column of Table 9.3 of Evaluation of Dredge Material Proposed for Discharge in Walters of the U.S.- Testing Manual (The Inland Testing Manual) published by USEPA.

* Krone et al. (1989), A method for analysis of butyltin species and measurement of butyltins in sediment and English Sole livers fro Puget Sound, Marine Environmental Research 27 (1989) 1-18. Interstitial water to be obtained by centrifuging the sediment and collecting the overlying water.

** UNEP/ ICO/ IAEA's Marine Environment Laboratory reference methods. These methods are available free of charge from UNEP/ Water or Marine Environment Studies Laboratory at IAEA's Marine Environment Laboratory. Interstitial water to be obtained by centrifuging the sediment and collecting the overlying water.

The technical circular recommends all samples should be promptly analysed although, under proper storage (4ºC in dark but not frozen), a maximum holding time of 2 weeks and 8 weeks for chemical test and biological test, respectively, is considered valid. Station number, sample length, diameter and depth, sampling date and time, together with a full description of the sample should be labelled on all sampling bottles.

All tests must be conducted by laboratories accredited by Hong Kong Laboratory Accreditation Scheme (HKOLAS) or, in case of overseas laboratories, by equivalent national accreditation for these tests.

3.3 Biological Screening (Tier III)

If Category M material is expected, Tier III Biological Screening could be required after the chemical screening to determine the disposal option under ETWB TC(W) No. 34/2002 and PNAP ADV-21. If Biological Screening is required, reference sediment will be collected from Location PS6 using surface grab sampler. The test endpoints and decision criteria are summarised in **Table 3.2**. If the sediment fails in any one of the three toxicity test, it is deemed to have failed the biological test. The species to be used for each type of test would be selected from species listed in **Table 3.3.**

Table 3.2: Failure Criteria for Tier III Biological Screening

Toxicity test	Endpoints measured	Failure criteria
a 10-day burrowing amphipod	Survival	Mean survival in test sediment is significantly different (p≤0.05)1 from mean survival in reference sediment and mean survival in test sediment < 80% of mean survival in reference sediment.
a 20-day burrowing polychaete	Dry Weight2	Mean dry weight in test sediment is significantly different (p≤0.05)1 from mean dry weight in reference sediment and mean dry weight in test sediment < 90% of mean dry weight in reference sediment.
a 48-96 hour larvae (bivalve or echinoderm)	Normality Survival3	Mean normality survival in test sediment is significantly different (p≤0.05)1 from mean normality survival in reference sediment and mean normality survival in test sediment < 80% of mean normality survival in reference sediment.

Note:
1 Statistically significant differences should be determined using appropriate two-sample comparisons (e.g. , t-tests) at a probability of p≤0.05.
2 Dry weight means total dry weight after deducting dead and missing worms.
3 Normality survival integrates the normality and survival end points, and measures survival of only the normal larvae relative to the starting number.

Table 3.3: Species Proposed for Tier III Biological Screening for Sediment Samples

Test types	Species	Reference Test Conditions*
a 10-day burrowing amphipod	Ampelisca abdita	U.S.EPA (1994)/ PSEP (1995)
	Leptocheirus plumulosus	U.S.EPA (1994)
	Eohaustorius estuarius	U.S.EPA (1994)/ PSEP (1995)
a 20-day burrowing polychaete	Neanthes arenaceodentata	PSEP (1995)
a 48-96 hour larvae (bivalve or echinoderm)	Bivalve:	
	Mytilus spp.	PSEP (1995)
	Crassostrea gigas	PSEP (1995)
	Echinoderm:	
	Dendraster excentricus	PSEP (1995)
	Strongylocentrotus spp.	PSEP (1995)

Note:
* U.S. EPA (U.S. Environmental Protection Agency) 1994. Methods for assessing the toxicity of sediment-associated contaminants with estuarine and marine amphipods. Office of Research and Development. U.S. Environmental Protection Agency, Cincinnati, OH. EPA/600/R94/025.
PSEP (Puget Sound Estuary Program) 1995. Recommended guidelines for conducting laboratory bioassays on Puget Sound sediments.

All chemical and biological tests must be conducted by laboratories with by Hong Kong Laboratory Accreditation Scheme (HOKLAS) accreditation or its Mutual Recognition Agreement ("MRA") accreditation bodies. The laboratory will conduct all the required analyses according to internationally recognised standard methods.

4. Advance Works for EIA Study Brief

4.1 Background

As discussed in **Section 1**, the GI and laboratory testing proposed in this Sediment Sampling and Testing Plan should cover the requirements of ETWB TC(W) No. 34/2002 and PNAP ADV-21. However, it should also cover the requirements of the Waste Management Implications specified in Appendix E1 Section 3 of the EIA Study Brief No. ESB-250/2012. Also, results from laboratory testing will be used for simulating and quantifying the degree of mobilization of various contaminants for water quality assessment. Therefore, additional sediment sample tests are proposed in this Section.

4.2 Additional Parameters for Sediment Sample Test

For each sediment sample, the Sediment Sampling and Testing Plan included the testing of 9 heavy metals and metalloids, and 3 organic mirco-pollutants (low and high molecular weight PAH, total PCBs and TBT) as listed in **Table 3.1**. The testing of the following additional parameters in the proposed reclamation in the non-CMP area, the periodical maintenance dredging of the navigation channel to the north of the proposed reclamation area, the tentative corridor for Option P2 for submarine fuel pipeline, and the Option C1 for the submarine cable are recommended to allow the evaluation of contamination by chlorinated pesticide and nutrient of the sediment as listed in **Table 4.1**.

Table 4.1: Parameters Proposed for Chlorinated Pesticides and Nutrient for Sediment Samples.

Parameter	Analytical Method	Reporting Limit (mg/kg)
Nutrient		
Ammoniacal Nitrogen (NH_3N)	APHA 4500-NH_3:G	10
Total Kjeldahl Nitrogen (TKN)	APHA 4500 N_{org}:B	20
Nitrate Nitrogen (NO_3-N)	APHA 4500-NO_3I	0.1
Nitrite Nitrogen (NO_2-N)	APHA 4500-NO_3I	0.1
Total Phosphorus (TP)	APHA 4500 P:B_4,F	20
Sediment Oxygen Demand (SOD, 20 Days)	APHA 5210B	10
Chlorinated Pesticides		

Aldrin	USEPA 8270C	0.05
Alpha-BHC		
Beta-BHC		
Delta-BHC		
Gamma-BHC		
Heptachlor		
Heptachlor epoxide		
Endosulfan I		
Endosulfan sulphate		
4, 4'-DDT		
4, 4'-DDD		
4, 4'-DDE		

4.3 Elutriate Tests

To facilitate the assessment of likelihood of release of contaminants from the marine sediment, it is also recommended to perform elutriate tests on sediment samples to simulate and quantify the degree of mobilization of various contaminants. Therefore, elutriate tests are proposed for the marine sediment samples to be taken at the following locations:

- Proposed reclamation area in the CMPs as shown **Drawing No. MCL/P132/EIA/4-001**;
- Proposed reclamation area outside the CMPs spaced at 600m intervals as shown **Drawing No. MCL/P132/EIA/3-001**;
- Periodical maintenance dredging of the navigation channel to the north of the proposed reclamation area spaced at 600m intervals as shown **Drawing No. MCL/P132/EIA/3-002**;
- Tentative corridor of the Option C1 for submarine cable spaced at 200m intervals as shown **Drawing No. MCL/P132/EIA/3-003**; and
- Tentative field joint area of the selected Option C1 for submarine cable spaced at less than 100m intervals as shown **Drawing No. MCL/P132/EIA/3-004**.

As mentioned in **Section 1.3**, the proposed reclamation in the CMP area will be constructed by DCM. The DCM process will involve injection of cement slurry under low pressure through the base of a vertical tube which is fitted with a wide, shallow auger at its lower end. Therefore, the process will not cause any disintegration of the existing capping layer of the contaminated mud pit, or substantive release of the sediment underneath the capping layer. Hence, elutriate test is proposed for the sediment samples to be collected in this CMP area only for water quality assessment propose.

The Options C1 for diversion of submarine cable will be constructed by water jetting method, and no dredged material will be generated. Therefore, elutriate test is proposed for the sediment samples to be collected at the concerned areas only for the purpose of water quality assessment.

Grab samples with sub-samples for elutriate tests will be taken at the seabed along the navigation channel to the north of the proposed reclamation area and the tentative corridor of Option C1 for the submarine cable. Continuous samples will be taken vertically from seabed down to the bottom of the vibrocore in the proposed reclamation in both the CMP area and non-CMP area, and tentative field joint area of Option C1 for submarine cable. On recovery, each vibrocore will be cut into sub-samples. The sub-samples for

elutriate test will be taken at seabed, 0.9m down, 1.9m down and then every 3m to bottom of the sediment layers.

The grab samples and sections of vibrocore tube will be cut, sealed and capped, labelled, stored in a dark environmental cool box below 4^{o}C immediately after collection on site. On transfer from site to laboratory, samples are kept at below 4^{o}C, by regularly replacing the ice packs.

The elutriate test is a procedure developed to simulate the release of dissolved contaminants from a dredged or excavation disposal operation in open waters, and may be considered a laboratory simulation of release of dissolved contaminants from a mechanical dredged or excavation disposal operation (USEPA and USACE 1998).

Standard elutriate preparation will be in accordance with USEPA 823/B-98-004 Dredged Material – Inland Testing Manual. Prior to use, all glassware will be thoroughly cleaned as appropriate for the contaminant analysis. At a minimum, glassware will be washed with detergent, rinsed with acetone, five times with tap water, placed in a clean 10% HCl acid bath for a minimum of 4 hours, rinsed five times with tap water, and then thoroughly flushed with either distilled or deionised water.

The elutriate are prepared by sub-sampling approximately 1 litre of sediment combined with unfiltered marine water collected on-site in a sediment-to-water ratio of 1:4 by volume in a pre-cleaned container in the laboratory. The mixture will be stirred for 30 minutes on a platform shaker. After the 30 minutes, the mixture will be allowed to settle for 1 hour and the supernatant will then be siphoned off without disturbing the settled material. The decanted solution will be centrifuged to remove particulates prior to chemical analysis (approximately 2000rpm for 30 min, until visually clear).

The elutriate samples discussed above would be tested for a suite of contaminants as presented in **Table 4.2** which are similar to the sediment samples. The test will also be performed on a blank sample taken from the water depth just above seabed (marine waters) for comparison.

Pore water samples will also be analyzed for each of the parameters using the testing methods as proposed in **Table 4.2**. Standard pore water preparation will be in accordance with USEPA Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual (2001) (or equivalent). The pore water will be prepared by sub-sampling approximately 1 litre of sediment in a pre-cleaned container in the laboratory and centrifuged at rotation speed at 3,000 rpm for 10 minutes. After the 10 minutes, the supernatant will be decanted without disturbing the sediment material. The pore water testing parameters would be the same as those for elutriate samples.

Table 4.2: Parameters Proposed for Elutriate Samples and Porewater Samples

Parameter	Analytical Method	Reporting Limit
Heavy Metals		
Silver (Ag)		1.0 µg/L
Cadmium (Cd)		0.2 µg/L
Copper (Cu)		1.0 µg/L
Nickel (Ni)	USEPA 6020	1.0 µg/L
Lead (Pb)	USEPA 7470A (Hg)	1.0 µg/L
Zinc (Zn)		1.0 µg/L
Chromium (Cr)		1.0 µg/L
Arsenic (As)		1.0 µg/L
Mercury (Hg)		0.1 µg/L

Parameter	Analytical Method	Reporting Limit
Nitrogen-Ammonia	APHA 4500-NH_3 G	0.01 mg/L
Nitrogen-Nitrate	APHA 4500-NO_3 I	0.01 mg/L
Nitrogen-Nitrite	APHA 4500-NO_3 I	0.01 mg/L
Total Kjeldahl Nitrogen (TKN)	APHA 4500P:J APHA 4500NO_3:I	0.1 mg/L
Polychlorinated Biphenyls (PCBs)	USEPA 8270C	0.01µg/L individually
Polynuclear Aromatic Hydrocarbons (PAHs)	USEPA 8270C	0.2µg/L individually
TBT	USEPA 3230	0.015µg/L
Chlorinated Pesticides Aldrin Alpha-BHC Beta-BHC Delta-BHC Gamma-BHC Heptachlor Heptachlor epoxide Endosulfan I Endosulfan sulphate 4, 4'-DDT 4, 4'-DDD 4, 4'-DDE	USEPA 8270C	0.1µg/L
Total Phosphorus	APHA 4500-P G	0.1 mg/L
Total Reactive Phosphorus	APHA 4500-P G	0.1 mg/L
pH	APHA 4500- NH_3 H	0.1 unit

The laboratory testing of samples collected will be carried out by an appropriate laboratory which is HOKLAS accredited. The laboratory will conduct the required analyses which fall under her accredited test categories according to standard method and technique used as specified in her scope of accreditation under HOKLAS while the remaining required analysis will be conducted according to in-house or other approved international standard methods. The key requirements for the on-site sampling and laboratory testing works are presented in **Appendix F**.

5. Geological Profile

The geological profile across part of the proposed reclamation in the non-CMP area and part of the tentative corridor of submarine fuel pipeline is presented in **Drawing No. MCL/P132/EIA/5-001**. As shown in the Drawing, the proposed reclamation in the non-CMP area would sit on marine ground consisting of marine mud, alluvium, completely decomposed granite and slightly decomposed granite, while the seabed material which would be affected by the installation of the proposed relocated submarine fuel pipeline in general consists of marine mud.

6. References

1. Environmental Protection Department, *Marine Water Quality in Hong Kong in 2010.*

2. Meinhardt (Hong Kong) Limited, 2008, *Hong Kong International Airport, Airport Master Plan 2030, Contract P131, Initial Land Formation Engineering Study, Final Construction Options Report*.

3. Mott MacDonald Limited, 2011, *Hong Kong International Airport, Contract P132 Engi* Shortcut to Show Desktop.lnk *neering Feasibility and Environmental Assessment Study for Airport Master Plan 2030, Non-Statutory Marine Environmental Monitoring Update 2009/2010 – Final Monitoring Report*.

4. ERM, 2012, *Environmental Monitoring and Audit for Contaminated Mud Pit at Sha Chau (2009-2013) – Investigation, Agreement No. CE 4/2009 (CE), 33rd Monthly Progress Report for Contaminated Mud Pits at Sha Chau – March 2012*.

824000 N
822000 N
820000 N
818000 N
804000 E
806000 E
808000 E
810000 E
812000 E
814000 E

LEGEND:

- VESSEL RESTRICTED AREA
- OPTION P1: DIVERSION OF SUBMARINE FUEL PIPELINE FROM AIRPORT TO SHA CHAU BY HDD METHOD
- OPTION P2: DIVERSION OF SUBMARINE FUEL PIPELINE BY DIRECT LAY METHOD

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0 250 500 750 1000 m
1 : 30 000 SCALE BAR

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OPTIONS FOR DIVERSION OF SUBMARINE FUEL PIPELINE

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Design	FY	02JAN13
Checkers	FY	02JAN13
Design Supervisor		
Authorised Representative		

EXPANSION OF HONG KONG INTERNATIONAL AIRPORT INTO A THREE-RUNWAY SYSTEM

Drawing No. MCL / P132 / EIA / 1-001

Scale at A3 1 : 30000

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818000 N

HKSAR BOUNDARY

PAMSTON ROAD

沙洲及龍鼓洲海岸公園
SHA CHAU AND LUNG KWU CHAU MARINE PARK

沙洲
SHA CHAU

龍鼓洲
LUNG KWU CHAU

青山灣
CASTLE PEAK BAY
TSING SHAN WAN

TUEN MUN TYPHOON SHELTER

PILLAR POINT

SIU LAM

BUTTERFLY BEACH

FERRY PIER

GOLDEN BEACH

PEARL ISLAND

大小磨刀
THE BROTHERS

大磨刀
TAI MO TO

小磨刀
SIU MO TO

監箭洲
TSZ KAN CHAU

東涌
TUNG CHUNG

東涌灣
TUNG CHUNG BAY

大白灣
DISCOVERY BAY
TAI PAK WAN

LEGEND:

- VESSEL RESTRICTED AREA
- EXISTING SUBMARINE CABLE
- OPTION C1: DIVERSION OF SUBMARINE CABLE FROM AIRPORT TO THE SOUTH OF MARINE PARK BY WATER JETTING METHOD WITH FIELD JOINT
- OPTION C2: DIVERSION OF SUBMARINE CABLE FROM AIRPORT TO SHA CHAU BY HDD METHOD
- OPTION C3: DIVERSION OF SUBMARINE CABLE FROM AIRPORT TO THE EAST OF SHA CHAU BY WATER JETTING METHOD
- OPTION C4: DIVERSION OF SUBMARINE CABLE FROM TUEN MUN TO THE EAST OF SHA CHAU BY WATER JETTING METHOD

0 500 1000 1500 2000 m
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OPTIONS FOR DIVERSION OF SUBMARINE 11kV CABLE

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Drawing No. MCL / P132 / EIA / 1-002

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818000 E
820000 E

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818000 N
816000 N

ESC-RMA
RMA
ESC-NNCA
ESC-NNBA
CNA
RNA
ESC-NNDA
ESC-RNA
ESC-NECA
ESC-NEBA
CPA
ESC-NEDA
ESC-NEAB
ESC-NNAB
CPB
CNB
RNB
ESC-RMB
1
NM6
(NS6)
10
2
9
8
RFB
ESC-RFB
3
4
6
7
5
RMB
HKSAR BOUNDARY

沙洲及龜鼓洲海岸公園
SHA CHAU AND LUNG KWU CHAU MARINE PARK

LEGEND:
- PROJECT BOUNDARY
- CONTRACT 194 SEDIMENT QUALITY MONITORING STATION
- CONTRACT M829 SEDIMENT QUALITY MONITORING STATION
- CONTRACT E007 SEDIMENT QUALITY MONITORING STATION
- 2009/2010 UPDATE SEDIMENT QUALITY MONITORING STATION
- SEDIMENT QUALITY MONITORING STATIONS FOR CONTAMINATED MUD PIT AT SHA CHAU
- EPD MONITORING STATION

0 500 1000 1500 2000 m
1 : 45,000 SCALE BAR

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LOCATION OF SEDIMENT QUALITY MONITORING STATIONS

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810000 E
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LEGEND:

VESSEL RESTRICTED AREA

RV01 VIBROCORE LOCATIONS FOR RECLAMATION AREA

HKSAR BOUNDARY

SHA CHAU

RV01 RV02 RV03 RV04 RV05 RV06 RV07 RV08 RV09 RV10 RV11

0 250 500 750 1000 m

1 : 20 000 SCALE BAR

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PROPOSED VIBROCORE LOCATIONS FOR RECLAMATION AREA

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Checkers	FY	02JAN13
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EXPANSION OF HONG KONG INTERNATIONAL AIRPORT INTO A THREE-RUNWAY SYSTEM

Drawing No. MCL / P132 / EIA / 3-001

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806000 E
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824000 N
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820000 N
818000 N

HKSAR BOUNDARY

LEGEND:

VESSEL RESTRICTED AREA

FG001 GRAB SAMPLE LOCATIONS FOR NAVIGATION CHANNEL TO THE NORTH OF THE RECLAMATION AREA

FG001 FG002 FG003 FG004 FG005 FG006 FG007 FG008 FG009

SHA CHAU

0 250 500 750 1000 m

1 : 20 000 SCALE BAR

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PROPOSED GRAB SAMPLE LOCATIONS FOR NAVIGATION CHANNEL TO THE NORTH OF THE RECLAMATION AREA

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Drawing No. MCL / P132 / EIA / 3-002

Scale at A3 1 : 20000

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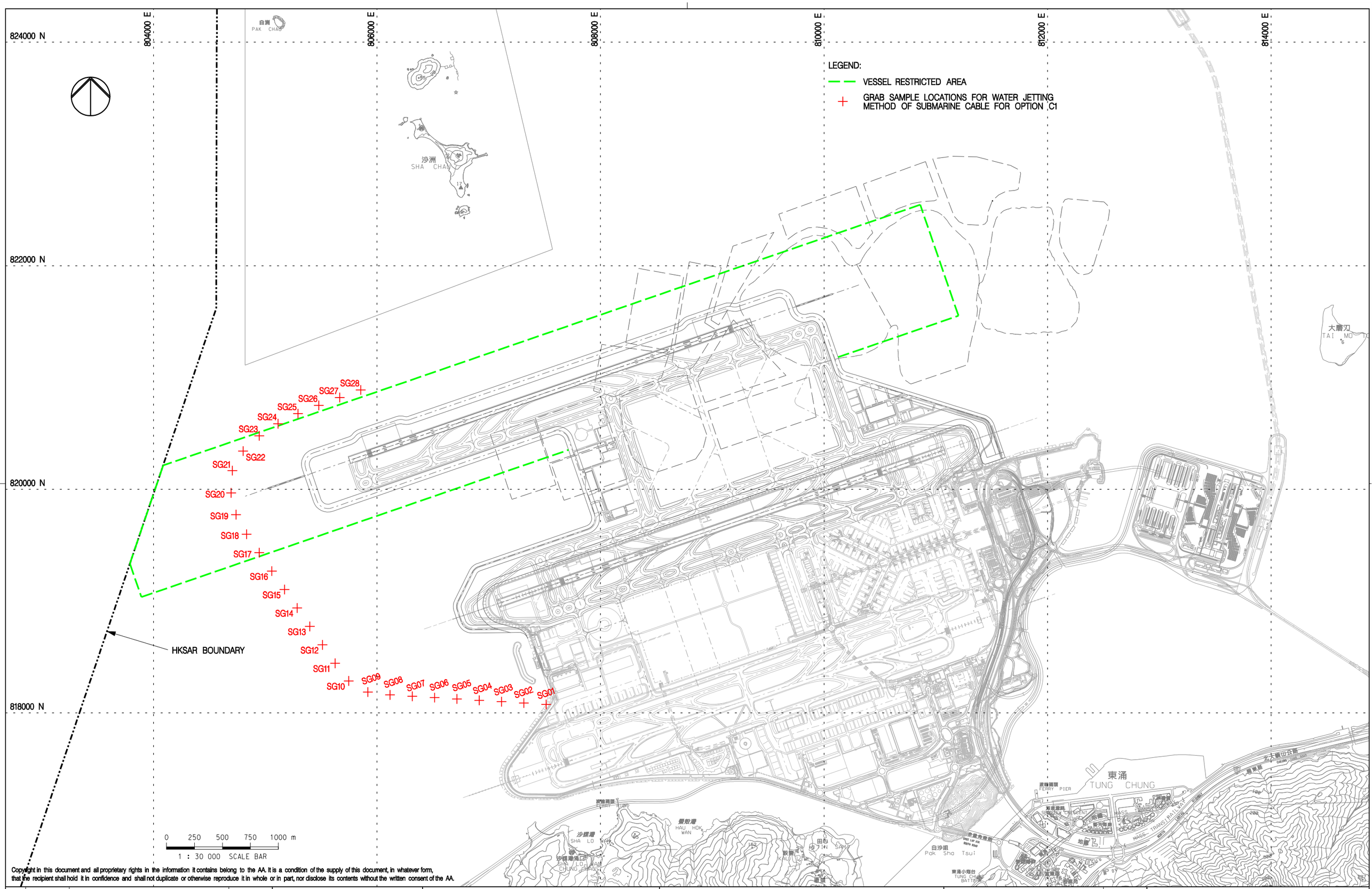

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PROPOSED GRAB SAMPLE LOCATIONS FOR SUBMARINE CABLE OPTION C1

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EXPANSION OF HONG KONG INTERNATIONAL AIRPORT INTO A THREE-RUNWAY SYSTEM

Drawing No. MCL / P132 / EIA / 3–003

Scale at A3 1 : 30000

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804000 E
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814000 E

LEGEND:

- VESSEL RESTRICTED AREA
- AS-FOUND CLP CABLE BY EGS
- AS-FOUND PIPELINE CABLE BY EGS
- FIELD JOINT AREA
- DOUBLE VIBROCORE LOCATIONS FOR FIELD JOINT OF SUBMARINE CABLE FOR OPTION C1

RV13
RV12

HKSAR BOUNDARY

白洲 PAK CHAU
沙洲 SHA CHAU
大鼎辺 TAI MO TO
東涌 TUNG CHUNG
白沙嘴 Pak Sha Tsui
東涌小炮台 TUNG CHUNG BATTERY
FERRY PIER
MASS TRANSIT RAILWAY

0 250 500 750 1000 m
1 : 30 000 SCALE BAR

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PROPOSED VIBROCORE LOCATIONS FOR SUBMARINE CABLE OPTION C1

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EXPANSION OF HONG KONG INTERNATIONAL AIRPORT INTO A THREE-RUNWAY SYSTEM

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822000 N
820000 N
818000 N

LEGEND:

VESSEL RESTRICTED AREA

VIBROCORE LOCATIONS FOR RECLAMATION AREA IN THE CMPs

SHA CHAU

HKSAR BOUNDARY

AV01
AV02
AV03
AV04
AV05
AV06
AV07
AV08
AV09
AV10
AV11

0 250 500 750 1000 m

1 : 20 000 SCALE BAR

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PROPOSED VIBROCORE LOCATIONS FOR RECLAMATION AREA IN THE CMPs

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Checkers	FY	02JAN13
Design Supervisor		
Authorised Representative		

EXPANSION OF HONG KONG INTERNATIONAL AIRPORT INTO A THREE-RUNWAY SYSTEM

Drawing No. MCL / P132 / EIA / 4-001

Scale at A3 1 : 20000

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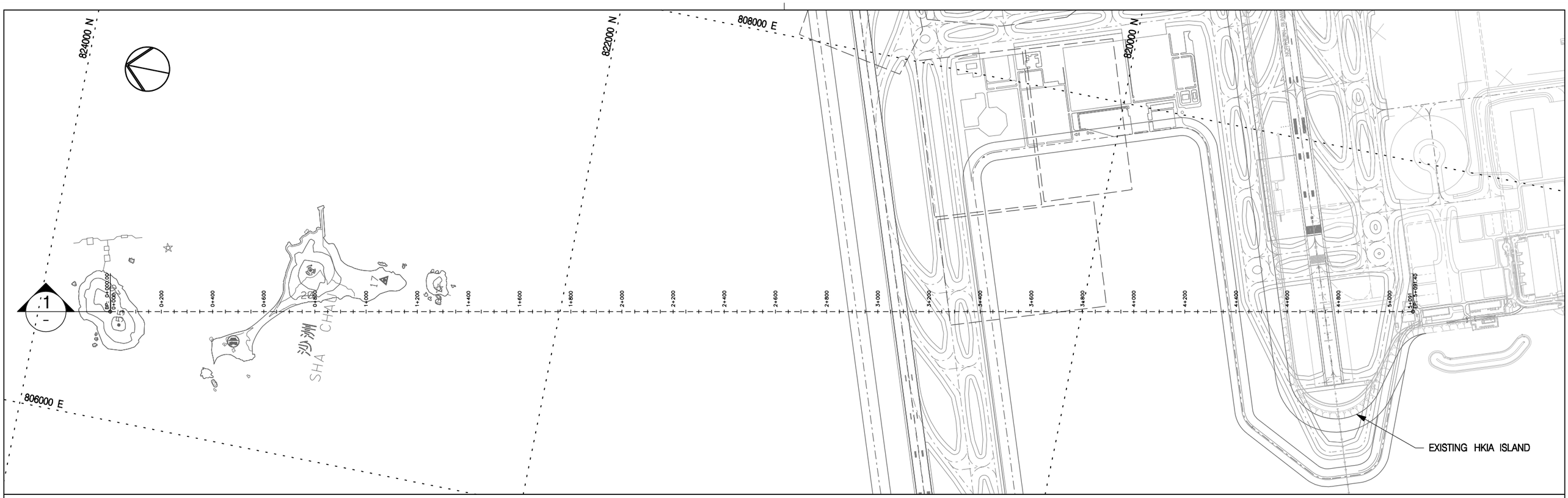
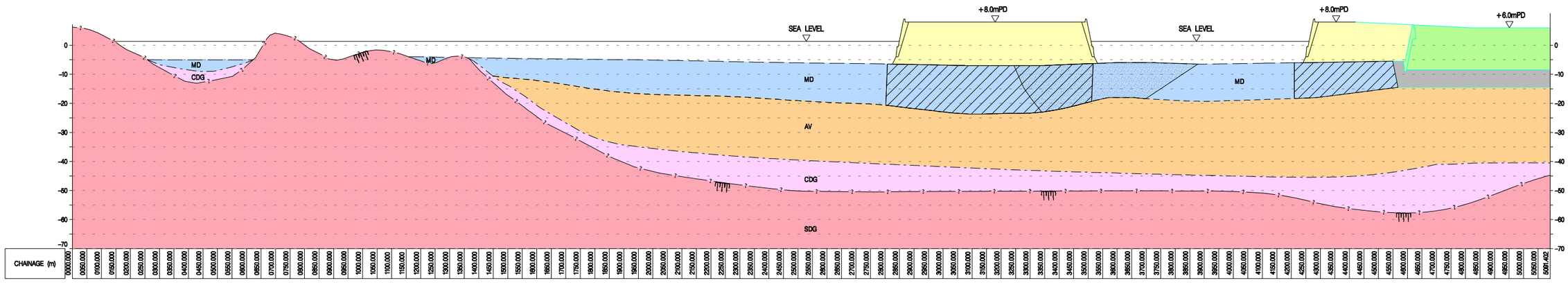


NOTES:

1. THE ROCKHEAD LINE WAS DERIVED SUBJECTIVELY ACCORDING TO BOREHOLE LOG INFORMATION AND TAKING INTO ACCOUNT THE GEOLOGICAL SETTING OF THE SITE. THE EXTRACTION OF THE ROCKHEAD LINE IS BASED GENERALLY ON BOREHOLE EVIDENCE.
2. THE OTHER STRATUM LINES (i.e. BASE OF MARINE DEPOSITS, BASE OF ALLUVIUM) WERE GENERATED BY DERIVED KRIGING INTERPOLATION OF BOREHOLE DATA POINTS ONTO A 10 M SQUARE CELL ELEVATION MATRIX.
3. THE INTERFACE BETWEEN THE EXISTING RECLAMATION AND THE PROPOSED RECLAMATION HAS BEEN FORMED BY A GRADATIONAL SLOPE.

PLAN
SCALE 1:15000

LEGEND:
- APPROXIMATE LOCATION OF CMP
- PROPOSED EXTENT OF DCM /GROUND IMPROVEMENT
- TYPE 'D' FILL
- SUITABLE FILL
- MARINE MUD (MD)
- ALLUVIUM (AV)
- COMPLETELY DECOMPOSED GRANITE (CDG)
- SLIGHTLY DECOMPOSED GRANITE (SDG)
- ROCKHEAD



SECTION 1-1
SCALE 1:15000

0 100 200 300 400 500 m
1 : 15 000 SCALE BAR

Rev.	Date	Description	Checked
A	02JAN13	FIRST ISSUE	FY

香港國際機場 HONG KONG INTERNATIONAL AIRPORT
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In association with
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Atkins China Limited
Clymene Enterprises
Deltares
Ecosystems Limited
SDA Marine Limited
Urbis Limited
URS Scott Wilson Limited

Title

GEOLOGICAL PROFILE

Consultant's Signatures for Approval		Date
Design	AM	02JAN13
Checkers	FY	02JAN13
Design Supervisor		
Authorised Representative		

EXPANSION OF HONG KONG INTERNATIONAL AIRPORT INTO A THREE-RUNWAY SYSTEM

Drawing No. MCL / P132 / EIA / 5-001

Scale at A3 1 : 15000

Rev. A

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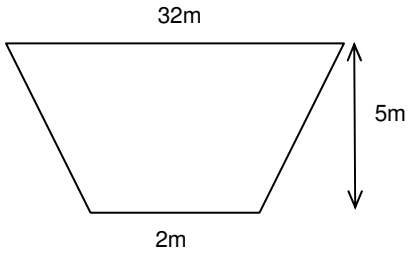
User name: yim42169

Plote Date: 31/12/2012 Time: 15:21:39

Appendix A Calculation of Estimated Quantity of Excavated Sediment

According to the Engineering Design Consultant, the extent of the excavation at the proposed field joint area would be approximately 120m in length, 32m in width and 5m in depth. The cross-section of trench for excavated sediment should be a trapezoid, as shown in **Figure A.1**.

Figure A.1: Cross-section of Trench under Option C1



With the length of 120m, the estimated quantity of excavated sediment in m^3 would be

$$\approx \left[\frac{(32\ m\ +\ 2\,m\ )\times\ 5\,m}{2} \right] \times 120\ \ m$$

Therefore, it is estimated that about 10,200m^3 of sediment would be generated during diversion of 11kV submarine cable under Option C1.

Appendix B Relevant EPD's Sediment Monitoring Results

Source: Environmental Protection Department, Marine Water Quality in Hong Kong in 2011

Summary statistics for bottom sediment quality in the Port Shelter and Mirs Bay WCZs, 2007 – 2011

Parameter	Inner Port Shelter	Outer Port Shelter		Starling Inlet	Crooked Island		Port Island	Mirs Bay (North)
	PS3	PS5	PS6	MS1	MS2	MS7	MS17	MS3
Number of samples	10	10	10	10	10	10	10	10
Particle Size Fractionation <63μm (%w/w)	87 (58 - 94)	59 (24 - 92)	73 (48 - 91)	86 (64 - 95)	91 (76 - 99)	92 (83 - 96)	87 (77 - 94)	78 (45 - 93)
Electrochemical Potential (mV)	-211 (-310 - -39)	-158 (-381 - -21)	-174 (-378 - -65)	-246 (-367 - -121)	-265 (-367 - -109)	-332 (-368 - -277)	-215 (-295 - -63)	-218 (-371 - -113)
Total Solids (%w/w)	37 (35 - 41)	51 (38 - 63)	52 (46 - 55)	40 (36 - 45)	33 (31 - 34)	30 (27 - 35)	35 (32 - 41)	47 (38 - 61)
Total Volatile Soilds (%w/w)	10.7 (8.5 - 12.0)	7.6 (4.7 - 10.0)	7.3 (6.4 - 8.3)	7.1 (6.4 - 7.8)	8.3 (7.5 - 9.4)	9.5 (8.9 - 11.0)	8.6 (7.8 - 9.3)	6.5 (3.1 - 8.9)
Chemical Oxygen Demand (mg/kg)	17300 (14000 - 20000)	11690 (9900 - 14000)	12100 (11000 - 14000)	15200 (11000 - 19000)	15200 (13000 - 17000)	16500 (13000 - 19000)	15300 (13000 - 18000)	12790 (9900 - 17000)
Total Carbon (%w/w)	1.2 (1.0 - 1.4)	1.9 (0.9 - 3.7)	1.4 (1.1 - 1.6)	0.7 (0.6 - 0.8)	0.6 (0.5 - 0.8)	0.7 (0.6 - 0.9)	0.8 (0.6 - 1.0)	0.7 (0.5 - 1.1)
Ammonical Nitrogen (mg/kg)	5.0 (0.1 - 11.0)	6.5 (1.3 - 11.0)	11.3 (0.4 - 60.0)	6.3 (0.1 - 13.0)	9.9 (0.1 - 20.0)	9.5 (4.8 - 14.0)	4.4 (0.2 - 7.1)	5.3 (1.4 - 10.0)
Total Kjeldahl Nitrogen (mg/kg)	560 (340 - 680)	420 (210 - 680)	440 (210 - 580)	440 (290 - 520)	560 (460 - 610)	600 (340 - 710)	640 (580 - 740)	410 (250 - 510)
Total Phosphorus (mg/kg)	170 (110 - 210)	160 (83 - 210)	190 (89 - 230)	160 (95 - 190)	170 (150 - 190)	180 (140 - 210)	200 (180 - 220)	150 (100 - 170)
Total Sulphide (mg/kg)	14 (4 - 41)	8 (1 - 23)	16 (1 - 98)	44 (11 - 120)	31 (1 - 69)	24 (2 - 96)	13 (1 - 35)	17 (2 - 54)
Total Cyanide (mg/kg)	0.1 (0.1 - 0.2)	0.1 (0.1 - 0.2)	<0.1 (0.1 - <0.1)	0.2 (0.1 - 0.2)	0.2 (0.1 - 0.2)	0.2 (0.1 - 0.2)	0.2 (0.1 - 0.2)	0.1 (0.1 - 0.2)
Arsenic (mg/kg)	5.7 (4.8 - 6.3)	4.1 (0.2 - 5.6)	5.7 (5.2 - 6.5)	8.2 (6.9 - 9.2)	7.1 (5.7 - 7.9)	6.7 (5.8 - 7.6)	6.3 (5.6 - 6.9)	6.3 (5.0 - 7.3)
Cadmium (mg/kg)	<0.1 (0.1 - <0.1)	<0.1 (0.1 - <0.1)	<0.1 (0.1 - <0.1)	0.3 (0.1 - 0.4)	0.3 (0.1 - 0.3)	0.2 (0.1 - 0.5)	<0.1 (0.1 - <0.1)	<0.1 (0.1 - <0.1)
Chromium (mg/kg)	26 (20 - 34)	22 (13 - 31)	24 (20 - 30)	28 (25 - 32)	36 (33 - 39)	35 (31 - 39)	33 (29 - 38)	27 (19 - 35)
Copper (mg/kg)	20 (12 - 25)	11 (6 - 16)	11 (9 - 14)	29 (20 - 39)	21 (14 - 23)	20 (16 - 26)	16 (14 - 19)	13 (10 - 17)
Lead (mg/kg)	36 (30 - 41)	28 (15 - 38)	30 (26 - 35)	47 (41 - 56)	46 (39 - 51)	43 (38 - 48)	44 (40 - 49)	34 (24 - 42)
Mercury (mg/kg)	0.08 (0.07 - 0.10)	0.05 (0.05 - 0.06)	<0.05 (0.05 - <0.05)	0.07 (0.06 - 0.10)	0.06 (0.05 - 0.07)	0.07 (0.06 - 0.09)	0.06 (0.05 - 0.07)	0.06 (0.05 - 0.13)
Nickel (mg/kg)	18 (15 - 21)	16 (9 - 24)	18 (15 - 22)	18 (16 - 20)	24 (21 - 25)	24 (22 - 27)	24 (21 - 28)	19 (13 - 23)
Silver (mg/kg)	0.2 (0.2 - 0.3)	<0.2 (0.2 - <0.2)	<0.2 (0.2 - <0.2)	0.9 (0.5 - 1.4)	0.3 (0.2 - 0.5)	0.2 (0.2 - 0.3)	<0.2 (0.2 - <0.2)	<0.2 (0.2 - <0.2)
Zinc (mg/kg)	91 (69 - 130)	66 (29 - 93)	66 (51 - 82)	100 (88 - 130)	100 (92 - 120)	100 (82 - 120)	96 (87 - 110)	74 (51 - 96)
Total Polychlorinated Biphenyls (PCBs) (μg/kg) [3]	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)	18 (18 - 18)
Low Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg) [4]	96 (90 - 140)	93 (90 - 110)	94 (90 - 130)	96 (90 - 140)	91 (90 - 100)	98 (90 - 160)	93 (90 - 110)	92 (90 - 100)
High Molecular Weight Polycylic Aromatic Hydrocarbons (PAHs) (μg/kg) [5] [6]	60 (38 - 82)	28 (19 - 36)	25 (20 - 40)	55 (28 - 190)	40 (25 - 51)	69 (28 - 170)	36 (29 - 44)	28 (18 - 67)

Note: 1 Data presented are arithmetic means ; data in brackets indicate ranges.

2 All data are based on the analyses of bulk (unsieved) sediment and are reported on a dry weight basis unless stated otherwise.

3 Total PCBs results are derived from the summation of 18 congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

4 Low molecular weight polyaromatic hydrocarbons (PAHs) include 6 congeners of molecular weight below 200, namely : Acenaphthene, Acenaphthylene, Anthracene, Flourene, Naphthalene and Phenanthrene.

5 High molecular weight polyaromatic hydrocarbons (PAHs) include 10 congeners of molecular weight above 200, namely : Fluoranthene, Pyrene, Benzo(a)anthracene, Chrysene, Benzo(b)fluoranthene, Benzo(k)fluoranthene, Benzo(a)pyrene, Dibenzo(a,h)anthracene, Benzo(g,h,i)perylene and Indeno(1,2,3-cd)pyrene.

6 Low and high molecular weight PAHs results are derived from the summation of the corresponding congeners. If the concentration of a congener is below report limit (RL), the result will be taken as 0.5xRL in the calculation.

Appendix C Relevant Non-statutory Marine Monitoring Results

Summary of Sediment Quality Parameters Recorded in September 2010

Monitoring Station / Sediment Quality Parameter	1	2	5	6	7	8	Average	LCEL	UCEL
Metals (mg/kg dry weight)									
Cadmium (Cd)	<0.2	<0.2	<0.2	<0.2	0.2	<0.2	<0.2	1.5	4
Chromium (Cr)	41	47	34	44	52	53	45.2	80	160
Copper (Cu)	24	36	26	34	43	39	33.7	65	110
Mercury (Hg)	0.05	0.15	0.08	0.09	0.12	0.12	0.10	0.5	1
Nickel (Ni)	24	29	21	28	33	34	28.2	40	40
Lead (Pb)	37	42	44	42	48	47	43.3	75	110
Silver (Ag)	0.2	0.3	0.3	0.2	0.3	0.3	0.3	1	2
Zinc (Zn)	106	134	121	136	154	152	133.8	200	270
Metalloid (mg/kg dry weight)									
Arsenic (As)	15	20	21	15	21	20	18.7	12	42
Organics-PAHs (μ g/kg dry weight)									
Naphthalene	<50	<50	<50	<50	<50	<50	<50	N/A	N/A
Acenaphthylene	<50	<50	<50	<50	<50	<50	<50	N/A	N/A
Acenaphthene	<50	<50	<50	<50	<50	<50	<50	N/A	N/A
Phenanthrene	<50	<50	<50	<50	<50	<50	<50	N/A	N/A
Anthracene	<50	<50	<50	<50	<50	<50	<50	N/A	N/A
Pyrene	<150	<150	<150	<150	<150	<150	<150	N/A	N/A
Benzo[a]anthracene	<150	<150	<150	<150	<150	<150	<150	N/A	N/A
Chrysene	<150	<150	<150	<150	<150	<150	<150	N/A	N/A
Benzo[b]&[k]fluoranthere	<150	<150	<150	<150	<150	<150	<150	N/A	N/A
Benzo[a]pyrene	<150	<150	<150	<150	<150	<150	<150	N/A	N/A
Indeno[1,2,3 – c.d]pyrene	<150	<150	<150	<150	<150	<150	<150	N/A	N/A
Benzo[g,h,i]perylene	<150	<150	<150	<150	<150	<150	<150	N/A	N/A
Low Molecular Weight PAH[2]	<550	<550	<550	<550	<550	<550	<550	550	3160
High Molecular Weight PAH[2]	<1700	<1700	<1700	<1700	<1700	<1700	<1700	1700	9600
Organics –non-PAHs (μ g/kg dry weight)									
Total PCBs	<18	<18	<18	<18	<18	<18	<18	23	180
Organochlorine Pesticides (mg/kg dry weight)									
Aldrin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A
p, p' - DDD	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A
p, p' - DDE	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A
p, p' - DDT	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	N/A	N/A
alpha – HCH	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A
beta - & gamma - HCH	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	<0.10	N/A	N/A
delta - HCH	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A
Dieldrin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A

Monitoring Station / Sediment Quality Parameter	1	2	5	6	7	8	Average	LCEL	UCEL
Endosulphate I	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A
Endosulphate II	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A
Endosulphate sulphate	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A
Endrin	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A
Endrin aldehyde	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A
Heptachlor	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A
Heptachlor epoxide	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	N/A	N/A

Note:

(1) Shaded values denote exceedance of LCEL but below UCEL

(2) Values less than reporting limit (indicated with "<") were substituted with half of the reporting limit to allow for graphical presentation.

(3) N/A denotes Not Applicable

Source: Mott MacDonald Limited, 2011, *Hong Kong International Airport, Contract P132 Engineering Feasibility and Environmental Assessment Study for Airport Master Plan 2030, Non-Statutory Marine Environmental Monitoring Update 2009/2010 – Final Monitoring Report*.

Appendix D Relevant EM&A Results at Sha Chau

Source: ERM, 2012, *Environmental Monitoring and Audit for Contaminated Mud Pit at Sha Chau (2009-2013) – Investigation, Agreement No. CE 4/2009 (CE), 33rd Monthly Progress Report for Contaminated Mud Pits at Sha Chau – March 2012*.

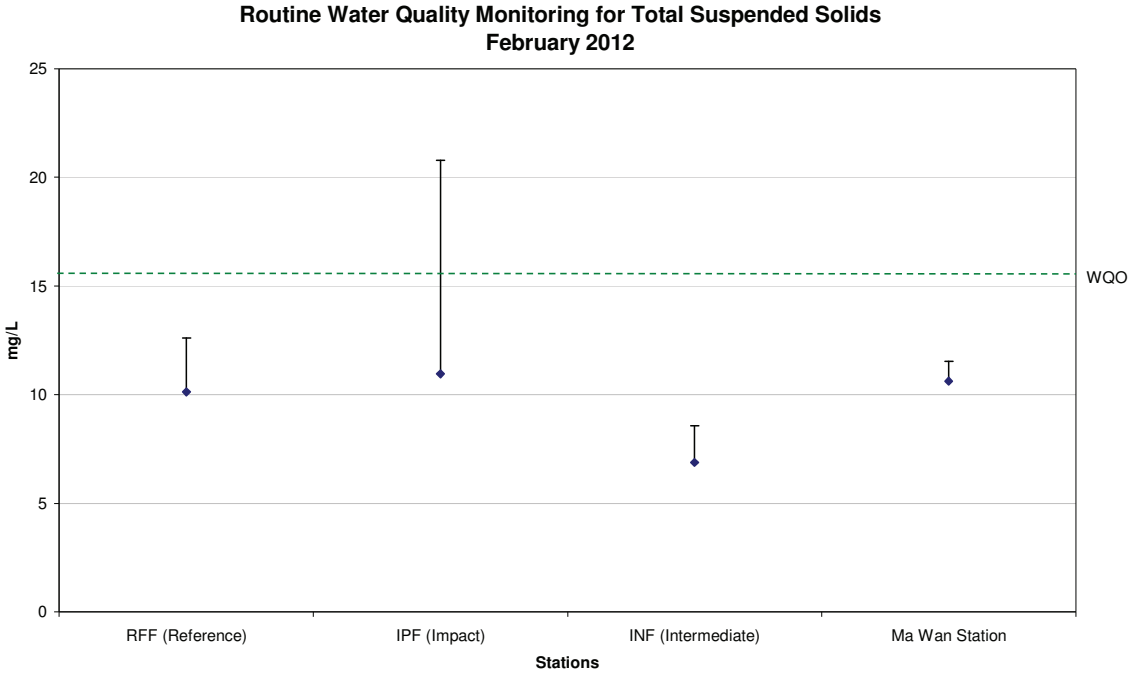


Figure 11: Concentration of Total Suspended Solids (mean + SD) in water samples for Routine Water Quality Monitoring for CMP V in February 2012.

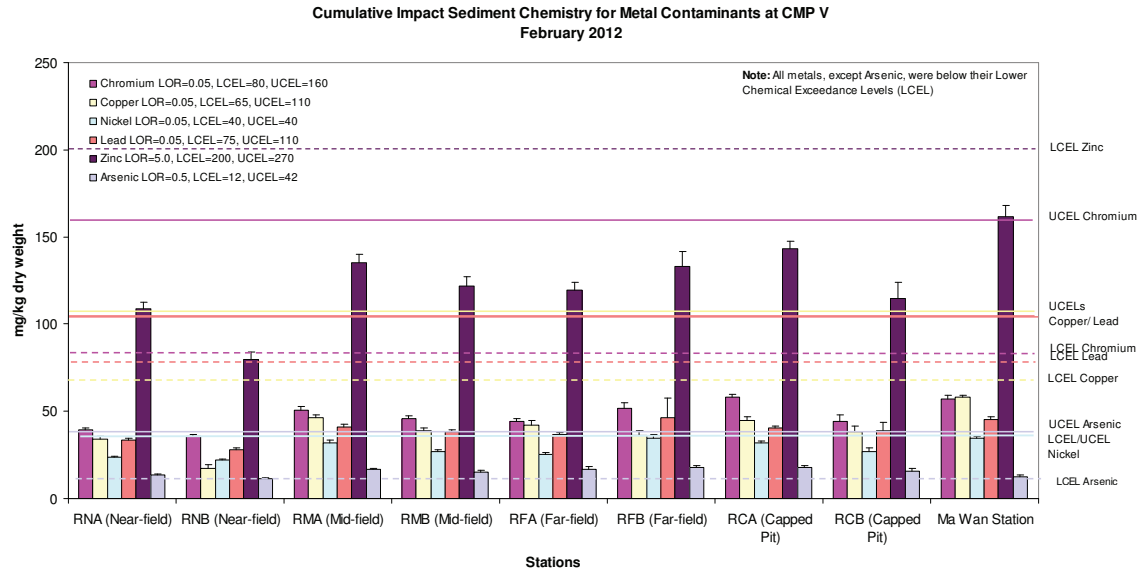


Figure 12: Concentration of Metals (CR, Cu, Ni, Pb, Zn, As; mean + SD) in sediment samples for Cumulative Impact Sediment Analysis for CMP V during February 2012.

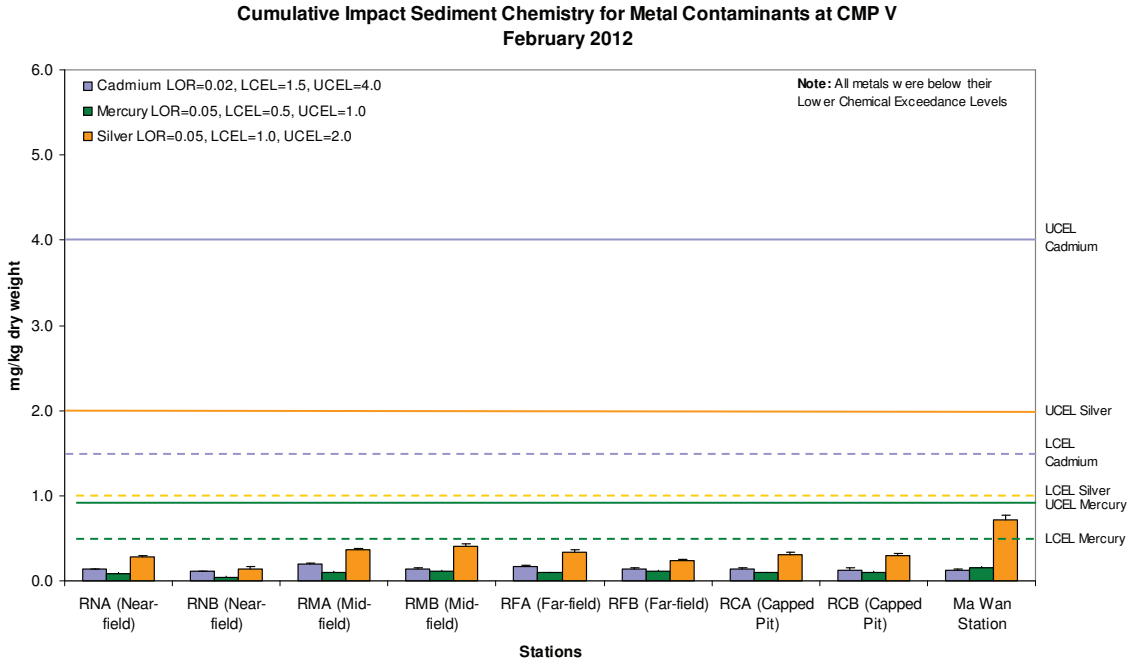


Figure 13: Concentration of Metals (Cd, Hg, Ag; mean + SD) in sediment samples for Cumulative Impact Sediment Analysis for CMP V during February 2012.

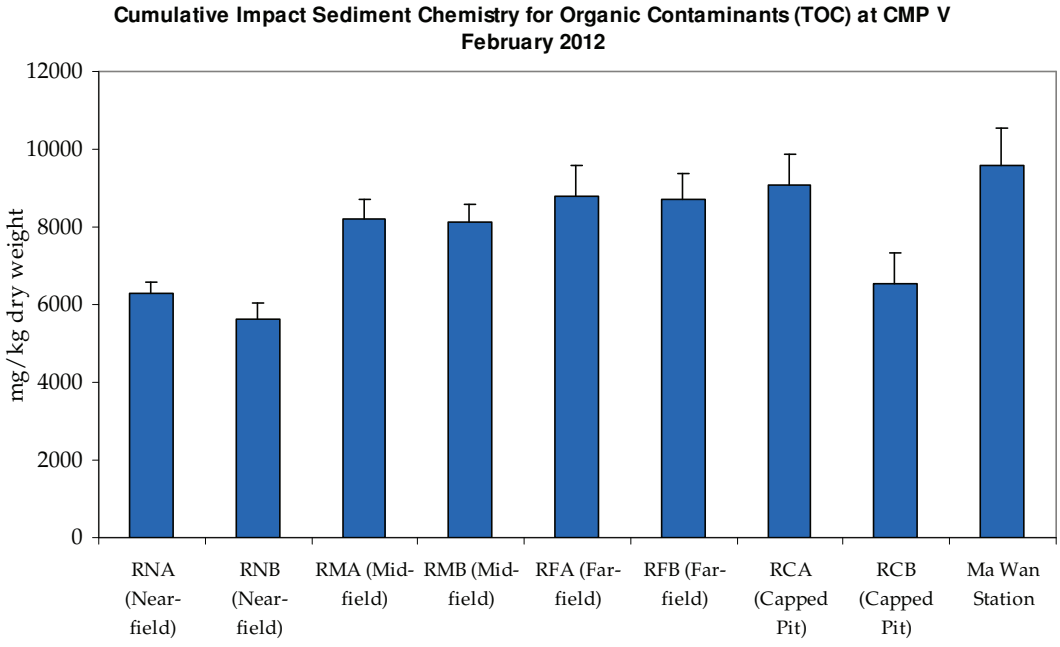


Figure 14: Concentration of Total Organic Carbon (TOC; mean + SD) in sediment samples for Cumulative Impact Sediment Analysis for CMP V during February 2012.

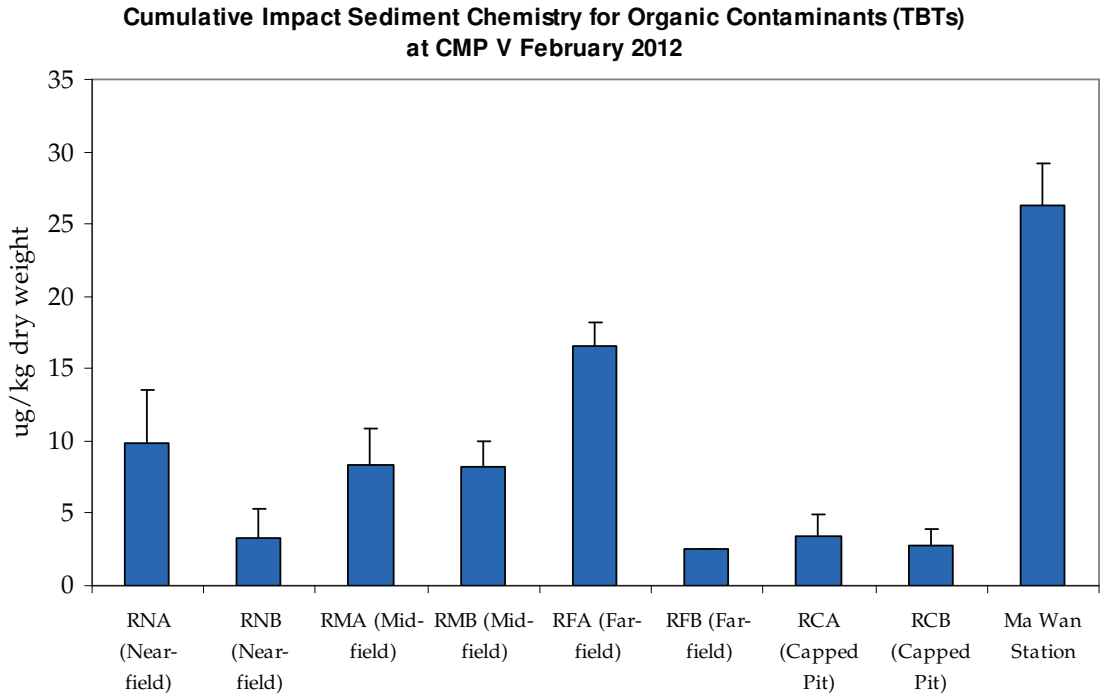


Figure 15: Concentration of Tributyltin (TBT; mean + SD) in sediment samples for Cumulative Impact Sediment Analysis during February 2012.

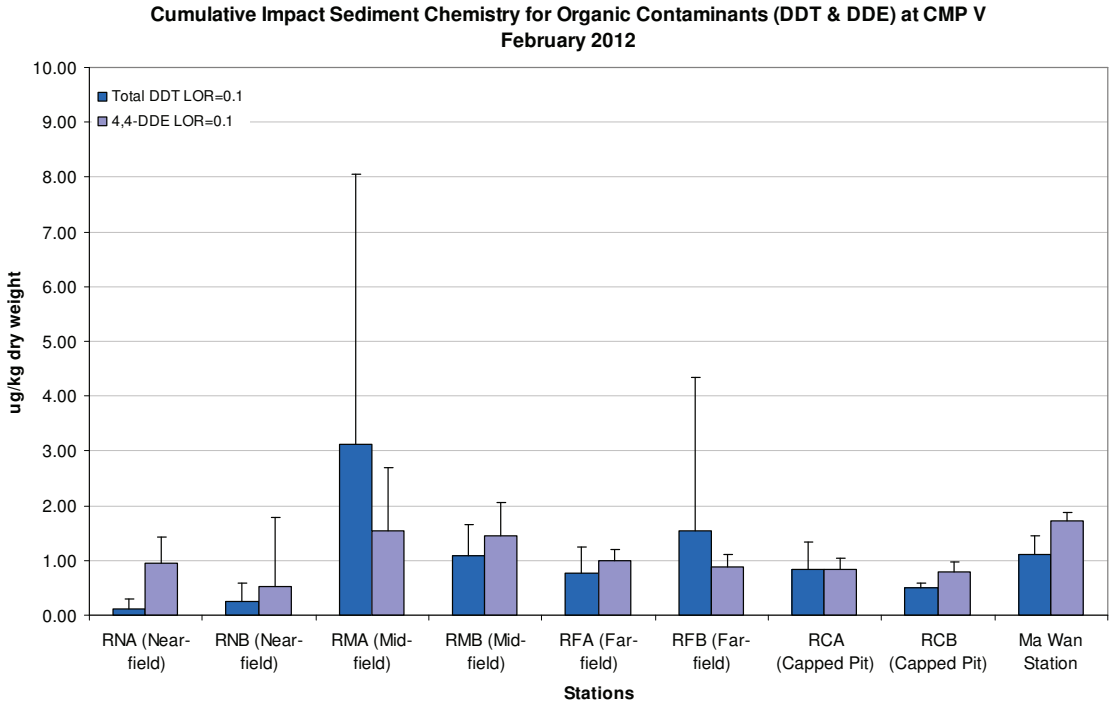


Figure 16: Concentration of Total DDT and 4,4″-DDE (mean + SD) in sediment samples for Cumulative Impact Sediment Chemistry for CMP V during March 2012.

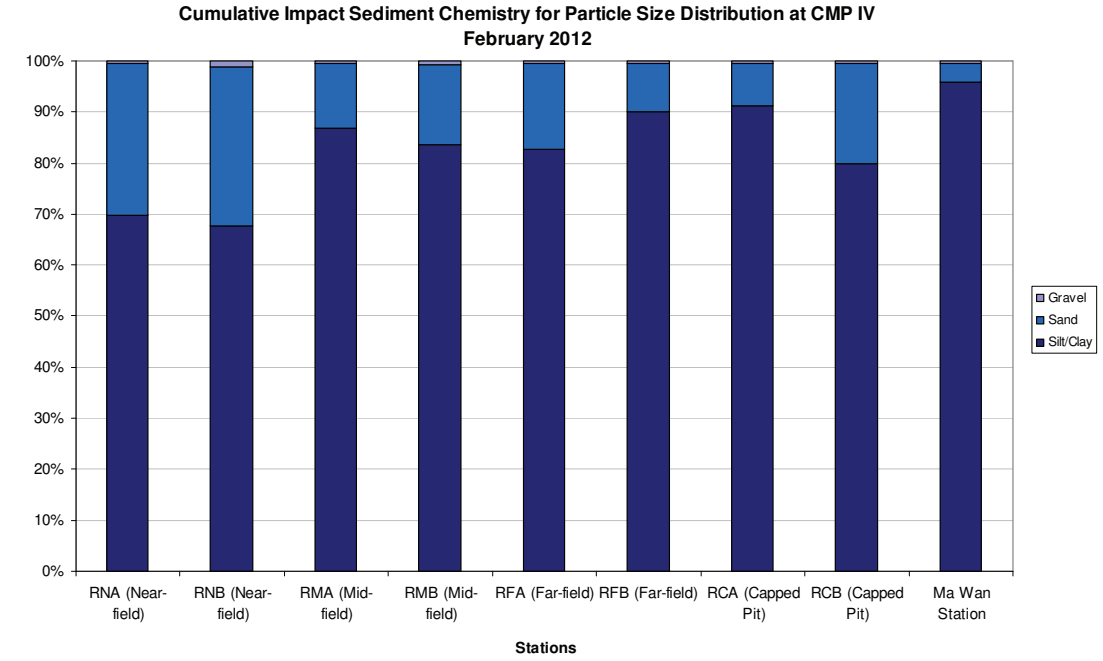


Figure 17: Particle Size Distribution (% mean) of sediment samples for Cumulative Impact Sediment Chemistry for CMP V during March 2012.

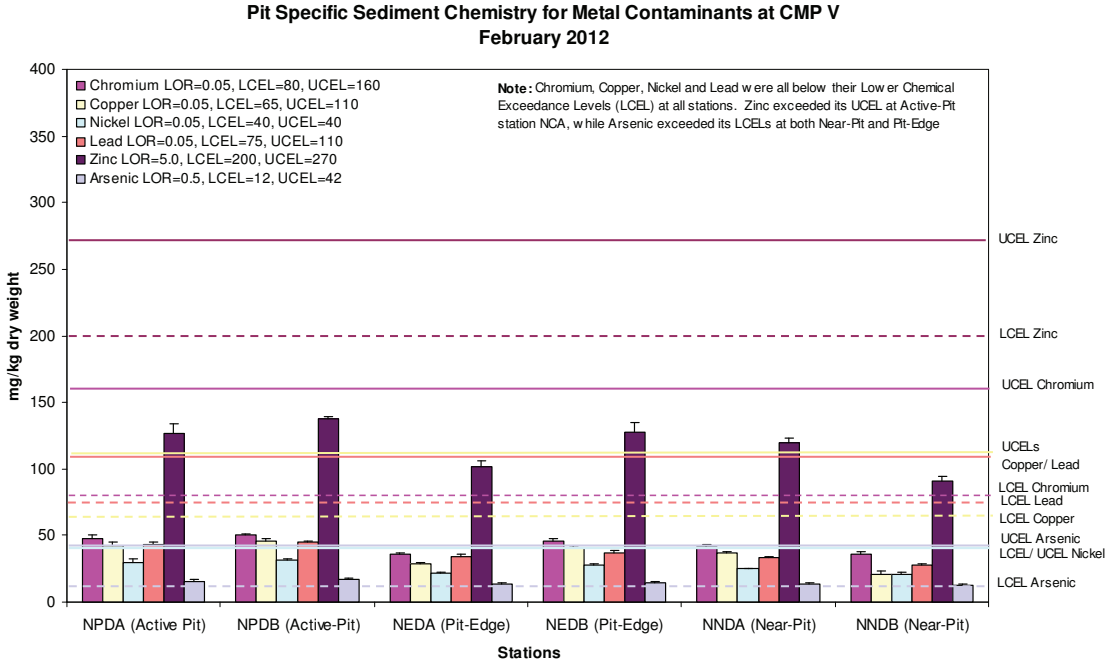


Figure 18: Concentration of Metals (Cr, Cu, Ni, Pb, Zn, As; mean + SD) in sediment samples for Pit Specific Sediment Chemistry for CMP V during February 2012.

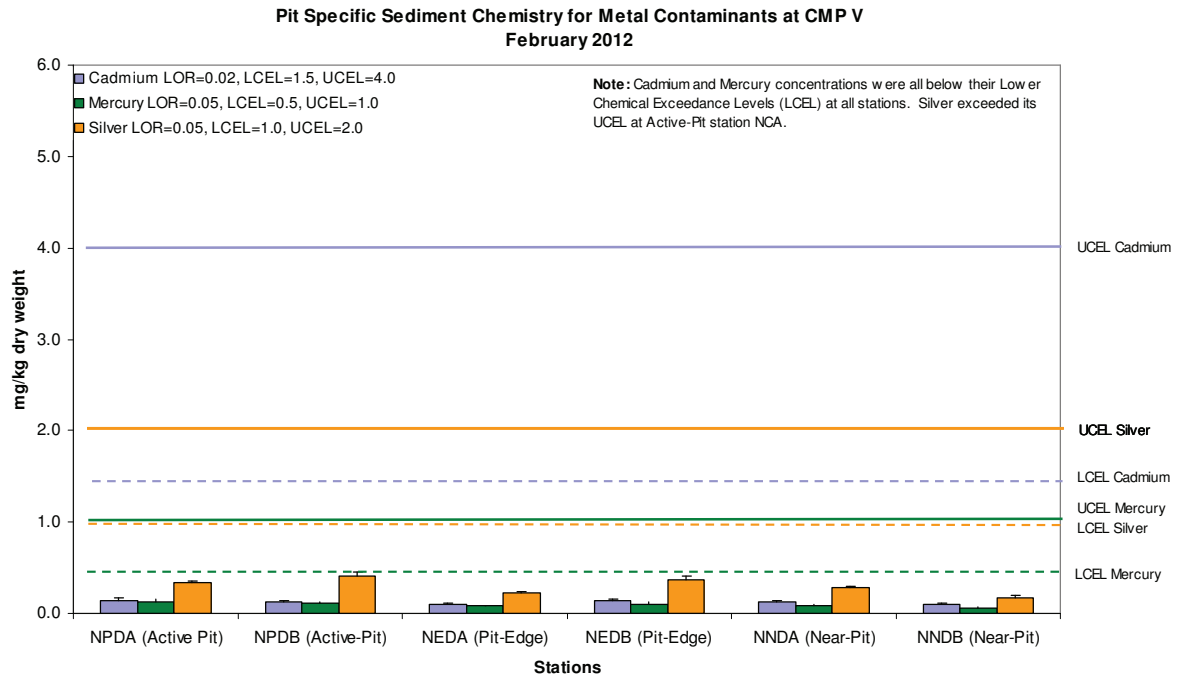


Figure 19: Concentration of Metals (Cd, Hg, Ag; mean + SD) in sediment samples for Pit Specific Sediment Chemistry for CMP V during February 2012.

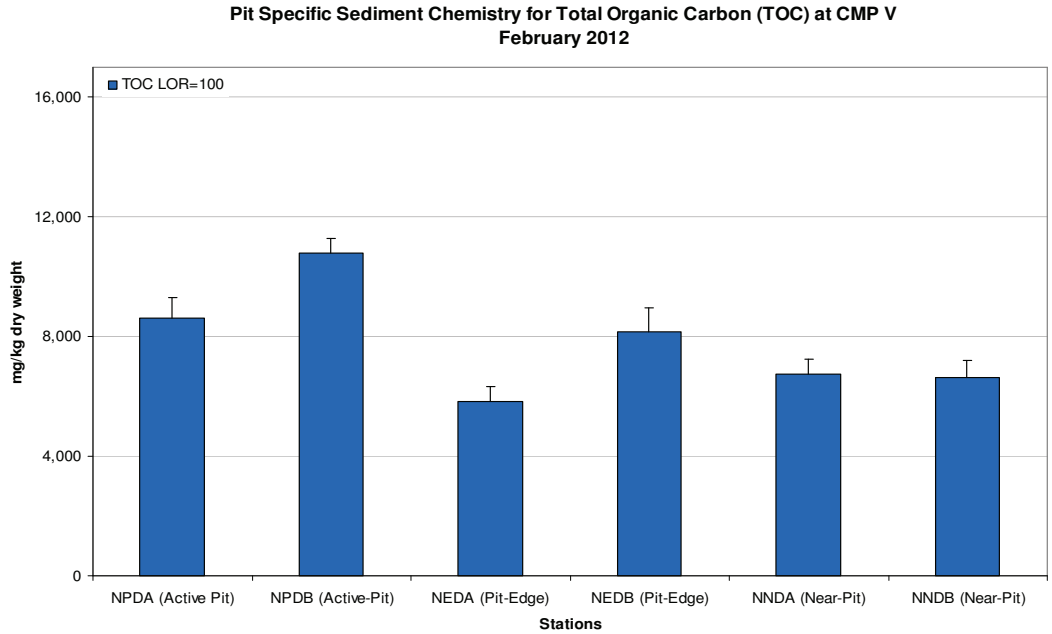


Figure 20: Concentration of Total Organic Carbon (TOC; mean + SD) in sediment samples for Pit Specific Sediment Chemistry for CMP V during February 2012.

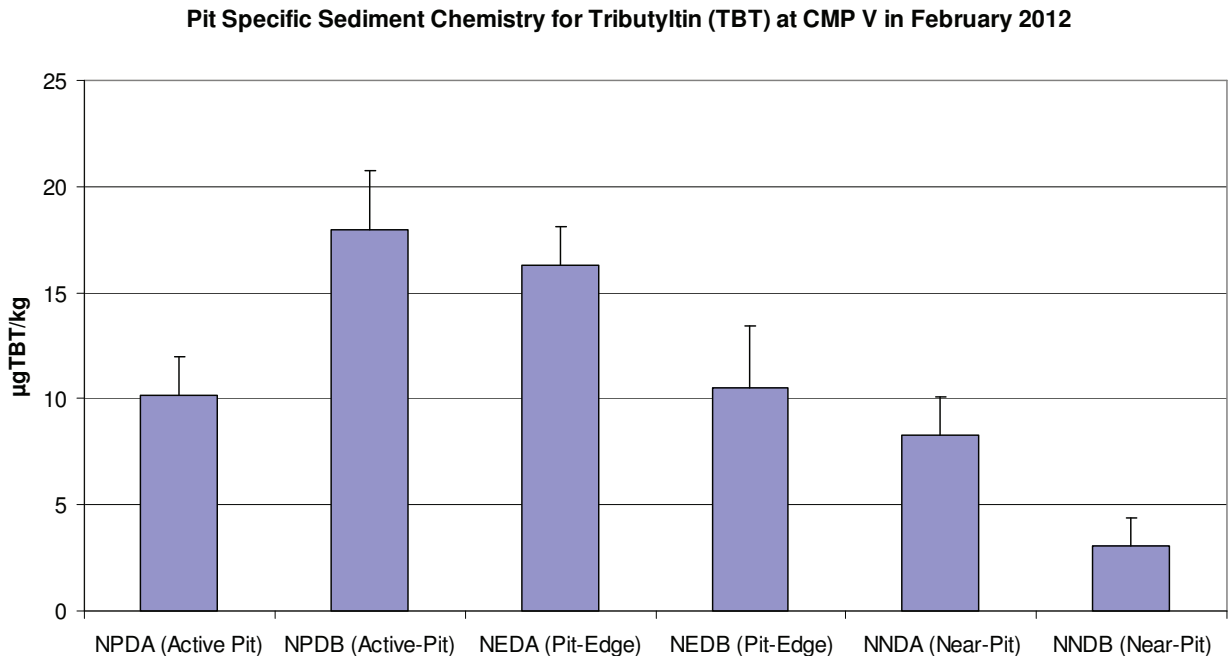


Figure 21: Concentration of Tributyltin (TBT; mean + SD) in sediment samples for Pit Specific Sediment Chemistry for CMP V during February 2012.

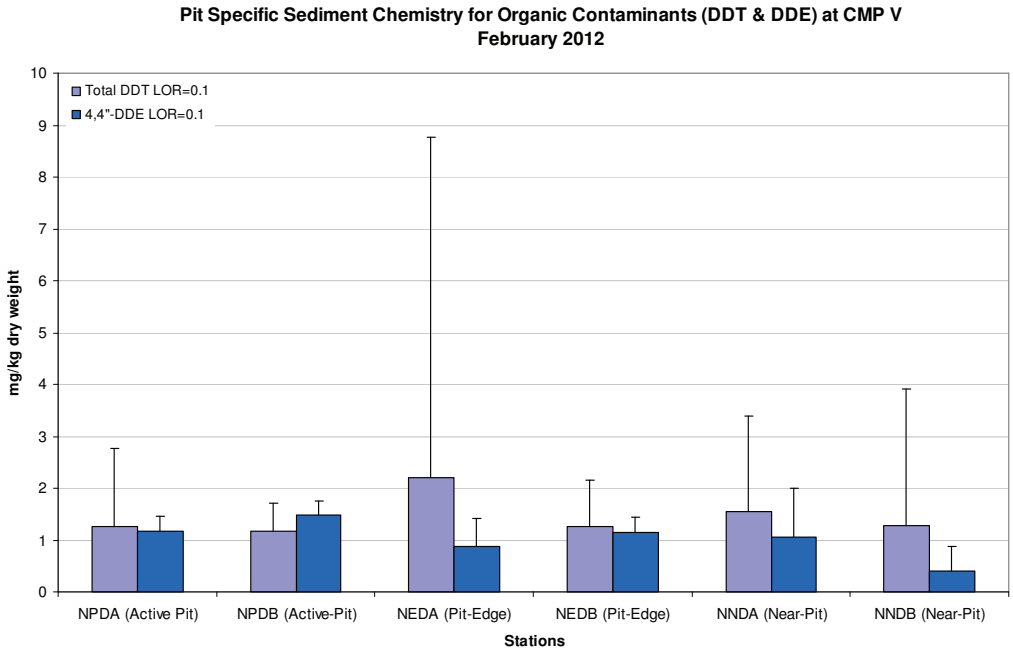


Figure 22: Concentration of Total DDT and 4,4″-DDE (mean + SD) in sediment samples for Pit Specific Sediment Chemistry for CMP V during February 2012.

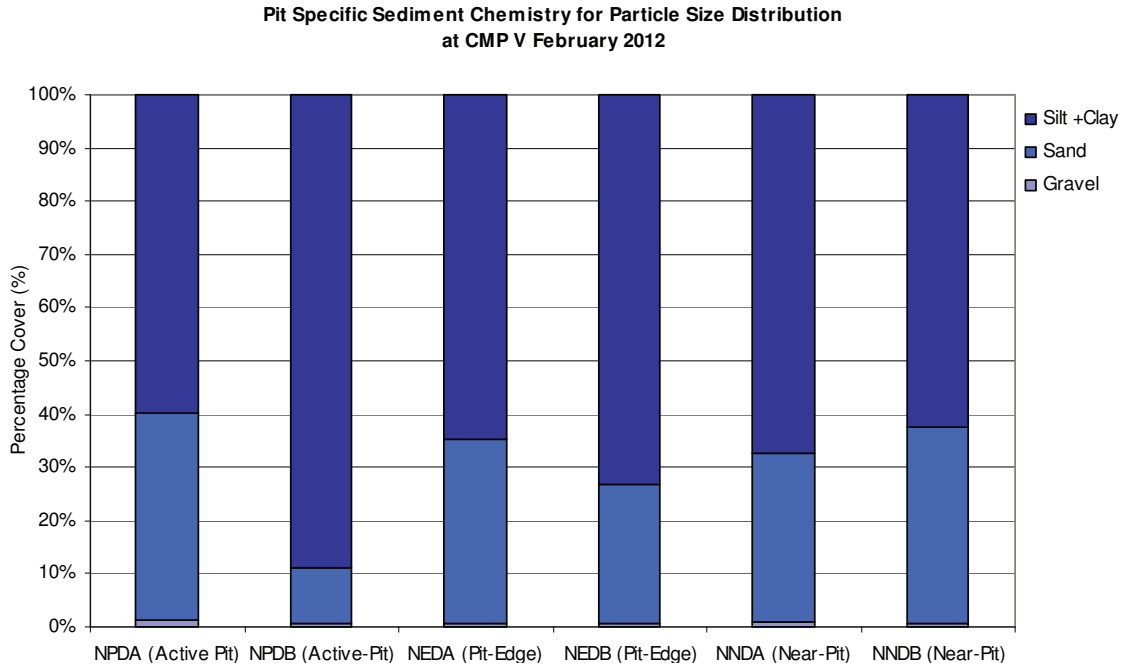


Figure 23: Particle Size Distribution (% mean) of sediment samples for Pit Specific Sediment Chemistry for CMP V during February 2012.

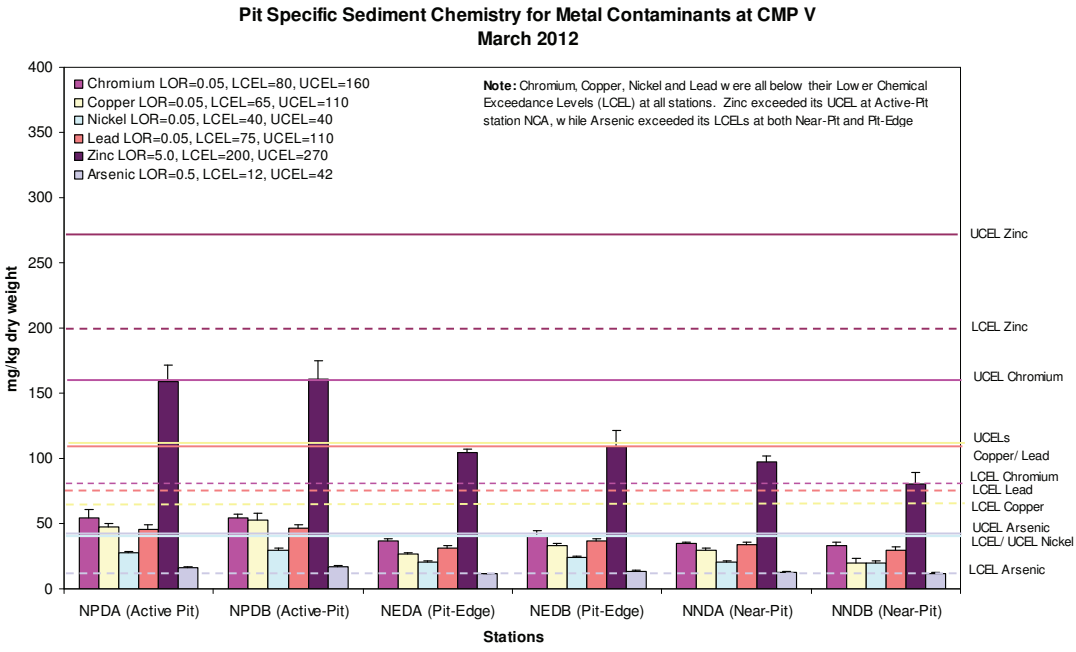


Figure 24: Concentration of Metals (Cr, Cu, Ni, Pb, Zn, As; mean + SD) in sediment samples for Pit Specific Sediment Chemistry for CMP V during March 2012.

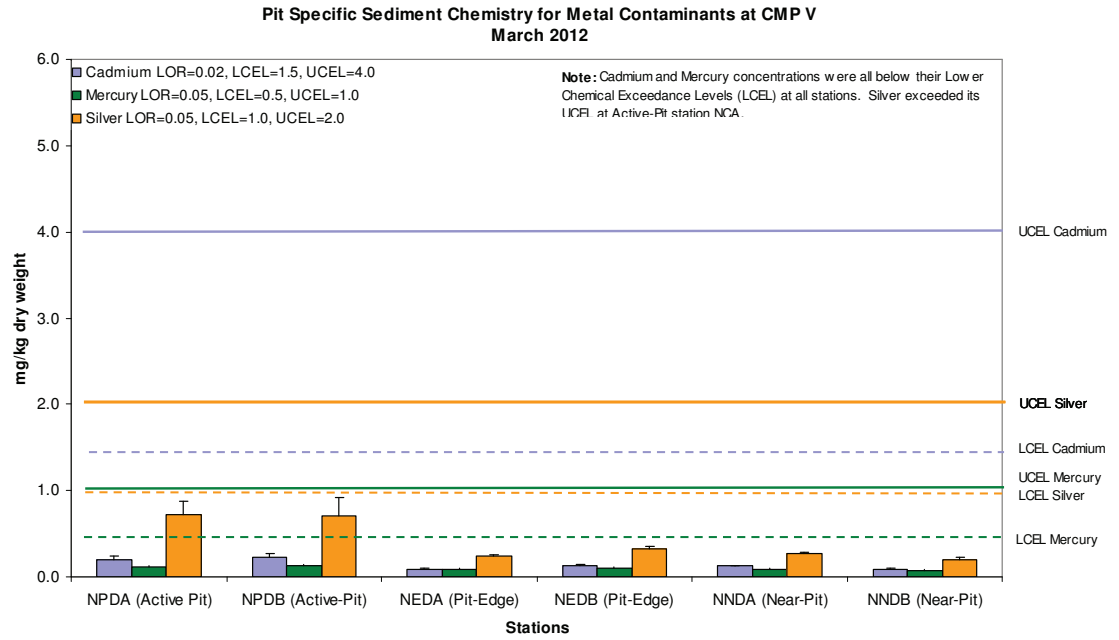


Figure 25: Concentration of Metals (Cd, Hg, Ag; mean + SD) in sediment samples for Pit Specific Sediment Chemistry for CMP V during March 2012.

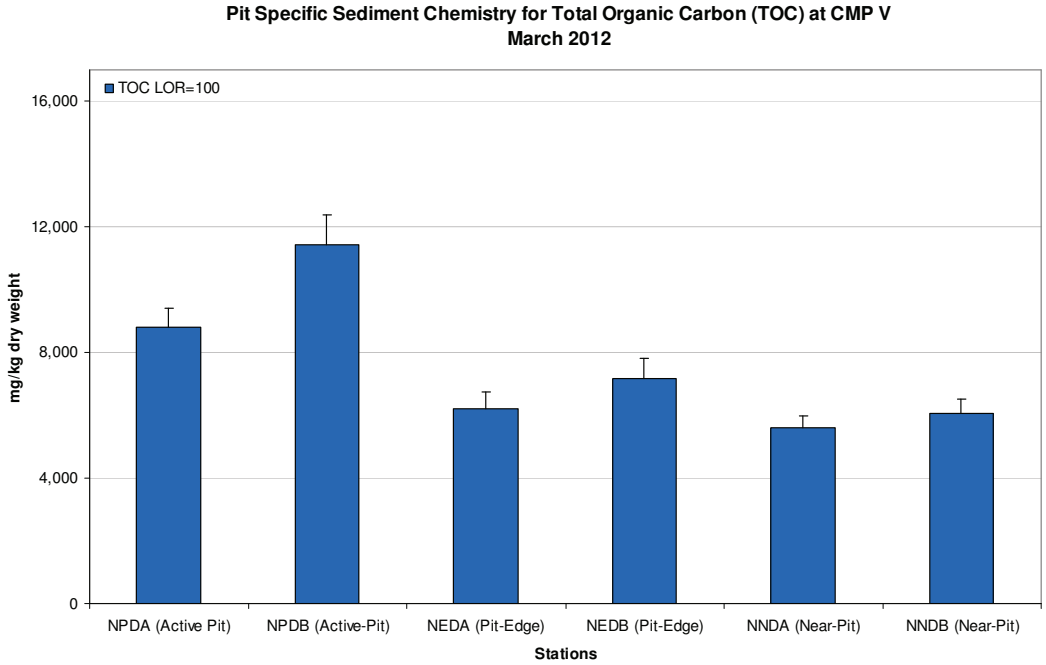


Figure 26: Concentration of Total Organic Carbon (TOC; mean + SD) in sediment samples for Pit Specific Sediment Chemistry for CMP V during March 2012.

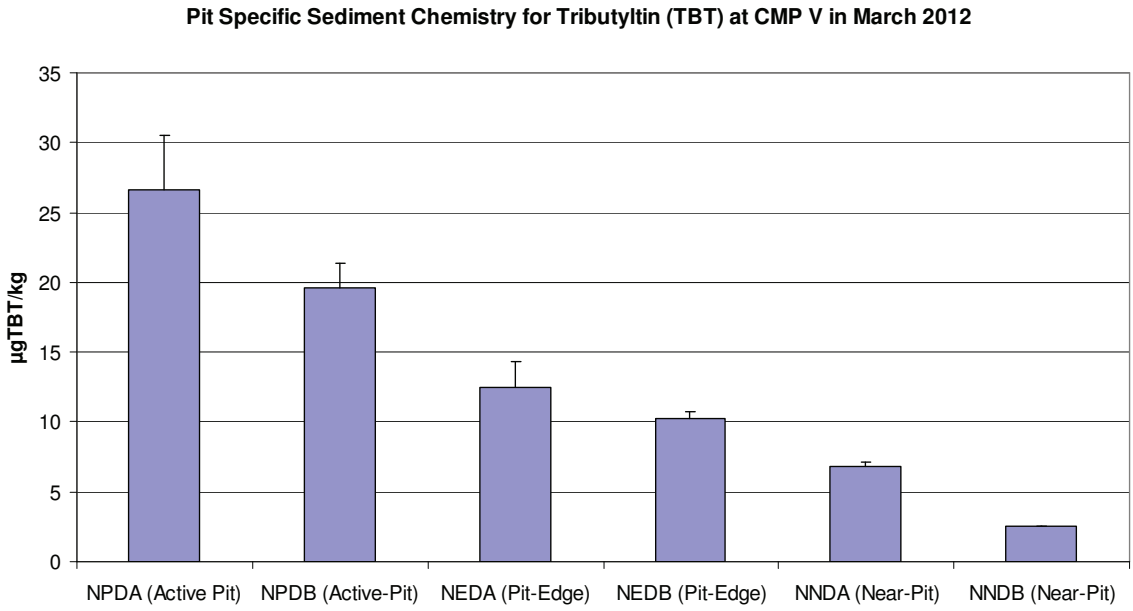


Figure 27: Concentration of Tributyltin (TBT; mean + SD) in sediment samples for Pit Specific Sediment Chemistry for CMP V during March 2012.

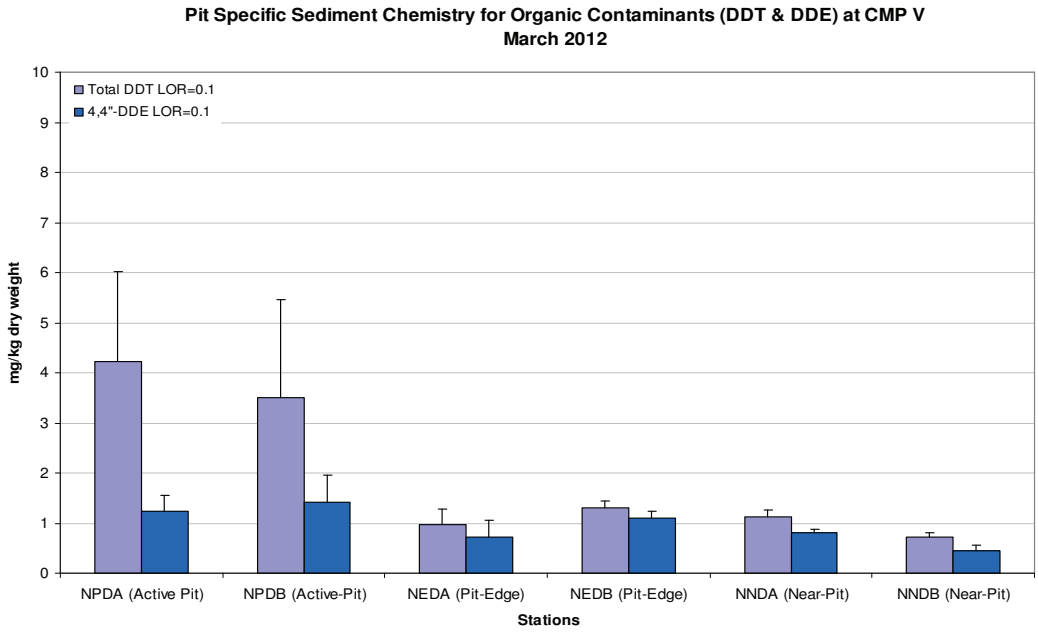


Figure 28: Concentration of Total DDT and 4,4″-DDE (mean + SD) in sediment samples for Pit Specific Sediment Chemistry for CMP V during March 2012.

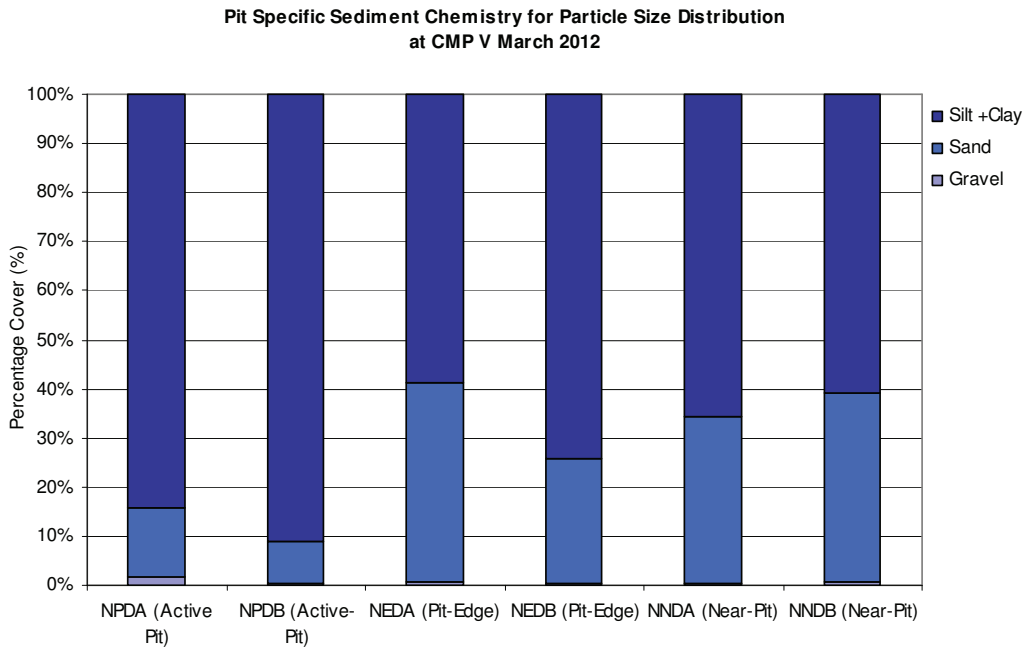


Figure 29: Particle Size Distribution (% mean) of sediment samples for Pit Specific Sediment Chemistry for CMP V during March 2012.

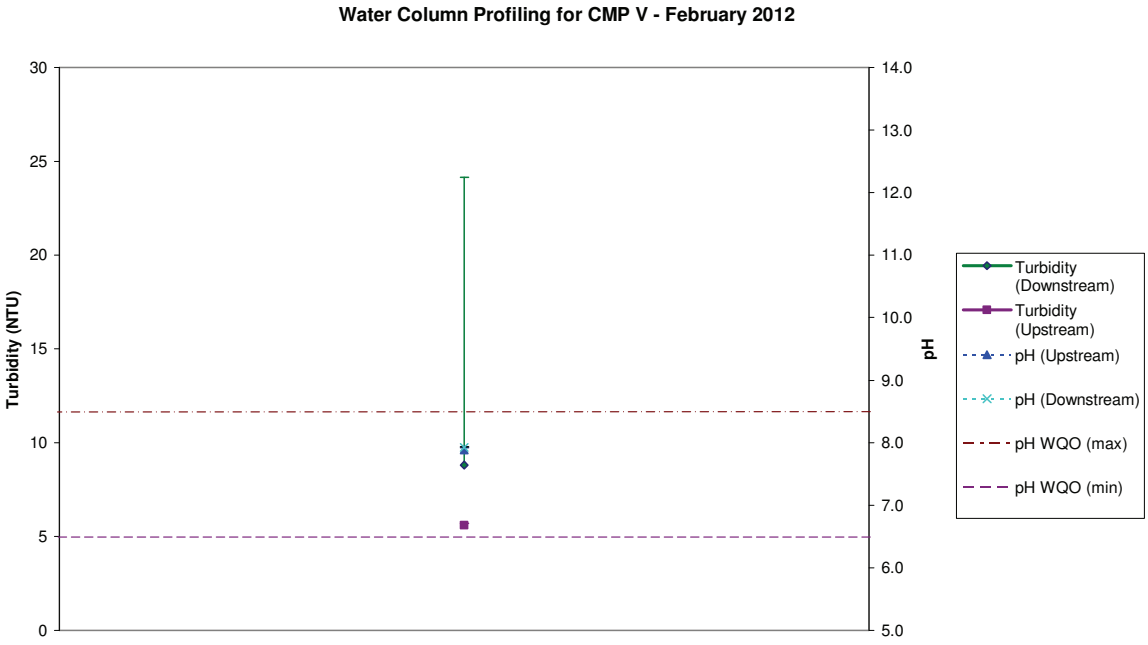


Figure 30: Turbidity and pH (mean + SD) during Water Column Profiling for CMP V in February 2012.

Appendix E Proposed Vibrocore and Grab Sampling Locations

Vibrocore / Grab Sample No.	Easting	Northing	Proposed Depth
Proposed reclamation area outside the contaminated mud pits (see Note 1)			
RV01	805477.935	820054.150	14.9m
RV02	806045.246	820249.491	14.9m
RV03	806612.558	820444.832	14.9m
RV04	807179.869	820640.173	14.9m
RV05	807747.180	820835.513	14.9m
RV06	808016.941	819772.559	14.9m
RV07	808584.252	819967.900	14.9m
RV08	809151.563	820163.241	14.9m
RV09	809718.874	820358.582	14.9m
RV10	810286.186	820553.923	14.9m
RV11	810853.497	820749.264	14.9m
Proposed reclamation area in the contaminated mud pits			
AV01	807236.529	820436.298	20.9m
AV02	807938.513	820588.415	18.1m
AV03	809150.292	820954.795	15.7m
AV04	808419.134	821062.358	16.0m
AV05	808584.070	821303.380	15.6m
AV06	809070.459	821560.196	16.3m
AV07	808130.989	820337.557	20.5m
AV08	808760.295	820660.001	20.0m
AV09	808878.048	821546.649	16.3m
AV10	809203.616	820601.130	11.8m
AV11	809445.359	821741.989	27.9m
Periodical maintenance dredging of navigation channel to the north of the proposed reclamation area			
FG001	804743.732	820757.500	Grab
FG002	805311.043	820952.841	Grab
FG003	805878.354	821148.182	Grab
FG004	806445.665	821343.522	Grab
FG005	807012.976	821538.863	Grab
FG006	807580.287	821734.204	Grab
FG007	808147.598	821929.545	Grab
FG008	808714.910	822124.886	Grab
FG009	809282.221	822320.227	Grab
Tentative corridor for Option C1 – diversion of the submarine cable by water jetting method			
SG01	807513.807	818075.714	Grab
SG02	807314.174	818087.827	Grab
SG03	807114.541	818099.939	Grab
SG04	806914.908	818112.052	Grab
SG05	806715.276	818124.164	Grab
SG06	806515.643	818136.277	Grab

Vibrocore / Grab Sample No.	Easting	Northing	Proposed Depth
SG07	806316.010	818148.389	Grab
SG08	806116.377	818160.502	Grab
SG09	805918.622	818185.778	Grab
SG10	805747.089	818285.390	Grab
SG11	805625.363	818443.440	Grab
SG12	805512.213	818608.355	Grab
SG13	805399.063	818773.271	Grab
SG14	805285.913	818938.186	Grab
SG15	805172.763	819103.101	Grab
SG16	805059.613	819268.016	Grab
SG17	804946.462	819432.932	Grab
SG18	804833.312	819597.847	Grab
SG19	804738.732	819773.402	Grab
SG20	804695.179	819967.953	Grab
SG21	804706.264	820167.011	Grab
SG22	804802.007	820341.679	Grab
SG23	804946.804	820478.473	Grab
SG24	805115.014	820586.502	Grab
SG25	805293.388	820676.767	Grab
SG26	805479.236	820750.577	Grab
SG27	805666.450	820820.934	Grab
SG28	805854.599	820888.755	Grab
Diversion of submarine cable from airport to the south of SCLKC Marine Park by water jetting method with field joint area (Option C1)			
RV12	806409.295	821026.527	14.9m
RV13	806389.016	821139.514	14.9m

Note:
1. Based on geological profile as presented in Drawing MCL-P132-EIA-5-001.

Mott MacDonald

Appendix F Key QA/QC Requirements for Relevant On-site Sampling and Laboratory Testing Works

HOKLAS Supplementary Criteria No. 10

"Environmental Testing" Test Category - Accreditation of Site Testing and Sampling (Water, Waste Water and Sediment)

1 INTRODUCTION

1.1 This document is an amplification and interpretation of the requirements of HKAS 002 and HOKLAS 003 for the accreditation of site testing and sampling of water, waste water and sediment. Where appropriate, the requirements given in HOKLAS Supplementary Criteria No. 6 "Environmental Testing" Test Category – Chemical Testing also apply.

1.2 Only laboratories already accredited for water, waste water and/or sediment testing may apply for extension of scope to cover site testing/sampling in the related areas. Organisations accredited for both testing at a permanent laboratory and the related site testing/sampling may, if they wish, undertake either one of the two activities separately (and issue HOKLAS endorsed sampling reports or test reports as appropriate).

1.3 Site testing includes testing performed at a site laboratory, or testing performed in-situ (e.g. using test probes for direct measurement of the water body for parameters like pH, temperature, flow, dissolved oxygen, turbidity, salinity, conductivity, etc.) Sampling means sampling activities carried out on site according to a pre-determined sampling plan and a set of documented sampling procedures, (including sample pretreatment and preservation by filtering, acidification, or refrigeration etc.)

1.4 The terms of accreditation for sampling are restricted to operations carried out in accordance with a set of documented and well defined procedures. Accreditation will not be granted for the design of sampling programmes (i.e. sampling plans) or the subsequent interpretation of test results from such sampling programmes.

1.5 Assessment, reassessment, and surveillance will be conducted at the individual sites as well as at the permanent laboratory.

2 QUALITY SYSTEM

2.1 The Quality Manual (QM) for the permanent laboratory shall provide for all aspects of operation of sampling, site testing, and the permanent laboratory. The QM shall contain a separate section dealing with site testing/sampling.

2.2 The QM shall therefore contain, or refer to, documentation concerning the following :

(a) an up-to-date register of sites.

(b) details of type of testing/sampling undertaken at each site, e.g. sampling (types of matrix, sampling types), testing at site laboratory, in-situ testing, etc.

(c) a statement of the quality policies and objectives for testing/sampling on site. This shall include a statement that a standard of service consistent with the requirements of HOKLAS shall be provided at all times for the HOKLAS accredited tests (including sampling).

(d) a separate scope listing (include sampling) performed on site and/or at the permanent laboratory.

2.3 The QM shall also contain details of how the quality system is applied to site testing/sampling, and in particular :

(a) an organisational chart for the permanent laboratory showing lines of responsibility for staff authorized to perform site testing and sampling.

(b) the arrangements for the supervision of site testing/sampling, and in particular where the site is not under the direct control of the laboratory.

(c) the responsibilities of staff nominated for control of all technical and quality matters concerned with site testing/sampling; there shall be a direct link between nominated staff and the technical management team and Quality Manager of the permanent laboratory.

2.4 Acceptance of job requests shall be based on information submitted by customer in a work request which should include a detailed sampling plan (or in-situ test plan) and the tests required (may be performed in permanent laboratory) for the samples.

The sampling plan (or in-situ test plan) shall include as minimum information, the exact location, sampling points, frequency, time, and type of sampling and number of samples required per sampling point. (A checklist for items normally appearing in a sampling plan (or in-situ test plan) is attached in annex I for reference)

3 SUB-CONTRACTING

3.1 If sub-contracting of the accredited tests/sampling is necessary, a laboratory accredited by HOKLAS or its MRA partners for the activities concerned shall be used.

4 CONTROL OF RECORDS

4.1 Procedures shall exist for recording and reporting all results obtained on site and shall be co-ordinated with the system operating in the permanent laboratory.

4.2 In case of sampling (or in-situ testing), the details of the sampling/testing event shall be recorded. For this purpose, a proforma record sheet (may include space for diagrams) should be provided in accordance with relevant standards. Other media such as videotape and photography should be used where appropriate to supplement written description and to serve as supporting evidence of the event.

4.3 Procedures shall exist for ensuring confidentiality and security of test data and samples held on site.

4.4 The person(s) performing the testing/sampling, and the supervisor present on site shall sign on the record sheet at the time when the activities are being carried out.

5 INTERNAL AUDITS AND MANAGEMENT REVIEWS

5.1 The QM shall contain or refer to documented detailed procedures for the regular audit and review of the quality system for sampling and testing carried out in both the permanent laboratory and on site.

5.2 The Quality Manager for the permanent laboratory or his deputy shall visit sites

as part of the audit and review programme.

(a) the site staff performance will be audited by the Quality Manager and/or his deputy at least annually.

(b) each type of testing/sampling listed on the HOKLAS site testing/sampling scope shall be audited and reviewed by the Quality Manager and/or his deputy at least annually.

5.3 The documented results of all audits so obtained for site testing/sampling will be examined by HOKLAS assessors during their regular visits to the permanent laboratory.

5.4 The Quality Manager of the permanent laboratory or his deputy shall monitor progress on remedial actions identified and recorded during audits and reviews. If necessary he shall make extra visits to sites to ensure that these actions have been discharged and the audit records completed.

6 PERSONNEL

6.1 Approved Signatory requirements shall be in accordance with section 3.3 of HOKLAS Supplementary Criteria No. 6. Approved signatories shall ensure that sufficient supervision is provided to testing/sampling staff on site.

6.2 The permanent laboratory shall have procedures for ensuring that staff deployed for testing/sampling on site are properly trained. Training programme shall also include criteria for acceptance of staff to become authorised site testing staff or sampler. Training and competence assessment records, including any raw data, shall be maintained. Records of authorisation shall also be maintained.

6.3 Sampling and on site testing shall only be performed by personnel who are employed by, or under contract to, the laboratory. Adequate on-site supervision shall be provided by trained laboratory staff when contract workers are used by the permanent laboratory to assist in testing/sampling. The contract workers shall be trained by the laboratory on the proper use of equipment and they shall possess sufficient technical knowledge and skill necessary for the correct performance of the activities they are responsible. Training records shall be maintained by the laboratory. Means to ensure that they carry out the sampling activities in accordance with the documented procedures is required.

7 ACCOMMODATION AND ENVIRONMENTAL CONDITIONS

7.1 The environment in which the sampling/tests are undertaken shall meet all testing/sampling procedure requirements, not invalidate the test results, or adversely affect the required accuracy and precision of measurement. The environmental conditions shall be recorded, if necessary.

7.2 Where sampling/tests are undertaken in a hostile environment, there shall be procedures for checking that the environment does not adversely affect the performance of sampling/test equipment.

7.3 Adequate measures shall be taken to ensure good housekeeping in the sampling/testing area.

7.4 In the case where automatic sampling/testing equipment is used and where operators may not be present all the time, there shall be provisions to ensure security of such equipment and integrity of results/samples obtained. Appropriate checks shall be performed on site to confirm calibration status and proper functioning before testing/sampling commences and at regular intervals.

8 TEST METHODS AND METHOD VALIDATION

8.1 Where available, procedures published in international and national standards should be employed. Normally, only standard sampling procedures will be accredited. Moreover, when a test standard specifies a sampling procedure, that sampling procedure shall be followed. A test/sampling procedures manual shall be available to all staff performing sampling or testing on site.

8.2 Any sampling procedure should be a step by step procedure and should take into consideration the requirement of the sampling plan provided, specific parameter of interest, sampling techniques, sample volume, sample preservation requirements, type of equipment, and calibration (if required), and reference should be made to any site testing procedures (if required) and to a proforma sampling record form (items which normally appear in a sampling procedure are listed in annex II for reference). Guidance on sampling is given in various parts of *ISO5667 Water Quality – Sampling*.

8.3 Procedures shall exist for provision of current test/sampling specifications to staff working on site. Documented on-site testing and/or sampling procedures,

and any amplification of standards and specifications, shall be available to staff testing/sampling on site.

8.4 All tests listed in the Scope of Accreditation for site testing/sampling shall be carried out on site in accordance with HOKLAS requirements and any specific requirements laid down by the customer. Where the customer imposes deviations, additions or exclusions from the accredited test/sampling procedures and conditions this shall be recorded in detail in the permanent work sheets and on all documents containing the sample information or test results. HOKLAS endorsed reports shall not be used in such cases because the procedures used have not been assessed by HKAS and hence are outside the scope of accreditation. Regulations on the inclusion of results of non-accredited activities in a HOKLAS endorsed report or certificate given in HKAS 002 and HOKLAS Supplementary Criteria No. 33 apply to these cases.

8.5 As far as possible, in-house test procedures shall be validated under conditions which are close to site testing conditions (i.e. similar sample matrix, flow, temperature).

9 EQUIPMENT

9.1 There shall be procedures for operating, maintaining and calibrating equipment used in site testing/sampling.

9.2 In addition, precautions shall be taken to ensure that after transportation to the site and during use, sampling, testing, and measuring equipment remains in a serviceable state and in calibration.

9.3 Appropriate checks shall be performed on site to confirm calibration status before testing/sampling commences. Where a complete (see section 10.4) calibration cannot be carried out on site, calibration status should be established in the permanent laboratory **before** and **after** site testing/sampling and augmented by on-site checks with suitable check standards before and during testing (section 12). If equipment is found to be unfit for use and/or out of calibration it shall not be used and shall immediately be withdrawn from service. Test results shall not be reported for tests carried out with equipment which is found to be out of calibration after use.

9.4 There shall be documented procedures for contingency situation when equipment is rendered inoperative or damaged at the site.

9.5 Automatic site sampling/testing equipment shall be checked (either on-site or in laboratory) at fixed intervals to ensure all operating parameters are as specified.

10 MEASUREMENT TRACEABILITY

10.1 Where it is necessary to use reference standards on site, adequate precautions shall be taken to ensure that the required calibration status is maintained during transportation and while on site.

10.2 Reference standards shall be maintained in a suitable environment at all times.

10.3 Standardization or calibration procedures are often written as part of test methods as it is normally necessary to perform a calibration every time before on-site testing/sampling. The calibration procedures and required calibration range shall be clearly stated. Calibration data shall clearly demonstrate that the proper sensitivities have been achieved for each method.

10.4 Solutions of single standards should be prepared from verified, or traceable stocks, and mixed as appropriate so that a single analysis run can be made to prepare individual standard calibration curves for several different compounds. A minimum of 3 points, but preferably more, shall be obtained for plotting the linear calibration graph. More calibration points are necessary for non-linear calibration graphs. The concentration of the calibration standards shall bracket the expected concentration of the analyte. No test results shall be reported beyond the range of calibration. A reagent blank shall also be analysed during calibration.

11 HANDLING OF TEST ITEMS

11.1 Precautions shall be taken during storage, handling and mounting to prevent damage to items under test on site or being transported to the permanent laboratory. Guidance given in *ISO5667 Water Quality – Sampling Part 3: Guidance on the preservation and handling of water samples* should be followed, where appropriate.

11.2 Each individual sample collected on site shall carry, as a minimum, a unique sample identity, the sampler identity, and date, time, and location of samping and, where relevant, the environmental conditions during sampling.

11.3 When automatic site sampling equipment is used over a period of time, due consideration shall be given to sample preservation requirements of each particular analyte being sampled.

12 ASSURING THE QUALITY OF TEST RESULTS

12.1 For site testing, the quality control plans shall be established in accordance with HOKLAS Supplementary Criteria No. 6 section 9.

12.2 For each site test procedure, the laboratory shall define the method used to derive practical quantitation limits. These are the limits above which quantitative results may be obtained with a specified degree of confidence. A suitable approach for determining the method practical quantitation limit is to find the lowest concentration where recoveries are repeatable and quantative. The signal corresponding to the practical quantitation limit should lie within the calibration graph.

12.3 For sampling, the laboratory shall set up a quality control system by including blanks, duplicates, controls, spikes as appropriate. Guidance given in *ISO5667-14 Water Quality – Sampling – Part 14: Guidance on quality assurance of environmental water sampling and handling* should be followed, where appropriate. The following quality control measures shall be followed where applicable:

(a) duplicate samples are taken at a minimum of once for every batch of samples or matrix type whichever is more frequent.

(b) field samples spiked with the analyte of interest are prepared at a minimum of once for every batch of sample or type of matrix whichever is more frequent. This is used to identify any field, transportation and matrix effects.

(c) field blanks are prepared and carried through the entire sampling procedure at a minimum of once per every batch of samples or type of matrix whichever is more frequent. A field blank is an appropriate amount of a sample matrix with negligible amounts of the parameters of interest (e.g. distilled water or artificial sea water) and processed through the entire sampling and analysis procedure as if it is an actual sample. A field blank is used to detect the presence or absence of possible

contamination during sampling.

13 REPORTING THE RESULTS

13.1 Results and information obtained from site tests/sampling shall be identified as such on reports and certificates issued by the permanent laboratory. Such test/sampling reports and certificates shall, in addition to information required in HKAS 002 and HOKLAS 003 section 5.10 (where appropriate), also contain the following information.

(a) reference to a customer's request form for site testing/sampling including sampling plan (or in-situ test plan), customer's specification on sampling procedure, and customer's test requirements.

(b) description and unambiguous identification of sample - this shall include sample code, site location, sampling point, identity of sampler, date/time of sampling, sample matrix, sample condition, etc. Description and unambiguous identification of the in-situ test event - including test code, type of test, site location, test point, site analyst, date/time of testing, matrix, etc.

(c) a proforma record sheet containing details of the sampling/in-situ test event as described in section 4.2 of this document.

(d) details of environmental conditions during site testing/sampling which may affect the interpretation of test results.

(e) any abnormalities or departures from standard procedures or conditions (e.g. section 8.4) during site testing/sampling.

(f) where relevant, a statement of compliance or non-compliance with requirements given in (a).

(g) reference to the sampling procedure used.

14 ACCESS TO SITES

14.1 Access to the sites shall be provided for assessors and HKAS staff. When the site is not under the direct control of the laboratory, the permanent laboratory shall

negotiate access for HKAS representatives to the appropriate parts of the site for assessment.

15 SCOPE OF ACCREDITATION

To indicate a laboratory has extended its accreditation to sampling and/or on-site testing of water, waste water and/or sediment, the scope of accreditation as entered into the HOKLAS directory of accredited laboratories should take the standard format as indicated in this section.

15.1 The following is an example of a typical entry for SAMPLING.

TEST CATEGORY	ITEMS, MATERIALS OR PRODUCT TESTED	SPECIFIC TESTS OR PROPERTIES MEASURED	SPECIFICATION, STANDARD METHOD OR TECHNIQUE USED
ENVIRONMENTAL TESTING	Water, waste water and sediment	Sampling :-	
		- rivers and streams	Standard method ___
		- marine water	Standard method ___
		- waste water	Standard method ___
		- ground water	Standard method ___
		- sediment	Standard method __

15.2 The following is an example of a typical entry for ON-SITE testing.

TEST CATEGORY	ITEMS, MATERIALS OR PRODUCT TESTED	SPECIFIC TESTS OR PROPERTIES MEASURED *	SPECIFICATION, STANDARD METHOD OR TECHNIQUE USED
ENVIRONMENTAL TESTING	Water and waste water	On-site testing :-	
		physical examination	
		- pH value	Method ___
		- turbidity	Method ___
		- dissolved oxygen	Method ___
		- conductivity	Method ___

"*" The parameters are given here as examples only and are by no means an exhaustive list.

ANNEX I

SAMPLING PLAN CHECKLIST

(also apply to in-situ testing)

(a) Is there a comprehensive description of the location, timing, frequency and type of sampling?
(b) Have arrangements been made to obtain samples from the sites?
(c) Is specialized sampling equipment needed?
(d) Are samplers experienced in a particular type of sampling required?
(e) Have all analytes been listed?
(f) Has the level of detection for each analyte been specified?
(g) Have methods been specified for each analyte?
(h) What sample sizes are needed based on method and desired level of detection?
(i) Is there a list of specific national/international standards, or method QA/QC protocols required?
(j) Do the method protocols comply with all the requirements of your accredited sampling procedure?
(k) How many samples are needed?
(l) How many sample sites are there?
(m) How many methods were specified?
(n) How many test samples are needed for each method?
(o) How many control site samples are needed?
(p) What types of QC samples are needed?
(q) How many of each type of QC samples are needed?
(r) How many exploratory samples are needed?
(s) How many supplementary samples will be taken?
(t) Is compositing of samples required?

Note : Samples = Test + Control + QC + Exploratory + Supplementary
Test Samples = Methods x Sample sites x Samples per site
Control Samples = Methods x Sample site x Samples per site
QC Samples = Methods x Type of QC sample x % required
Exploratory Samples = (test samples + control samples) x 5 to 15%
Supplementary Samples = (test samples + control samples) x 5 to 15%

ANNEX II

ITEMS APPEARING IN SAMPLING PROCEDURE

(For reference only)

(a) The types of observations to be recorded or tests to be carried out on site.

(b) Information concerning analytical methods for testing, level of detection, etc.

(c) Instructions for modifying procedures in case of problems. A contingency plan may be included.

(d) A list of all sampling equipment, including all sampling devices and all sampling containers. (Are the container's materials consistent with analytes? Are the container's sizes consistent with amount of samples needed?) The list should also include items like pre-treatment of sample containers, preservation materials/chemicals, materials for cleaning the equipment, labels, tape, waterproof pens and packaging materials, chain-of-custody forms and sample seals, chemical protective clothing or other safety equipment.

(e) Instructions for cleaning equipment before and after sampling.

(f) Instructions for equipment calibration and/or use.

(g) Instructions for cleaning or handling sample containers.

(h) Instructions for each type of sample collection, including numbers of samples and sample sizes designated for each type, any special sampling times or conditions, numbers, types and sizes of all QC samples, numbers, types and sizes of exploratory and supplementary samples, instructions for compositing samples, instructions for field preparations or measurements.

(i) Instructions for completing sample labels.

(j) Instructions for preserving each type of sample, including maximum holding times of samples and sample storage conditions, e.g. frozen, chilled to 2-6°C, in the dark, etc.

(k) Instructions for packaging, transport, and storage.

(l) Instructions for chain-of custody procedures.

(m) Safety plans.

(n) Instructions for contacting the supervisor or quality manager for advice in case of doubt.

(o) Instructions for recording of pertinent information, including taking photographs and/or videotaping.

ANNEX III

Reference

1. ISO 5667-1 :2006 *Water quality -- Sampling -- Part 1 : Guidance on the design of sampling programmes and sampling techniques*

2. ISO 5667-3 :2003 *Water quality -- Sampling -- Part 3 : Guidance on the preservation and handling of samples*

3. ISO 5667-4 : 1987 *Water quality -- Sampling -- Part 4 : Guidance on sampling from lakes, natural and man-made*

4. ISO 5667-5 : 2006 *Water quality -- Sampling -- Part 5 : Guidance on sampling of drinking water used for food and beverage processing*

5. ISO 5667-6 :2005 *Water quality -- Sampling -- Part 6 : Guidance on sampling of rivers and streams*

6. ISO 5667-7 : 1993 *Water quality -- Sampling -- Part 7 : Guidance on sampling of water and steam in boiler plants*

7. ISO 5667-8 : 1993 *Water quality -- Sampling -- Part 8 : Guidance on the sampling of wet deposition*

8. ISO 5667-9 : 1992 *Water quality -- Sampling -- Part 9 : Guidance on sampling from marine waters*

9. ISO 5667-10 : 1992 *Water quality -- Sampling -- Part 10 : Guidance on sampling of waste waters*

10. ISO 5667-11 : 2009 *Water quality -- Sampling -- Part 11 : Guidance on sampling of ground waters*

11. ISO 5667-12 : 1995 *Water quality -- Sampling -- Part 12 : Guidance on sampling of bottom sediments*

12. ISO 5667-13 : 2011 *Water quality -- Sampling -- Part 13 : Guidance on sampling of sludges*

13. ISO 5667-14 : 1998 *Water quality -- Sampling -- Part 14 : Guidance on quality assurance of environmental water sampling and handling*

14. ISO 5667-15 : 2009 *Water quality -- Sampling -- Part 15 : Guidance on preservation and handling of sludge and sediment samples*

15. ISO 5667-16 : 1998 *Water quality -- Sampling -- Part 16 : Guidance on biotesting of samples*

16. ISO 5667-17 : 2008 *Water quality -- Sampling -- Part 17 : Guidance on sampling of bulk suspended solids*

17. ISO 5667-19:2004 *Water quality – Sampling – Part 19 : Guidance on sampling of marine sediments*

18. ISO 5667-20:2008 *Water quality -- Sampling -- Part 20: Guidance on the use of sampling data for decision making -- compliance with thresholds and classification systems*