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1. INTRODUCTION

1.1 Project Background

1.1.1 In December 2010, Drainage Services Department (DSD) commissioned Atkins China Limited (ACL) to undertake Design and Construction of Upgrading of Cheung Chau and Tai O Sewage Collection, Treatment and Disposal Facilities under Agreement No. CE 15/2010 (DS).

1.1.2 An Environmental Impact Assessment (EIA) Study Brief No. ESB-211/2009 was issued to cover the upgrading of *Tai O Sewage Collection, Treatment and Disposal Facilities* (hereinafter referred as the "Tai O Project").

1.1.3 Based on the preliminary design carried out under another assignment (Agreement No. CE 31/2007 (DS) Upgrading of Cheung Chau and Tai O Sewage Collection, Treatment and Disposal Facilities – Investigation), the Tai O Project includes reclamation for the expansion of Tai O Sewage Treatment Works (STW) and installation of a new submarine outfall that would involve dredging activities. **Figure 1.1** shows the proposed submarine outfall and the extent of the reclamation based on the preliminary design. Dredged sediments will be generated and required for disposal of.

1.1.4 A section of rising main will run along Tai O Road connecting the existing sewer at Tai O Fire Station and the proposed Hang Mei Sewage Pumping Station. Two sections of the proposed rising main will run underneath the Tai O Creek as shown in **Figures 1.2 and 1.3**. Trenchless methods will be used to construct these two sections of the proposed rising main and excavated sediments will be disposed of.

1.1.5 In accordance with the EIA Study Brief No. ESB-211/2009 Appendix D Clause 3(x), this Sediment Sampling and Testing Plan (SSTP) is prepared, making reference to the Environmental, Transport and Works Bureau Technical Circular (Works) No. 34/2002, Management of Dredged/ Excavated Sediment (hereafter referred as ETWB TC(W) No. 34/2002), to seek the agreement from the Director of Environmental Protection on the sampling and testing proposal for the sediment quality assessment and water quality assessment.

1.1.6 Analytical results will be used for the EIA study under the Project.

1.1.7 It should be noted that this Sediment Sampling and Testing Plan (SSTP) has been prepared based on the information obtained from the Investigation Stage under Agreement No. CE 31/2007 (DS). The engineering design is being reviewed and is subject to change during the Design and Construction Stage under this Assignment. The Working Paper No. 3 (Rev 2) Sediment Sampling and Testing Plan was submitted to EPD on 4 August 2011 and EPD confirmed that they had no comments on the working paper on 7 September 2011. The proposed drilling works were subsequently being arranged to be carried out by the term contractor under the management of CEDD/GEO accordingly. However, according to the recent site visit findings, it was found that the two proposed drill holes at Tai O creek (i.e. R1 and R2) were infeasible to be set up due to safety concern on working over water. It was also considered unsafe to shift the proposed locations to the areas close to the bank of the river channel. Therefore, R1 is proposed to be shifted next to the Proposed Jacking Pit and R2 is proposed to be shifted next to Proposed Receiving Pit. The revised locations of sediment sampling are shown in **Figures 1.2 and 1.3**. The revised

location was submitted under the Working Paper No.3 (Rev.3) Sediment Sampling and Testing Plan to EPD on 30 November 2011 and EPD confirmed that they had no in-principle objection via email on 26 January 2012. In order to reduce the disturbance to the adjacent water of Tai O Creek, it is proposed that the two dillholes (i.e. R1 and R2) and the associated sediment sampling and testing works would be carried out during construction of the trenchless sewer (by pipe jacking across the Tai O Creek).

1.1.8 It was reported by the term contractor under the management of CEDD/GEO that one of the proposed locations (i.e. D7) could not be reached by marine craft due to shallow water. Therefore D7 has been cancelled.

1.1.9 As the latest development of the project, it is revealed from the preliminary water quality modelling results that the length of submarine outfall required would be within 200m. As such the two outermost sediment sampling and testing locations (i.e. D12 and D13) would not be required.

1.1.10 It should be noted that this SSTP will provide information of the methodology and approach to estimating the sediment quality and amount of different type of sediments arising from this Project to be dealt with/ disposed of. A separate sediment sampling and testing plan will be required for submission to EPD when applying for the dumping permit under Dumping at Sea Ordinance (DASO).

2. ENVIRONMENTAL LEGISLATION, STANDARDS AND GUIDELINES

2.1 Management and Assessment of Marine Sediment

2.1.1 ETWB TC(W) No. 34/2002 sets out procedures for seeking approval to dredge/excavate sediment and the management framework for marine disposal of such sediment. This Technical Circular outlines the requirements to be followed in assessing sediment quality and classifying the sediment and explains the marine disposal arrangement for the classified materials.

2.1.2 The sediment quality should be assessed according to sediment quality criteria in Appendix A of ETWB TC(W) No. 34/2002. As specified in the Technical Circular, sediments are classified into three categories based on their contaminant levels. The classification is as follows:

- Category L: Sediment with all contaminant levels not exceeding the Lower Chemical Exceedance Level (LCEL). The materials must be dredged, transported and disposed of in a manner which minimizes the loss of contaminants either into solution or by resuspension.
- Category M: Sediment with any one or more contaminant levels exceeding the LCEL and none exceeding the Upper Chemical Exceedance Level (UCEL). The material must be dredged and transported with care, and must be effectively isolated from the environment upon final disposal unless appropriate biological tests demonstrate that the material will not adversely affect the marine environment.
- Category H: Sediment with any one or more contaminant levels exceeding the UCEL. The material must be dredged and transported with great care, and must be effectively isolated from the environment upon final disposal.

2.1.3 The sediment quality criteria for the classification of sediment are shown in **Table 2-1** below.

Table 2-1 Chemical Testing Parameters

Contaminants	Lower Chemical Exceedance Level (LCEL)	Upper Chemical Exceedance Level (UCEL)
Metals (mg/kg dry wt.)		
Cadmium (Cd)	1.5	4
Chromium (Cr)	80	160
Copper (Cu)	65	110
Mercury (Hg)	0.5	1
Nickel (Ni)*	40	40
Lead (Pb)	75	110
Silver (Ag)	1	2
Zinc (Zn)	200	270

Contaminants	Lower Chemical Exceedance Level (LCEL)	Upper Chemical Exceedance Level (UCEL)
Metalloid (mg/kg dry wt.)		
Arsenic	12	42
Organic-PAHs (µg/kg dry wt.)		
Low Molecular Weight PAHs	550	3160
High Molecular Weight PAHs	1700	9600
Organic-non-PAHs (µg/kg dry wt.)		
Total PCBs	23	180
Organometallics (µg TBT/L in Interstitial water)		
Tributyltin*	0.15	0.15

Note:
* The contaminant level is considered to have exceeded the UCEL if it is greater than the value shown.

2.1.4 For biological screening, the test endpoints and decision criteria are summarized in **Table 2-2.** The sediment is deemed to have failed the biological test if it fails in any one of the three toxicity tests.

Table 2-2 Test Endpoints and Decision Criteria for Tier III Biological Screening

Toxicity Test	Endpoints Measured	Failure Criteria
10-day 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.
20-day polychaete worm	Dry Weight[2]	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.
48-96 hour larvae (bivalve or echinoderm)	Normality Survival[3]	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.

Notes:
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.

2.1.5 All the chemical and biological screening results, the categories of sediment, estimated quantities of different categories and the corresponding types of disposal required based on the chemical and biological screening results and ETWB TC(W) No. 34/2002.

2.2 Disposal of Marine Sediment

2.2.1 The disposal of marine sediment is controlled under the Dumping at Sea Ordinance (DASO). EPD controls dumping at sea by means of DASO permit which are issued to the Contractor responsible for the disposal of dredged/ excavated sediment. The Contractor who will be undertaking the works must make a formal application to EPD for a dumping permit, and if the permit is granted, it will be the Contractor's responsibility to ensure that the dumping permit conditions are met to EPD's satisfaction. According to Section 7 of ETWB TC(W) No. 34/2002, applications for approval of dredging/ excavation sediment proposals and allocation of marine disposal space shall be made to the Secretary of Marine Fill Committee (MFC).

3. SEDIMENT SAMPLING AND TESTING

3.1 General

3.1.1 The sediment quality sampling and testing will follow the requirements under the EIA Study Brief No. ESB-211/2009 and ETWB TC(W) No. 34/2002.

3.1.2 Elutriate tests will also be undertaken for the sediment samples in order to investigate the potential impacts resulting from the sediment-bonded pollutants being released into the ambient marine water during the dredging works.

3.2 Sediment Excavation Plan, Estimated Volume and Timetable for Sediment Excavation

3.2.1 The reclaimed area is approximately 2,600m^2. The expected total dredging volume (for both the reclamation and the submarine outfall) will be approximately 30,000m^3 (reclamation: 10,000m^3; outfall: 20,000m^3). The proposed boundary of the dredging / excavation site is provided in **Figure 3.1**.

3.2.2 It is estimated that approximately 180m^3 sediment will be generated from the construction of the proposed rising main.

3.2.3 There are no specific previous dredging/ excavation history of the site or other information available. The proposed dredging site is located adjacent to the existing Tai O Sewage Treatment Works with an existing outfall lying offshore. No other uses were identified.

3.3 Sampling Location

3.3.1 As there is an existing outfall next to the proposed submarine outfall, a sampling grid of 50 x 50m will be adopted with reference to ETWB TC(W) No. 34/2002. A total of seven sediment sampling locations as shown in **Figure 1.1** are proposed.

3.3.2 For the proposed rising main, a total of two sediment sampling locations are shown in **Figures 1.2 and 1.3**.

3.3.3 The sampling schedule is summarised in **Table 3-1**.

Table 3-1 Sample Sampling Schedule

Works Site	Proposed Sampling Location			Relevant Figure Number	Remarks
	ID	Easting	Northing		
Reclamation and Proposed Submarine Outfall	D7	803517.23	813624.90	Figure 1.1	Para. 1.1.8
	D8	803494.31	813664.28		-
	D9	803456.85	813697.40		
	D10	803419.40	813730.53		
	D11	803381.95	813763.65		
	D12	803344.50	813796.78		Para. 1.1.9
	D13	803307.05	813829.90		
Rising Main at Tai O Creek	R1	804341.45	812633.02	Figures 1.2 and 1.3	Para. 1.1.7
	R2	804549.14	812488.69		

3.4 Sampling Method and Depth of Sampling

3.4.1 The proposed dredging depth for the submarine outfall and reclamation area is about 7.2m. Therefore, vibrocores will be undertaken for a depth of 7.2m in accordance with ETWB TC(W) No. 34/2002. The vertical profile of the sediment samples to be undertaken should be the seabed, 0.9m, 1.9m, 2.9m, 5.9m and 7.2m below the seabed.

3.4.2 The sleeve of the proposed rising main is about 2m in diameter and will be running at -1.9 mPD. The existing riverbed is estimated to be 2.3 mPD and the ground level is at about 4.6 mPD. Therefore, the vibrocores will be undertaken for a depth of 7m and the sediment sample will be undertaken at approximately 4m below the riverbed for testing.

3.4.3 Vibrocores will be used to collect sediment samples. However, if the sediment point is found to be in sandy nature, grab samples will be collected.

3.4.4 If biological screening is required, samples of reference sediment would be collected from the surface sediment of EPD's routine marine sediment monitoring station PS6 (22° 19.168' N, 114° 18.745' E) at Port Shelter.

3.5 Sampling Parameters

(i) Tier II Chemical Screening

3.5.1 All samples should be tested for all parameters stated in Table 1 – Analytical Methodology in Appendix B of ETWB TC(W) No. 34/2002. The parameters to be analyzed, methodology used and detection limits are presented in **Table 3-2**.

Table 3-2 Chemical Testing Parameters

Parameters	Preparation Method US EPA Method	Determination method US EPA Method	Reporting Limit
Metals (mg/kg dry weight)			
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
Metalloid (mg/kg dry weight)			
Arsenic	3050B	6020A or 7000A or 7061A	1
Organic-PAHs (µg/kg dry weight)			
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-PAHs (µg/kg dry weight)			
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

Notes:

† Low molecular weight PAHs include acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene.

†† High molecular weight PAHs include benzo(a)anthracene, benzo(a)pyrene, chrysene, dibenzo(a,h)anthracene, fluoranthene, pyrene, benzo(b)fluoranthene, benzo(k)fluoranthene, 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 Dredged Material Proposed for Discharge in Waters 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 from 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 refers to IAEA's Marine Environment Laboratory reference methods. These methods are available free of charge from UNEP/Water or Marine Environmental Studies Laboratory at IAEA's Marine Environment Laboratory. Interstitial water to be obtained by centrifuging the sediment and collecting the overlying water.

(ii) Tier III Biological Screening

3.5.2 In accordance with the guidelines of ETWB TC(W) No. 34/2002, Tier III biological screening is necessary for all Category M and certain Category H sediment samples in which one or more contaminants exceed 10 times of LCEL.

3.5.3 In general, the biological screening should be conducted on composite samples. Composite will be prepared by mixing up to 5 samples of the same category (M or H) which are continuous in vertical or horizontal profile.

3.5.4 According to ETWB TC(W) No. 34/2002, the following three toxicity tests (to be considered as one set) will be conducted on Category M and certain Category H sediments:

- a 10-day burrowing amphipod toxicity test;
- a 20-day burrowing polychaete toxicity test; and
- a 48-96 hour larvae (bivalve or echinoderm) toxicity test.

3.5.5 The preparation of samples for biological screening test is described in **Table 3-3**:

Table 3-3 Sample Preparation Requirements for Biological Screening Test

Sediment Characteristics	Preparation method
Category H sediment (>10 LCEL)	Sample to be mixed with 9 portions of reference sediment
Category M sediment or Category H sediment (> 10 x LCEL) suspected of ammonia contamination	Additional set of sample (after dilution for Category H sediment) to be purged# for ammonia removal (for amphipod test only)

Note:

\# If the ammonia concentration in the overlying water of the test system is ≥ 20 mg/L, purging of sediment is required. This is performed by replacing the overlying water at a rate of 6 volume replacements/24 h for 24 hours, and repeated once only if ammonia level still exceeds 20 mg/L.

3.5.6 The species to be used for each type of biological test and the test conditions are listed in **Table 3-4** below:

Table 3-4 Data Quality Objectives for Laboratory Testing

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

Notes:

* 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.

3.5.7 Category H sediment with one or more contaminant levels exceeding 10 times LCEL should also be subjected to the above three toxicity tests but in a diluted manner (dilution test). All biological tests should be conducted by accredited laboratories and include appropriate quality assurance/ quality control such as negative control and positive control.

3.5.8 Additional ancillary parameters including moisture content, grain size, total organic content, ammonia and salinity of porewater should also be analyzed. **Table 3-5** presents the methodology used and detection limits.

Table 3-5 Biological Screening Ancillary Parameters

Parameters	Determination Method
Moisture Content	By oven drying at 105 ± 5°C (Geospec 3 Test 5.1)
Grain Size Distribution	Geospec 3 Test 8.5
Total Organic Carbon	APHA 5310B
Ammonia	APHA 4500-NH_3 F (Phenate method)
Salinity of Pore Water	APHA 2520B: Electrical conductivity method

3.5.9 The samples should be promptly analyzed. If it is impractical, the recommenced maximum holding time in ETWB TC(W) No. 34/2002 is 2 weeks for chemical test and 8 weeks for biological test.

3.6 Marine Sediment Sampling Method

3.6.1 The exact sampling locations will be determined on site and subject to fine adjustment due to site-specific conditions (e.g. presence of foundations, underground utilities, delivery pipes and services).

3.6.2 Upon determination of the exact sampling locations, a survey shall be undertaken to measure the Hong Kong Grid Co-ordinates and mPD levels of the sampling locations.

3.6.3 Sediment samples shall be taken using boreholes method, piston sampler or split-spoon samplers shall be used to collect marine sediment and dry drilling method (i.e. without liquid medium) shall be applied as far as possible. Continuous sampling of the marine sediment shall be conducted at each borehole.

3.6.4 If necessary, inspection pits shall be constructed for the inspection of any underground utilities prior to the construction of boreholes, with dimension of no less than 1.5m (length) by 1.5m (width), and with depth of 1.5m below the ground level. Excavation shall be terminated once the utility pipework is identified at the designated locations.

3.6.5 Field personnel shall wear clean PVC/latex gloves whilst handling sampling equipment and carry out sampling. All sampling equipment shall be cleaned prior to obtaining each sample.

3.6.6 A clean area immediately adjacent to the sample location shall be established, using a clean plastic sheet, on which all cleaned, and foil wrapped equipment may be placed.

3.6.7 Ceramic spoons shall be used for spit-spoon sampling. The sampling spoons must be cleaned between samples.

3.6.8 For piston sampling, the sample will be store within the piston should be retained and store at 0-4°C in laboratory

3.6.9 For spilt-spoon sampling, sufficient sediment sample shall be placed in a pre-cleaned

glass sample jar. All samples should be retained and stored at 0-4°C in laboratory.

3.6.10 At each borehole sampling location, the marine sediment samples as specified in **Section 3.4** will be taken for laboratory analysis.

3.6.11 Strata logging for boreholes and trial pits shall be undertaken by a qualified geologist during the course of drilling/digging and sampling. The logs shall include the general stratigraphic descriptions, depth of marine sediment sampling, sample notation and level of groundwater (if encountered). The presence of rocks/boulders/cobbles and foreign materials such as metals, wood and plastics shall also be recorded. If trial pits are used, photographic records shall be taken.

3.7 Sample Size and Handling Procedures

3.7.1 The size of samples collected should be adequate for the tier of chemical testing as well as the next tier of biological testing. These are described in **Table 3-6**.

Table 3-6 Samples Size for Sediment Testing Parameters

Parameters to Be Tested	Sample Size
Metals and metalloid	0.5 L
Organic	0.5 L
Biological response	6 L

Note:
* Quantity to be confirmed by testing laboratory. The quantity of reference sediment to be collected needs to be separately worked out for each case, especially if biological dilution tests are anticipated.

3.7.2 The containers shall be marked with the sampling location codes and the depths at which the samples were taken. If the contents are hazardous, this shall be clearly marked on the container and precautions taken during transport. Samples shall be stored at between 0-4°C but never frozen. Samples shall be delivered to laboratory within 24 hours of the samples being collected and analysed within 2 days of delivery. Wastewater generated during sampling should be stored in tanks, tested and disposal of according to relevant standards.

3.8 QA / QC Procedures

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

4. ELUTRIATE TEST

4.1 Sample Collection and Laboratory Analysis

4.1.1 The purpose of the elutriate test is to simulate the release of dissolved contaminants from dredging operations.

4.1.2 The elutriate test requires the collection of ambient water for mixing with sediment samples for analysis. Blank seawater samples will be used and analysed to study the concentration of contaminates released from the sediment.

4.1.3 The testing parameters, analytical methods, reporting limits and QA/QC procedures for the elutriate test are listed in **Table 4-1**. Standard elutriate preparation for sediment and marine water samples will be carried out in accordance with "Evaluation of Dredged Material Proposed for Ocean Disposal – Testing Manual, USEPA and US Army Corps of Engineers, EPA 503/8- 91/001, 1991" and "Evaluation of Dredged Material Proposed for Discharge on Waters of the US – Testing Manual (Inland Testing Manual), USEPA and US Army Corps of Engineers, EPA 823-B-98/004, 1998".

Table 4-1 Testing Parameters for Elutriate Test

Parameters	Instrumentation	Analytical Method	Reporting Limit
Cadmium (Cd)	ICP-MS	USEPA 6020A	0.2 µg /L
Chromium (Cr)	ICP-MS	USEPA 6020A	1 µg /L
Copper (Cu)	ICP-MS	USEPA 6020A	1 µg /L
Mercury (Hg)	ICP-AES/CV-AAS	USEPA 6010B/ APHA 3112B	0.1 µg /L
Nickel (Ni)	ICP-MS	USEPA 6020A	1 µg /L
Lead (Pb)	ICP-MS	USEPA 6020A	1 µg /L
Silver (Ag)	ICP-MS	USEPA 6020A	1 µg /L
Zinc (Zn)	ICP-MS	USEPA 6020A	4 µg /L
Metalloid (µg/L)			
Arsenic (As)	ICP-MS	USEPA 6020A	2 µg /L
Organic PAHs (µg/L)			
Low Molecular Weight PAHs	GC-MSD	USEPA 3510C or 3630C or 8270C	0.2 µg /L
High Molecular Weight PAHs			
Organic Non-PAHs (µg/L)			
Total PCBs	GC-ECD/GC-MSD	USEPA 3510C or 3630C or 8270C	0.01 µg /L
Organometallics (µg TBT/L in interstitial water)			
Tributylin (TBT)	GC-MSD	UNEP / IOC / IAEA [(2)]	0.015 µg /L

Parameters	Instrumentation	Analytical Method	Reporting Limit
Chlorinated Pesticides (µg/L)			
Alpha-BHC Beta-BHC Gamma-BHC Delta-BHC Heptachlor Aldrin Heptachlor epoxide Endosulfan p,p'-DDT p,p'-DDD p,p'-DDE Endosulfan sulfate	GCMSD/ GCECD	USEPA 3510C USEPA 3620B USEPA 8270C USEPA 8081A	0.1 µg /L (individually)
Nutrients			
Ammonia	FIA	APHA 4500-NH3 H	0.025mg/L
Nitrite as N	FIA	APHA 4500-NO3 I	0.025mg-/L
Nitrate as N	FIA	APHA 4500-NO3 I	0.025mg-/L
Total Kjeldahl Nitrogen (TKN)	Kjeldahl	APHA 4500-Norg + NH3 C	0.05 mg-/L
Total P	Colorimetric	APHA 4500-PB&E	0.02 mg-/L
Reactive P	FIA	APHA 4500-PF	0.01 mg-/L

Remarks:
(1) Low molecular weight PAHs include acenaphthene, acenaphthylene, anthracene, fluorene, naphthalene, and phenanthrene; High molecular weight PAHs include benzo[a]anthracene, benzo[a]pyrene, chrysene, dibenzo[a,h]anthracene, fluoranthene, pyrene, benzo[b]fluoranthene, benzo[k]fluoranthene, indeno[1,2,3-c,d]pyrene and benzo[g,h,i]perylene.
(2) UNEP/ICO/IAEA refers to IAEA's Marine Environmental Laboratory reference methods.

4.1.4 For each of the seven sediment sampling locations at Tai O Sewage Treatment Works, samples for elutriate test are to be collected for six layers at depths of 0.0 (seabed level), 0.9m, 1.9m, 2.9m, 5.9m and 7.2m below the seabed and form a composite sample for analysis. Equal portions of the selected sediment samples from each layer will be homogenized to form a composite sediment sample. Therefore, there will be a total of seven composite samples for elutriate test.

4.1.5 No elutriate will be undertaken for the proposed rising main as it will be constructed underneath the riverbed of Tai O Creek using pipe jacking method. The sediment at Tai O Creek will not be disturbed during the construction phase.

4.2 Proposed Assessment Criteria for Contaminants Released from Marine Sediment

4.2.1 There is no existing legislative standard or guideline in Hong Kong for individual heavy metals and micro-organic pollutants (PCBs, PAHs and TBT) in marine waters. International standards will be adopted as the assessment criteria. The international standards include the UK Water Quality Standards, Australian Water Quality Guidelines, USEPA Criterion and relevant research studies. The assessment criteria for other parameters including unionised ammonia (UIA) and total inorganic nitrogen

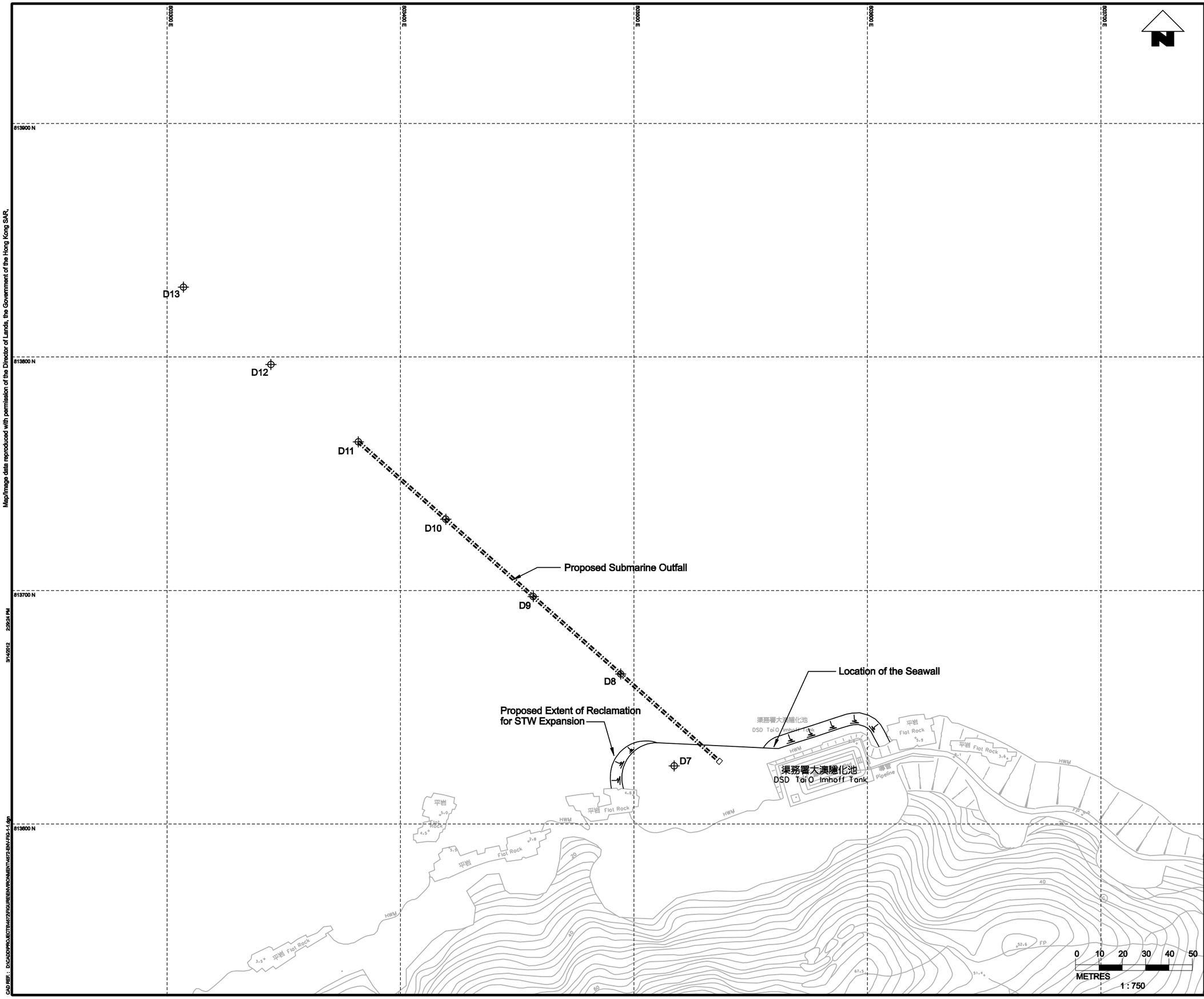
(TIN) are based on the WQOs for the North Western WCZ. The proposed assessment criteria for parameters included in the elutriate test are shown in **Table 4-2**.

Table 4-2 Assessment Criteria for Contaminants Released from Marine Sediment

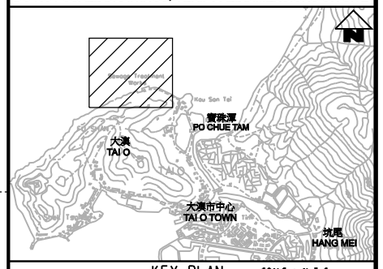
Contaminant	Criteria (µg/L)	Reference
Arsenic (As)	25	UK Water Quality Standard for Coastal Surface Water (Zabel T F and Cole S 1999)
Cadmium (Cd)	2.5	UK Water Quality Standard for Coastal Surface Water (Zabel T F and Cole S 1999)
Chromium (Cr)	15	UK Water Quality Standard for Coastal Surface Water (Zabel T F and Cole S 1999)
Copper (Cu)	5	UK Water Quality Standard for Coastal Surface Water (Zabel T F and Cole S 1999)
Lead (Pb)	25	UK Water Quality Standard for Coastal Surface Water (Zabel T F and Cole S 1999)
Mercury (Hg)	0.3	UK Water Quality Standard for Coastal Surface Water (Zabel T F and Cole S 1999)
Nickel (Ni) 30	30	UK Water Quality Standard for Coastal Surface Water (Zabel T F and Cole S 1999)
Silver (Ag)	2.6	Australian Water Quality Guidelines for Marine Waters
Zinc (Zn)	40	UK Water Quality Standard for Coastal Surface Water (Zabel T F and Cole S 1999)
Total PAHs	3	Australian Water Quality Guidelines for Fresh and Marine Waters (ANZEC 2000)
Total PCBs	0.03	USEPA Salt Water Chronic Criterion (USEPA 2009b)
Tributytin (TBT) 0.1 µg/L	0.10	Michael H. Salazar and Sandra M. Salazar (1996). "Mussels as Bioindicators: Effects of TBT on Survival, Bioaccumulation, and Growth under Natural Conditions" in Organotin, edited by M.A. Champ and P.F.Seligman. Chapman & Hall, London.
Un-ionised Ammonia (UIA)	21	WQO for North Western Supplementary Water Control Zone
Total Inorganic Nitrogen (TIN)	500	WQO for North Western Supplementary Water Control Zone

Notes:
Australian and New Zealand Environment and Conservation Council (ANZEC), 2000. Australian and New Zealand Guidelines for Fresh and Marine Water Quality (2000)
USEPA 2009a. National Recommended Water Quality Criteria - Salt Water Acute Criterion (USEPA , Office of Water, Office of Science and Technology 4304T, 2009)
USEPA 2009b. USEPA National Recommended Water Quality Criteria - Salt Water Chronic Criterion (USEPA , Office of Water, Office of Science and Technology 4304T, 2009)
Zabel T F and Cole S (1999). The derivation of Environmental Quality Standards for the protection of aquatic life in the UK. Journal of the Chartered Institute of Water and Environmental Management, 13, pp. 436–440.

Figures



DO NOT SCALE DRAWINGS, VERIFY ALL DIMENSIONS ON SITE



KEY PLAN SCALE : N.T.S.

Notes :

1. The location of proposed marine drillhole and proposed trial pits are indicative only. The exact locations shall be determined on site and agreed by the Engineer.
2. For the size of trial pits, the size and depths of GI boreholes, and the size and depths of boreholes for sediment sampling, refer to the contract specification.

Legend :

Proposed Submarine Outfall

D7 Proposed Borehole for Sediment Sampling only

Legend	No.	Description
D7	7	Proposed Borehole for Sediment Sampling only

REV	DESCRIPTION	BY	DATE	CHK'D	AUTH

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PROJECT

UPGRADING OF CHEUNG CHAU AND TAI O SEWAGE COLLECTION, TREATMENT AND DISPOSAL FACILITIES - DESIGN AND CONSTRUCTION

AGREEMENT NO. CE 15/2010 (DS)

TITLE

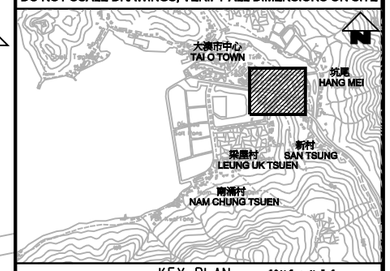
Proposed Submarine Outfall, Reclamation Area and Sediment Sampling Locations

STATUS REVIEW

SCALE AT A1	DESIGN	DRAWN	CHECKED	AUTHORISED
1:750	SO	AC	HKML	XY
	DATE MAR 2012	DATE MAR 2012	DATE MAR 2012	DATE MAR 2012

DRAWING No. FIGURE 1.1 REVISION -

DO NOT SCALE DRAWINGS, VERIFY ALL DIMENSIONS ON SITE



KEY PLAN SCALE : N.T.S.

LEGEND:

- RM — Proposed Sewer Rising Main
- RM(T) — Proposed Sewer Rising Main to be Constructed by Trenchless method
- R1 — Proposed Borehole for Sediment Sampling only

LOCATION	EASTING	NORTHING
R1	804341.45	812633.02

REV	DESCRIPTION	BY	DATE	CHK'D	AUTH

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UPGRADING OF CHEUNG CHAU AND TAI O SEWAGE COLLECTION, TREATMENT AND DISPOSAL FACILITIES - DESIGN AND CONSTRUCTION

AGREEMENT NO. CE 15/2010 (DS)

TITLE

Proposed Rising Main at Tai O Creek next to Tai O Fire Station and Sediment Sampling Locations

STATUS REVIEW

SCALE AT A1	DESIGN	DRAWN	CHECKED	AUTHORISED
1:500	SO	AC	HKML	XY
	DATE NOV 2011	DATE NOV 2011	DATE NOV 2011	DATE NOV 2011

DRAWING No. FIGURE 1.2 REVISION -

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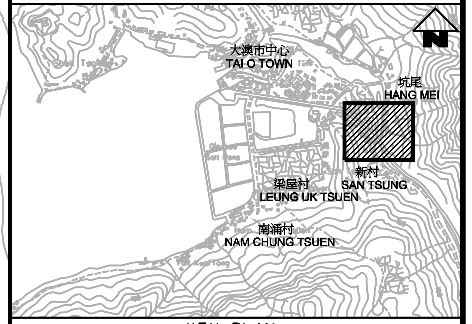
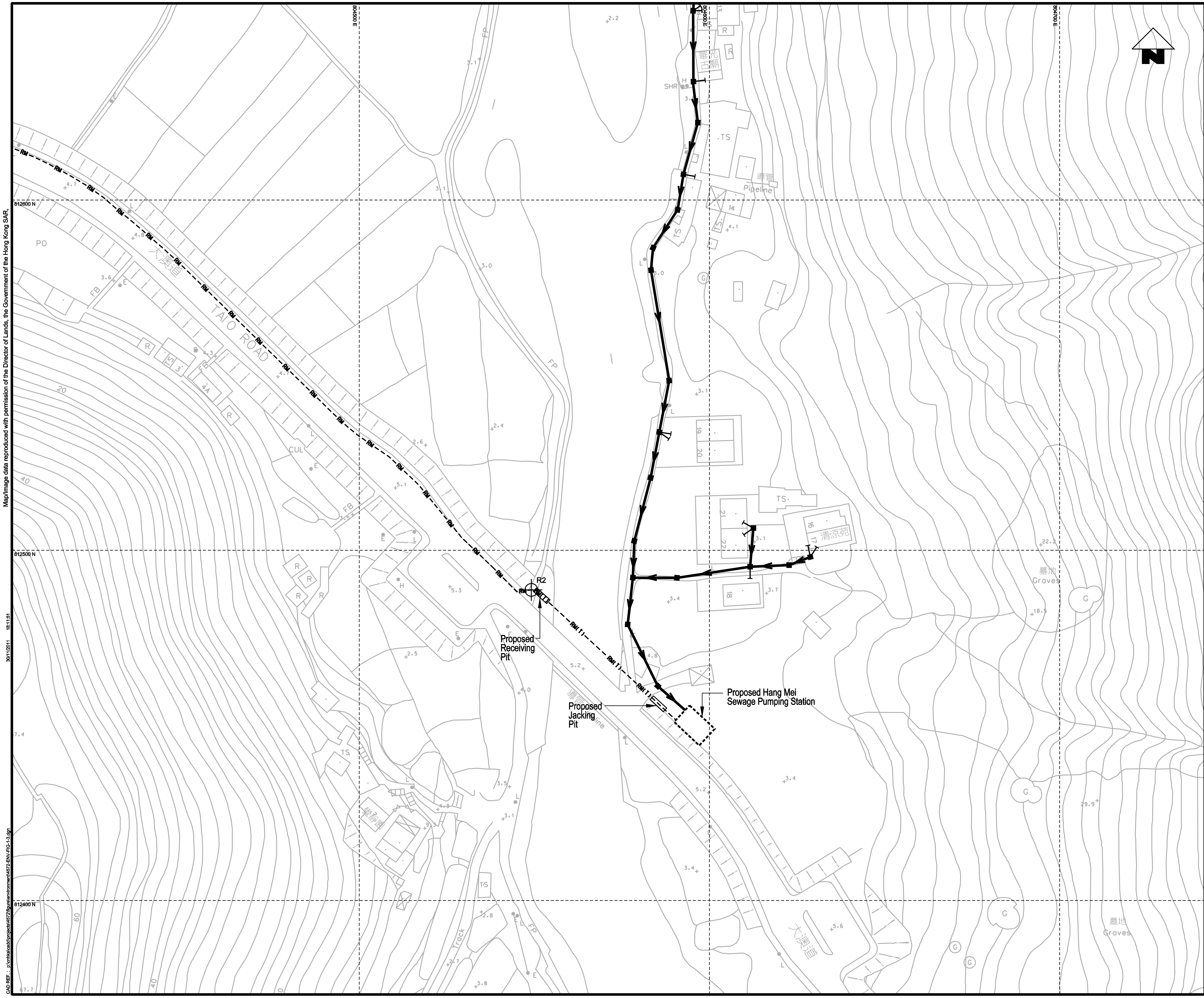
DO NOT SCALE DRAWINGS, VERIFY ALL DIMENSIONS ON SITE



KEY PLAN SCALE : N.T.S.



LEGEND:

- Proposed Sewer in The Project
- RM — Proposed Sewer Rising Main
- RM(T) — Proposed Sewer Rising Main to be Constructed by Trenchless method
- R2 — Proposed Borehole for Sediment Sampling only

LOCATION	EASTING	NORTHING
R2	804549.14	812488.69

REV	DESCRIPTION	BY	DATE	CHK'D	AUTH

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AGREEMENT NO. CE 15/2010 (DS)

TITLE

Proposed Rising Main at Tai O Creek next to Proposed Hang Mei Sewage Pumping Station and Sediment Sampling Locations

STATUS: REVIEW

SCALE AT A1	DESIGN	DRAWN	CHECKED	AUTHORISED
1:500	SO	AC	HKML	XY
	DATE NOV 2011	DATE NOV 2011	DATE NOV 2011	DATE NOV 2011

DRAWING No. FIGURE 1.3 REVISION -

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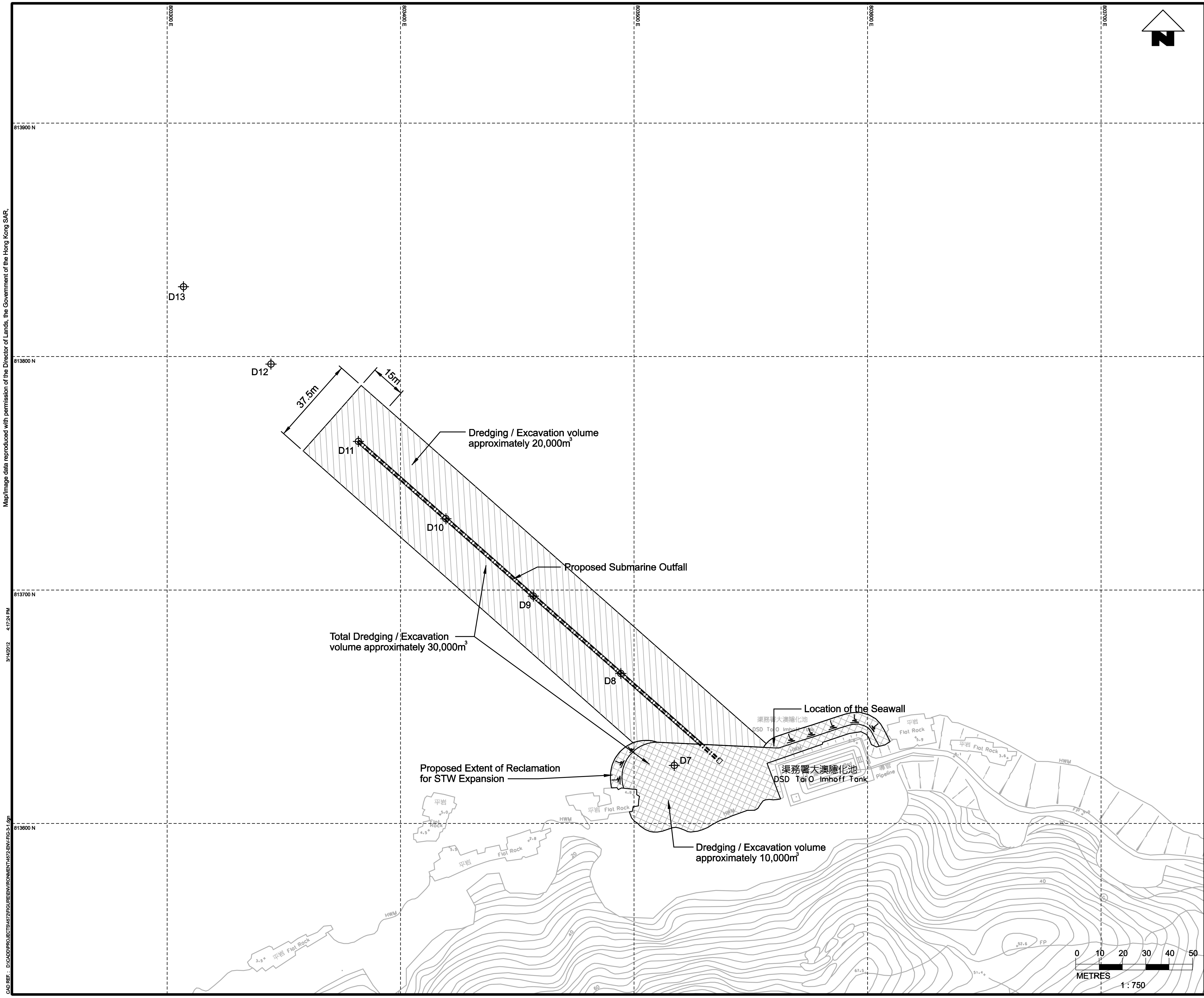

DO NOT SCALE DRAWINGS, VERIFY ALL DIMENSIONS ON SITE

KEY PLAN SCALE : N.T.S.

Notes :

1. The location of proposed marine drillhole and proposed trial pits are indicative only. The exact locations shall be determined on site and agreed by the Engineer.
2. For the size of trial pits, the size and depths of GI boreholes, and the size and depths of boreholes for sediment sampling, refer to the contract specification.

Legend :

- Proposed Submarine Outfall
- D7 Proposed Borehole for Sediment Sampling only
- Dredging / Excavation Boundary for the Proposed Submarine Outfall
- Dredging / Excavation Boundary for Reclamation

Legend	No.	Description
D7	7	Proposed Borehole for Sediment Sampling only

REV	DESCRIPTION	BY	DATE	CHK'D	AUTH

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AGREEMENT NO. CE 15/2010 (DS)

TITLE

Proposed boundary of the dredging / excavation site

STATUS REVIEW

SCALE AT A1	DESIGN	DRAWN	CHECKED	AUTHORISED
1:750	SO	AC	HKML	XY
	DATE MAR 2012	DATE MAR 2012	DATE MAR 2012	DATE MAR 2012

DRAWING No. FIGURE 3.1 REVISION -