Appendix 9D5

Cumulative Dredging and Sediment Loss Rates

Appendix 9D5

Assumptions on Dredging and Sediment Loss Rates for the Cumulative Construction Impact Assessment on the Marine Environment (Sequence A)

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D5-1.1 Background

D5-1.1.1 During the construction of the proposed Tuen Mun Chek Lap Kok Link (TM-CLKL), the Hong Kong Boundary Crossing Facilities (HKBCF) and HZMB Hong Kong Link Road (HKLR) (TM-CLKL+HKBCF+HKLR), sediment losses to suspension as a result of dredging and filling activities are a significant concern with respect to impacts on marine water quality and the marine environment. In addition, dredging and filling operations at neighbouring work sites could result in cumulative impacts on the marine environment during the marine works for the TM-CLKL+HKBCF+HKLR.

D5-1.1.2 Projects which could be constructed concurrently with the TM-CLKL+HKBCF+HKLR and which could result in cumulative construction impacts are presented in Table 1. Table 1 also includes details of the type of impacts associated with each project to be considered under the current studies.

Table 1 Summary of Possible Concurrent Projects with the Potential to Result in Cumulative Construction Impacts with the TM-CLKL+HKBCF+HKLR

Proposed Development	Notes
Kwai Tsing Container Basin Dredging	Capital dredging to increase water depths
Lantau Logistics Park (LLP)	72ha development for construction impacts
Tonggu Channel	Annual maintenance dredging
Mainland Section of Hong Kong Zhuihao Macao Bridge (HZMB)	Construction
Tuen Mun Chek Lap Kok Link (TM-CLKL)	Subject of current study
Hong Kong Link Road (HKLR)	Subject of current study
HZMB Hong Kong Boundary Crossing Facilities (HKBCF)	Subject of current study
Existing and Proposed Contaminated Mud Disposal Facility at East of Sha Chau and South of Brothers	Construction dredging and backfilling operations
Mud Disposal Facility at North Brothers	Disposal operations

D5-1.1.3 Those projects which will be considered likely to have cumulative construction impacts with the TM-CLKL+HKBCF+HKLR are discussed in more detail below together with the best estimates on the volumes of marine sediment to be dredged, dredging rates and potential rates of loss of fine sediment to suspension during their construction.

D5-1.1.4 The rates of sediment lost to suspension during dredging, disposal and filling operations depends principally on the rates of dredging, filling and disposal and the type of equipment used (Trailer Suction Hopper Dredger (TSHD), grab dredger or Cutter Suction Dredgers (CSD)).

D5-1.1.5 In estimating the rates of loss of fine sediment to suspension during dredging for the TM-CLKL+HKBCF+HKLR works and all concurrent, standard loss rates which have been assumed in previous Environmental Impact Assessments (EIAs) in Hong Kong have been used and full References to these previous studies have been given.

D5-1.1.6 For the Mainland section of HZMB, an EIA (Reference 7) has been carried out by Mainland consultants. In the EIA, the consultants used different parameters for some aspects of the calculations of sediment losses to suspension. As a result, for the discussion of the potential sediment losses from the construction works for the HZMB, it will be necessary to confirm the parameters and standard to be adopted and some correspondences between the Mainland authority/consultants has been solicited (References 3, 8 and 9). These are further discussed in the subsequent section.

D5-1.1.7 When modelling the sediment losses to suspension, the water quality model will also use standard coefficients describing the physical properties of fine sediment which have been used in previous studies in Hong Kong. Principally, a settling velocity of 0.5mm/s will be used and it will be assumed that the critical shear stresses for erosion and deposition are $0.3N/m^2$ and $0.2N/m^2$ respectively and that, in water depths of 0.2m or less, deposition does not occur as a result of wave action (References 5 & 6).

D5-2 KWAI TSING CONTAINER BASIN DREDGING

D5-2.1 Background

D5-2.1.1 It is proposed to increase water depths in the Kwai Tsing Basin, Northern Fairway and Western Fairway from approximately 15.5m to 17m. Sediment losses during dredging in the Southern Rambler Channel are unlikely to travel far from the dredging site. However, when dredging at the western end of the Northern Fairway or in the Western Fairway, there is the potential for any sediment losses to be transported some distance from the dredging area. Cumulative impacts with the TM-CLKL+HKBCF+HKLR, while improbable, are most likely to occur when dredging is taking place at the Western extent of the Northern Fairway or in the Western Fairway but the impacts from dredging in the Rambler Channel will also be assessed. A Project Profile (PP) has been prepared for the Kwai Tsing Container Basin dredging but, in the PP, no concurrent works in North Lantau Waters were considered likely to have cumulative impacts with the Kwai Tsing Container Basin dredging.

D5-2.2 Estimated Dredging and Sediment Loss rates

D5-2.2.1 The Project Profile (PP) assumed the dredging works would begin in October 2010 and provides the following information on the dredging, as detailed in Table 2 below.

Table 2 Estimated Volumes of Material to be Dredged for Kwai Tsing Container Basin Dredging

Fiscal Year	In-situ Volume of Type 1 (Open Sea) Sediment Produced (m^3)	In-situ Volume of Type 2 (Confined Marine) Sediment Produced (m^3)
2010-11	200,000	800,000
2011-12	550,000	2,200,000
2012-13	350,000	1,400,000
Total	**1,100,000**	**4,400,000**

D5-2.2.2 In advance of the required site investigation but based on previous maintenance dredging records, the Type 1 material listed in Table 2 above corresponds to the material to be dredged from the Western Fairway while the Type 2 material will be dredged from the Western Fairway and Kwai Tsing Container Basin. However, the dredging programme has not yet been developed to:

1. Indicate when dredging in these different areas might take place; and
2. Indicate which of the grab dredgers and small TSHDs mentioned in the PP would be used in each area and how many dredgers would be working simultaneously.

D5-2.2.3 Normally, closed grabs would be used for Type 2 material but it may be unlikely that grab dredgers and barges would be allowed to moor in the middle of the main fairways. As a result, in the main shipping channel, it will be assumed that small TSHDs will be used. With respect to the rate of sediment lost to suspension, TSHDs would also represent the worst case with respect to sediment losses as has been assumed in many previous studies.

D5-2.2.4 Based on the annual dredging rates given in Table 2 above and that dredging in the fiscal year 2010-11 may only last 100 days, the equivalent daily production rates (assuming 350 working days per full year) are given in Table 3 below.

Table 3 Estimated Production Rates of Kwai Tsing Container Basin Dredging Based on Table 2

Fiscal Year	Type 1 Dredging Rate (m^3/day)	Type 2 Dredging Rate (m^3/day)
2010-11	2,000	8,000
2011-12	1,571	6,286
2012-13[1]	*1,000*	*4,000*
Average 2010-2012	**1,786**	**7,143**

Notes: 1 The duration of dredging in 2012-13 is not known but is expected to be shorter than 350 days. The data for 2012-2013 has not been used in calculating the average dredging rates.

D5-2.2.5 In recent correspondence of 10th November 2008 (Ref: PW WP/KTCB/02 Pt.01), CEDD indicated that dredging could begin on 20/12/2010 and finish on 20/12/2012. If this dredging programme is implemented, the maximum mean dredging rate for Type 2 material over the two year period (700 working days) would become 6,285m^3/day. In order to ensure that the worst case is assessed, it is proposed that a maximum daily production rate of 8,000m^3 is assumed.

D5-2.2.6 It is thought that the maximum estimated production rate for Type 2 material of 8,000m^3/day could be achieved easily by a small to medium TSHD or by two grab dredgers working 24 hours per day as has been assumed in the PP.

D5-2.2.7 Typical small to medium sized TSHDs which commonly operate in Hong Kong waters have capacities in the range 3,000m^3-5,500m^3 [1] and, for the purpose of the assessment of cumulative impacts with the construction of the TM-CLKL+HKBCF+HKLR, a nominal capacity of 4,500m^3 will be assumed[1]. Larger TSHDs could carry out the dredging but, for Type 2 material requiring disposal at the Contaminated Mud Pits, smaller TSHDs may be required to ensure safe access to the disposal area. It will be further assumed that the typical loading time for the TSHD will be 17 minutes[1] within which time the dredger would load 3,050m^3 of in-situ material (allowing for bulking and water in the hopper). Based on these assumptions, the maximum daily production rate (8,000m^3/day) could be achieved in 2.62 dredging cycles.

[1] Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area Agreement No. CE 12/2002(EP), ERM May 2005

D5-2.2.8 If the Type 2 material is to be placed in the ESC CMPs, it is thought that up to 8 dredging cycles each day should be possible without exceeding the approved maximum disposal rate at the CMPs but it may be that the apparently low production rate of 8,000m^3/day is the result of constraints imposed by the need to dredge in a very busy shipping channel and the expectation that other concurrent projects will require some of the maximum daily disposal capacity of 26,700m^3 at the CMPs.

D5-2.2.9 For the purposes of the assessment of cumulative impacts with the construction of the TM-CLKL+HKBCF+HKLR, it will be assumed that the worst case will be the operation of a single TSHD of 4,500m^3 nominal capacity carrying out 2.62 dredging cycles per day and taking 17 minutes to fill the hopper with 3,050m^3 of in-situ material. If it is assumed that the rate of sediment loss to suspension (principally caused by the dragheads bulldozing the seabed) is equivalent to 7kg/m^3 dredged, the rate of sediment lost to suspension will be equivalent to 20.9kg/s[1]. In the model studies, it will be assumed that the dredging is intermittent and takes place for 17 minutes every 11.63 hours, equivalent to 2.62 dredging cycles per day (Table 4). Furthermore, it will also be assumed the dredging works will be on-going on the selected scenario years for the modelling.

D5-2.2.10 It is thought that the worst case with respect to sediment losses and potential cumulative impacts with the TM-CLKL+HKBCF+HKLR works will occur during the initial removal of Type 2 material using TSHDs at the western extent of the Northern Fairway where tidal currents are strongest. Sediment losses when dredging in the Southern Rambler Channel area may not travel as far from the dredging site and so are less likely to result in cumulative impacts with the construction of the HKBCF. However, in order to ensure that the possible impacts from the different aspects of the dredging works are simulated, it will be assumed that one dredging cycle per day takes place at the western extent of the Northern Fairway while the second dredging cycle each day takes place in the Southern Rambler Channel.

Table 4 Summary of Worst Case Dredging Loss Scenario for Kwai Tsing Container Basin Dredging

Location	Dredging Period	Sediment Loss Rate (kg/s)	Duration of Dredging (minutes)	Interval between dredging cycles (hours)
Western end of the Northern Fairway	2010-2013	20.9	17	11.63
Southern Rambler Channel	2010-2013	20.9	17	11.63

D5-3 EXISTING & PLANNED MUD DISPOSAL FACILITIES AT EAST OF SHA CHAU AND SOUTH OF THE BROTHERS

D5-3.1 Background

D5-3.1.1 Information on the programme for the construction and operation of the existing and planned contaminated mud disposal facilities (Figure 1) was provided by CEDD (Ref FM DS/STU/56, 8TH September 2008) and is summarised in Table 5 below.

Table 5 Proposed Programme for Construction and Operation of the Contaminated Mud Pits

Location	Filling/Dredging Period	Disposal/Fill Rate (m^3/day)
North of Brothers	Possibly after 2009 (under review)	100,000 (Cat L) 26,700 (Cat M)
Existing East of Sha Chau	In use until mid 2010	26,700 (Cat M)
Proposed East of Sha Chau	Mid 2009 - 2010 Mid 2010 – 2012	Construction:100,000m^3/week Filling : 26,700m^3/day
Proposed South of Brothers	Mid 2011 – 2012 Mid 2012 - ongoing	Construction:100,000m^3/week Filling : 26,700m^3/day

D5-3.1.2 It is still uncertain whether or not the backfilling of the North Brothers Borrow Pit will begin within the construction period for the TM-CLKL+HKBCF+HKLR. It has also not yet been decided whether to use the pit for uncontaminated (Category L) material or moderately contaminated material (Category M).

D5-3.1.3 Under the current programme, the existing CMP (CMP IV) at East of Sha Chau will be backfilled while the construction of the proposed new CMPs (CMP V) at East of Sha Chau are being constructed. Once the new CMPs are in operation, the existing CMP will be capped during the same period. Similarly, when the new CMP at East of Sha Chau is being backfilled, the proposed South of the Brothers CMP could be under construction. Once the proposed South of the Brothers CMP is being backfilled, the new East of Sha Chau CMPs could be being capped with clean sand and marine mud.

D5-3.1.4 The combined works for the CMP are summarised in Table 6.

Table 6 Expected Construction and Operation Sequence for the Contaminated Mud Pits

Date	Backfilling Operations	Construction
2009-10	Backfilling the existing CMP IVc	Construction of the Proposed East of Sha Chau CMP
2010-11	Backfilling the Proposed East of Sha Chau CMP	Construction of the Proposed East of Sha Chau CMP
2011-12	Backfilling the Proposed East of Sha Chau CMP	Construction of the South of Brothers CMP
2012 -	Backfilling the South of Brothers CMP	Construction of the South of Brothers CMP

D5-3.2 Estimated Dredging and Sediment Loss rates

D5-3.2.1 Construction for the TM-CLKL+HKBCF+HKLR is planned to begin in September 2010 with dredging for the seawalls being carried out by grab dredgers. Once the soft marine deposits have been removed, sand fill will be placed in the dredged trench followed by construction of the seawalls. Once the seawalls have been constructed apart from an opening to allow access, the remainder of the dredging will be carried out within the almost completed seawalls with no significant loss of sediment to the surrounding waters. As a result, cumulative impacts from sediment lost to suspension at the contaminated mud pits and from the dredging and filling works for the seawalls will only persist during the period 2010-2011 when the proposed East of Sha Chau pits will be in operation. It is intended that this dredging/reclamation behind the seawall approach be adopted as much as possible although the applicability also depends on the specific portion of the reclamation area and the anticipated construction sequences of each area are further discussed in Sections D5-8 to 10.

D5-3.2.2 The Proposed East of Sha Chau facility consists of four separate pits while the proposed South of Brothers consists of three separate pits and the construction, backfilling and capping of each set of pits will proceed in parallel. Backfilling of each CMP in turn will proceed at a maximum rate of 26,700m^3/day while construction of each new pit will proceed at a maximum rate of 100,000m^3/week, equivalent to 14,285m^3/day. Capping of backfilled pits will proceed at a rate of no more than 26,700m^3/day. In practice, the programme for the construction of the pits, backfilling and capping will depend on the rate of supply of contaminated (Category M) dredged material and capping material. However, with respect to the assessment of the cumulative impacts during construction of the TMLKL+HKBCF+HKLR, it will be assumed that the programme detailed in Table 6 will be followed.

D5-3.2.3 It is also noted that capping of backfilled pits proceeds in an infrequent manner and the daily disposal rates are expected to be less than the maximum permitted rate of 26,700m^3/day. In addition, it is possible that some capping could, on occasion, be carried out using a small TSHD. However, in the current studies, following the methodology adopted in the EIA for the proposed new pits, it will be assumed that capping is carried out at the maximum permitted rate using bottom dumping barges.

D5-3.2.4 The representative barge and TSHD hopper capacities, the dry densities of the material being placed in the pits and the loss rates for TSHD and barge material to be used in the current studies have been taken from the EIA for the proposed new pits and are summarised in Table 7.

Table 7 Hong Kong Standard Parameters for the Calculation of Loss Rates

Parameter	Value (Reference 1)
Barge capacity	$800m^3$
TSHD capacity	$4,500m^3$
Dry Density of dredged material within a barge	$750kg/m^3$
Dry Density of dredged material within a TSHD	$556\ kg/m^3$
Loss rate to suspension from barge bottom dumping	3%
Loss rate to suspension from TSHD bottom dumping	5%

D5-3.2.5 In the EIA, loss rates for TSHD discharging down the suction arm and down floating hose to a down a pipe discharging near the bottom of the pit were also assessed. However, the loss rates for these disposal options are less than from bottom dumping and so, for the worst case scenario with respect to construction impacts, only bottom dumping TSHD will be considered in the model studies.

D5-3.2.6 It is noted that, in Reference 1, the total instantaneous loss of sediment to suspension during each disposal operation event by a bottom dumping TSHD was subsequently calculated to be 168,750kg using a dry density of $750kg/m^3$ instead of $556kg/m^3$. It may be that, in the model studies, a dry density of $556kg/m^3$ was used and, in the current studies, it will be assumed that the instantaneous loss to suspension from a TSHD will be 125,100kg based on a hopper capacity of $4,500m^3$, a dry density of $556kg/m^3$ and a loss rate of 5%.

D5-3.2.7 In Reference 1, it was estimated that, in the relatively shallow water at East of Sha Chau, an $8m^3$ grab could achieve a production rate of $475m^3$/hour at the start of the dredging for a new pit compared to the average required rate of $298m^3$/hour to achieve the maximum allowed dredging rate of $100,000m^3$/week. In the current studies, as discussed below, it will be assumed that the worst case scenario arises when dredging for a new pit is nearing completion and so it is proposed that the average dredging rate of $298m^3$/hour for a grab will be used.

D5-3.2.8 Based on the parameters in Table 7 and the dredging rates for construction of new pits assumed in Reference 1, the following worst case loss rates will be assumed in the model studies (Table 8).

Table 8 Assumed Sediment Loss Rates for Possible Works Activities at the Proposed Contaminated Mud Pits East of Sha Chau

Activity	Dredging/ Disposal Rates	Loss Rate	Duration (minutes)	Frequency	Total Loss (kg/day)
Barge disposal[1]	26,700 (m^3/day)	18,000 (kg/event)	0	33.3 events/day 43 mins	602,800
TSHD disposall[2] (bottom dumping)	26,700 (m^3/day)	125,100 (kg/event)	0	6 events/day 4 hours	750,600
Dredging[1] (Grab[3])	596 (m^3/hour)	2.8 kg/s	Continuous	Continuous	241,920
Dredging[4] (TSHD)	3,050 (m^3/cycle)	20.9 kg/s	17	4.7 cycles/day 5.5 hours	116,300

Notes: 1 *For bottom dumping barges and grab dredging, it is assumed the sediment loss is distributed evenly over the water depth;*
2 *For TSHD disposal, allowing for the draught of the vessel, it is assumed that the sediment losses enter the bottom 60% of the water column (Reference 1);*
3 *Two grab dredgers are assumed to be required to complete the construction of a new pit within a year. The average dredging rate at east of Sha Chau to achieve 100,000m^3/week is equivalent to 298m^3/hr with a loss rate of 1.4kg/s for each of 2 grabs;*
4 *For TSHD dredging, it is assumed all sediment losses enter the bottom 1m of the water column.*

D5-3.2.9 The barge disposal and loss rates and volumes in Table 8 apply to both the disposal of contaminated material and to capping using uncontaminated material. Trailer disposal by bottom dumping is only likely to be undertaken at the proposed new East of Sha Chau pits where water depths will allow access but it is thought that only barges or TSHD discharging through a floating hose could access the South of Brothers pits.

D5-3.2.10 Once dredging for a new pit is underway, some of the sediment lost to suspension will be confined within the pit and will not be dispersed by the tidal currents. Similarly, at the start of the disposal operations in a newly constructed pit, much of the sediment lost to suspension will also be confined within the depth of the pit. As a result, the worst case with respect to sediment losses being transported from the pit area by tidal currents will occur at the start of dredging a new pit and when the active pit is almost backfilled. However, for operational reasons, as the active pit approaches its maximum backfill level, the next pit to be used will be nearing completion. If a TSHD is used to excavate the new pit, all sediment losses would be confined in the bottom 1m of the pit and would be very unlikely to be transported away from the pit by the tidal currents. Based on the data presented in Table 8, therefore, it will be assumed that the worst case to be simulated will occur when completing the backfilling of the active pit using a bottom dumping trailer and completing the dredging of a new pit using two grab dredgers.

D5-3.2.11 When disposing of dredged material in the contaminated mud pits, the greatest potential for sediment losses arises when TSHDs are used. However, it is unlikely that the full daily capacity of the pits would be taken up by 6 TSHDs working every 4 hours. A more realistic worst case scenario which would also distribute the sediment losses throughout each day could involve three trips by a bottom dumping TSHD and 16.5 (rounded up to 17) trips by a barges in a 24-hour period which would give a total daily loss rate of 681,300m^3. Based on the above information and calculation and also some further clarification from CEDD on the tentative phasing of various the CMPs, the specific concurrent activities for the selected scenario years are proposed. Based on these assumptions, the sediment loss rates proposed to be employed in the model studies are detailed in Table 9.

Table 9 Summary of Sediment Loss Rates to be Modelled for CMPs

Scenario	CMPs	Activity	Rates	Loss Rate	Duration (minutes)	Frequency	Total Loss (kg/day)
2011	ESC IVc	TSHD (4,500m^3)	13,500	125,100	0	8 hours	375,300
	ESC IVc	Barges (800m^3)	13200 (m^3/day)	18000 (kg/event)	0	87 minutes	306,000
	ESC Va	TSHD (4,500m^3)	13,500	125,100	0	8 hours	375,300
	ESC Va	Barges (800m^3)	13200 (m^3/day)	18000 (kg/event)	0	87 minutes	306,000
2012	ESC Va	TSHD (4,500m^3)	13,500	125,100	0	8 hours	375,300
	ESC Va	Barges (800m^3)	13200 (m^3/day)	18000 (kg/event)	0	87 minutes	306,000
	ESC Vb	TSHD (4,500m^3)	13,500	125,100	0	8 hours	375,300
	ESC Vb	Barges (800m^3)	13200 (m^3/day)	18000 (kg/event)	0	87 minutes	306,000
	ESC Vc	Dredging (2 grabs)	596 (m^3/hour)	2.8 kg/s	Continuous	Continuous	241,920
2013	ESC Vc	TSHD (4,500m^3)	13,500	125,100	0	8 hours	375,300
	ESC Vc	Barges (800m^3)	13200 (m^3/day)	18000 (kg/event)	0	87 minutes	306,000
	ESC Vd	Dredging (2 grabs)	596 (m^3/hour)	2.8 kg/s	Continuous	Continuous	241,920
	SB Pit A	Dredging (2 grabs)	596 (m^3/hour)	2.8 kg/s	Continuous	Continuous	241,920
	SB Pit B	Dredging (2 grabs)	596 (m^3/hour)	2.8 kg/s	Continuous	Continuous	241,920

D5-4 BACKFILLING NORTH BROTHERS MARINE BORROW AREA

D5-4.1 Introduction

D5-4.1.1 Backfilling the North Brothers Marine Borrow Area (NBMBA) (Figure 2) could begin after 2009. At present, there is no firm programme to begin the backfilling operations at the NBMBA but, in order to assess the worst case scenario, it will be assumed that the NBMBA could be in operation in 2010 at the start of construction for the TM-CLKL+HKBCF+HKLR. It is also possible that backfilling operations might be underway in 2012 when the HKBCF Phase I works are finishing and in 2014 when the marine works for TM-CLKL+HKBCF+HKLR are nearing completion. As a result, when assessing cumulative construction impacts, the disposal operations at the NBMBA will be assumed to be on-going at all stages of the construction works for the TM-CLKL+HKBCF+HKLR.

D5-4.2 Sediment Loss rates

D5-4.2.1 In the previous EIA for the NBMBA (Reference 5), it was concluded that the disposal of moderately contaminated dredged material at the rate of 26,700m^3/day or uncontaminated material at the rate of 100,000m^3/day in the NBMBA would not result in unacceptable direct or cumulative impacts (with the East of Sha Chau disposal operations) on marine water quality. The more recent EIA for the proposed new Contaminated Mud Pits at East of Sha Chau and South of the Brothers (Reference 1) also assessed cumulative impacts with the NBMBA using these same disposal rates at the NBMBA and again concluded that no unacceptable impacts on the marine environment would arise.

D5-4.2.2 As a result, it is proposed that, for the purposes of assessing worst case potential cumulative impacts with construction of the TM-CLKL+HKBCF+HKLR, it is assumed that the NBMBA is being used to receive 100,000m^3/day of uncontaminated material.

D5-4.2.3 In both References 1 and 5, it was found that the worst case with respect to sediment losses to the receiving waters would arise when TSHDs were placing most of the material in the NBMBA. In Reference 5, a 24-hour worst case disposal programme was calculated to consist of bottom dumping from 12 TSHD of 8,000m^3 capacity and bottom dumping from 5 barges of 800m^3 capacity. The TSHD operations were assumed to be at 2 hour intervals throughout each day and that barge operations took place mid-way between two TSHD operations.

D5-4.2.4 In Reference 5, in order to minimise the potential for sediment to escape from the pit area, it was recommended that disposal operations should take place at the western end of the borrow area on the ebb tide and at the eastern end of the borrow area on the flood tide. However, for the purposes of assessing the worst case scenario, it will be assumed that all disposal operations take place in the western pit closest to the project site for the TM-CLKL+HKBCF+HKLR.

D5-4.2.5 Based on these worst case assumptions, it is proposed that the following disposal programme and loss rates taken from Reference 5 are again employed in the assessment of potential cumulative impacts with the construction of the TM-CLKL+HKBCF+HKLR.

Table 10 Assumed Schedule for Disposal Events ~ North Brothers MBA

Hour	Type	Capacity (m^3)	Hour	Type	Capacity (m^3)
00:00	Trailer	8,000	13:00	Barge	800
02:00	Trailer	8,000	14:00	Trailer	8,000
04:00	Trailer	8,000	16:00	Trailer	8,000
05:00	Barge	800	17:00	Barge	800
06:00	Trailer	8,000	18:00	Trailer	8,000
08:00	Trailer	8,000	20:00	Trailer	8,000
09:00	Barge	800	21:00	Barge	800
10:00	Trailer	8,000	22:00	Trailer	8,000
12:00	Trailer	8,000	**Total Volume (m^3)**		**100,000**

Table 11 Assumed Disposal Operation and Sediment Loss Parameters

Borrow Area	Total Dumped (m^3/day)		Number of events/day		Mud Density (kg/m^3)		Loss rate		Total Losses / dump (kg)	
	Trailer	Barge	Trailer	Barge	Trailer	Barge	Trailer	Barge	Trailer	Barge
North Brothers	96,000	4,000	12	5	556	750	5%	3%	222,400	18,000

Notes: Trailers are assumed to be 8,000m^3 capacity
Barges are assumed to have 800m^3 capacity

D5-5 LANTAU LOGISTICS PARK

D5-5.1 Introduction

D5-5.1.1 The LLP 72ha development (Phase I) will be constructed by first dredging a trench for the seawall and, once a length of trench has been dredged, sand filling and seawall construction will be carried out more or less simultaneously with the dredging. An opening in the seawall 100m wide will be left to provide access to the works area within the seawalls and the opening will be protected by a double silt curtain. All subsequent dredging and filling for the reclamation will be carried out within the area protected by the seawalls and silt curtains and no losses of sediment to suspension are expected to exit the works area. The only potential for cumulative impacts with the construction of the TM-CLKL+HKBCF+HKLR are, therefore, expected to arise during the seawall construction for the LLP.

D5-5.1.2 It is proposed that the seawall will be constructed beginning at both the east and west ends using 2 grab dredgers at each end. Construction for the seawall is expected to be completed within the first 6-7 months of the construction programme which is under review at present. However, at this stage, construction is expected to begin in quarter 2 of 2010.

D5-5.2 Estimated Dredging, Filling and Sediment Loss rates

D5-5.2.1 The maximum daily dredging rate will be no greater than 19,600m^3/day and it will be assumed that this is equivalent to a maximum daily dredging rate of 9,800m^3/day on each of the eastern and western seawall sections. Filling for the seawall foundation will is expected to proceed at a rate of 19,200m^3/day (assumed to be equivalent to 9,600m^3/day on each of the two seawall sections). Following completion of the foundations, it will be assumed that, compared to the dredging and filling works, there will be negligible loss of fine material when placing the seawall rock.

D5-5.2.2 The greatest potential for cumulative impacts is expected to arise when the seawall has been substantially completed and the grab dredgers on each section of the seawall are at their closest approach. At this time, the dredging will also be taking place in relatively open waters which could allow any sediment losses to disperse into the far field. Sand filling for the seawall foundation will also be taking place relatively close to the dredging works, say at 500m from the dredgers.

D5-5.2.3 It will be assumed that the sediment loss rate for grab dredgers is 17kg/m^3 dredged and that work proceeds 24 hours per day. As in previous studies in Hong Kong, it will be assumed that, assuming good quality sand is sourced, 5% of the fill material is fine (<63μm) and that 5% of that fine material will be lost to suspension. In order to calculate the rate of loss of sediment to suspension, it will be assumed that the fine material has a density of 1,600kg/m^3 which will not result in an underestimate of the loss of fine material. The sediment loss rates to be used in the model studies can, therefore, be summarised as follows in Table 12.

Table 12 Assumed Sediment Loss Rates for Each of the East and West Seawall Sections

Activity	Production Rate (m^3/day)	Loss Rate	Duration	Frequency	Sediment Loss Rate
Dredging[1] Western Seawall	9,800	17kg/m^3	Continuous	-	1.92kg/s
Dredging[1] Eastern Seawall	9,800	17kg/m^3	Continuous	-	1.92kg/s
Filling[2] Western Seawall	9,600	5% of material <63μm	Instantaneous	2hours	3,200 kg/event
Filling[2] Eastern Seawall	9,600	5% of material <63μm	Instantaneous	2 hours	3,200 kg/event

Notes: 1 *Assuming 2 grab dredgers in operation on each seawall, the production rate per grab will be 4,900m^3/day with a loss rate per grab of 0.96kg/s*

2 *Based on bottom dumping of 12 barges of 800m^3*

D5-6 TONGGU CHANNEL MAINTENANCE DREDGING

D5-6.1 Introduction

D5-6.1.1 Information on the maintenance dredging requirements for the Tonggu Channel (Figure 3) has been obtained from an EIA for the channel carried out in 2005 (Reference 2) and the sediment loss rates are presented below based on the data obtained from the EIA and parameters used in previous studies in Hong Kong.

D5-6.1.2 The Tonggu Channel has been divided into three Zones (Figure 4). In order to minimise impacts in Hong Kong waters, dredging in Zone I is only permitted on the flood tide and dredging in Zone II is only permitted on the ebb tide. In Zone III, there is no restriction on the tidal windows permitted for dredging.

D5-6.1.3 The dredged material is proposed to be placed either in the reclamation in Dachan Bay or at Aizhou South (Zone C) as shown in Figure 3. Considering the distance between the Tonggu Channel and the Aizhou South (Zone C) disposal ground, potential cumulative impacts between the disposal operations and construction losses from the TM-CLKL+HKBCF+HKLR will not be considered significant. It is also assumed that any dredged material placed in the Dachan Bay reclamation will be contained behind enclosing seawalls and the potential for significant losses to the Main estuary and possibly the Urmston Road will also be considered to be insignificant.

D5-6.1.4 It is noted that subsequent to the issue of the 2005 EIA report, the alignment of the Tonggu Channel was shifted north-west to avoid Hong Kong waters. As such, while data obtained from the 2005 EIA is used as a basis for deriving sediment losses, the modelling will use the actual alignment as obtained from the PRC Maritime Safety Administration (Figure 4). Figure 4 also present the schematic shift of the three zones from the proposed alignment in the 2005 EIA report to the actual alignment.

D5-6.2 Estimated Dredging and Sediment Loss rates

D5-6.2.1 Maintenance dredging for the Tonggu Channel is expected to take place for a period of no more than 12 weeks each year and, based on the 2005 EIA (Reference 2) it is expected that one TSHD with a hopper capacity of 12,500m^3 would be used to dredge Zones I and II while a second TSHD of the same capacity would dredge Zone III.

D5-6.2.2 The maximum volumes to be dredged from each Zone each year and the production rates are presented in Table 13 and have been taken from Reference 2.

Table 13 Dredging Volumes and Production Rates for the Tonggu Channel

Zone	Dredged Volume (m3)	Production Rate (m3/week)	Duration (days)
Zone I	336,000	36,746	64
Zone II	311,572	34,074	64
	198,428	68,149	20
Total Zone II	510,000	68,149	84
Zone III	912,000	95,896	67
Total	1,758,000		

D5-6.2.3 The operational performance of the 12,500m^3 capacity TSHD as detailed in the EIA is presented in Table 14.

Table 14 Expected Tonggu Channel Maintenance Dredging Performance Data

Dredger Parameter	Zone I	Zone II	Zone III
Hopper Volume (m^3)	12,500	12,500	12,500
In-situ Volume (m^3)	4,375	4,375	6,250
Loading Time (minutes)	35	35	60
Production Rate (m^3/min)	125	125	104
Cycle Time (minutes)	223	240	342
Weekly Production (m^3)	128,611	119,260	217,227

D5-6.2.4 In the EIA, it was assumed that the sediment losses for the TSHD without any overflow will be equivalent to 7kg/m^3 dredged which is the same as has been assumed in previous studies in Hong Kong. In the EIA, it was also stated that no overflowing would be permitted in Zones I and II but limited overflowing would be permitted in Zone III. When overflowing takes place, an environmental valve is used which encourages the overflow to descend rapidly to the seabed as a density current with minimal mixing of the sediment losses over the water column. It was assumed in the EIA that an additional 8kg/m^3 dredged would be lost if overflowing occurred and that it would only occur during the last 5minutes of the 60 minute dredging cycle. The additional overflow loss, therefore, amounts to approximately 5% of the total combined loss during a dredging cycle.

D5-6.2.5 From Table 13, it can be seen that the maintenance dredging works are anticipated to last 60 days or more and, when simulating the maintenance dredging, it will be assumed that dredging in all three Zones will be ongoing with dredging in Zones I and II alternating according to the tidal conditions.

D5-6.2.6 Based on this information from the EIA, the parameters defining the sediment loss rates proposed to be used in the current cumulative construction impact studies are summarised in Table 15.

Table 15 Assumed Sediment Loss Rate for the Tonggu Channel Maintenance Dredging

Location	Production Rate (m^3/min)	Sediment Loss Rate kg/m^3 / (kg/s)	Duration of Dredging (mins)	Interval between dredging cycles (minutes)
Zone I[1]	125	7 / 14.6	35	188[1]
Zone II[2]	125	7 / 14.6	35	205[2]
Zone III	104	7 / 12.1 15 / 26.0[3]	60	282 / 129[4]

Notes 1 Flood tide dredging only
2 Ebb tide dredging only
3 The loss rate of 12.1kg/s applies to the first 55 minutes of dredging while the loss rate of 26.0kg/s applies only to the last 5 minutes of dredging when overflowing could occur
4 129 minutes for disposal at Dachan Bay, 282 minutes for disposal at Aizhou.

D5-6.2.7 From Table 13, the required daily production rate for Zones I is equivalent to one flood tide dredging cycle per day while the required production rates for Zones II and III are equivalent to 2 dredging cycles per day with the Zone II dredging taking place on the ebb tide only. In the model studies, therefore, one flood tide dredging cycle will be simulated in Zone I and two dredging cycles will be simulated in each of Zones II and III and the dredging locations in each Zone will be selected to be closest to the TM-CLKL+HKBCF project site.

D5-7 MAINLAND SECTION OF HONG KONG ZHUHAI MACAO BRIDGE (HZMB)

D5-7.1 Background

D5-7.1.1 The construction programme for the HZMB has not yet been finalised and so it will be necessary to assume the worst case with respect to potential cumulative impacts resulting from sediment losses during the simultaneous construction of the HZMB, HLKR and the TM-CLKL+HKBCF. It may be that this worst case scenario will not arise once the construction works have begun but it will be assumed that if the worst case scenario is acceptable with respect to impacts on the marine environment, then the other possible construction scenarios which might arise should also be acceptable.

D5-7.1.2 When calculating sediment loss rates for dredging and filling for concurrent construction works in Hong Kong in the previous sections of this paper, standard parameters which have been used in previous Hong Kong studies have again been used. However, HPDI, the Mainland consultants who are responsible for the Ocean Environmental Impact Assessment (OEIA) for the Mainland sections of the HZMB, have used similar but different parameters. When deriving the potential sediment loss rates to be used in the current studies of cumulative construction impacts, both the standard Hong Kong parameters and the parameters employed in the HZMB OEIA (Reference 7) have been used to provide a comparison.

D5-7.1.3 One major difference between the assumptions made in the HZMB OEIA and in Hong Kong is that the OEIA assumed that the TSHD and CSD would be allowed to overflow when dredging mud. Overflowing from TSHD when dredging mud is not permitted in Hong Kong and the main issues relating to the inclusion of overflowing in the current studies is discussed further below.

D5-7.1.4 The HZMB will include piled bridge sections, a tunnel section, artificial islands at each end of the tunnel section and artificial islands for the boundary crossing facility at the Zhuhai and Macao landfalls. The Macao and Zhuhai boundary crossing facility artificial islands on the western side of the Pearl Estuary, however, are too far (40km) from the TM-CLKL+HKBCF+HKLR to be considered significant with respect to cumulative construction impacts. As a result, none of the works at the western end of the HZMB will be considered further.

D5-7.2 Artificial Islands

D5-7.2.1 At the eastern and western ends of the tunnel section, artificial islands will be constructed (Figure 5). The eastern island is approximately 150m from the Hong Kong SAR boundary while the western island is approximately 6.6km from the Hong Kong SAR boundary. The HZMB OEIA assumed that one 13 m^3 grab dredger, one 4500 m^3 TSHD and one 2500 m^3/h CSD would be deployed for the construction of each island and the construction works will be completed in 3 months (cf. Section 3.2.2 of Reference 7). Further to the meeting between the HKSAR Government, Highways Department (HyD) and the Advance Work

Coordination Group Project Office of HZMB (Reference 9), it was clarified that only a fleet of 3 x 10,000m^3 capacity TSHD would be deployed for the works at each island although only one dredger will be dredging at each island at any time. Based on the information available at present, it has been assumed that the seawalls for the islands will be constructed first (leaving a 100m wide gap to allow access, as a worse case) and that the east and west island seawalls will be built at the same time with one TSHD working simultaneously on each of the seawalls. The programem for the seawall construction was confirmed to be 8 months followed by 8 month reclamation behind the completed seawall.

D5-7.2.2 The dredging volumes, rates of dredging and dredging equipment to be used will be the same for both islands. As a result, the rates of sediment loss for each island will also be the same. The western island, in addition to being over 6km farther from the TM-CLKL+HKBCF+HKLR works, lies on the western side of the main flow channel in the lower Pearl Estuary where the strong tidal flows are in a North-South direction. These tidal flows will disperse any sediment losses rapidly and will tend to inhibit the dispersion of sediment towards the TM-CLKL+HKBCF+HKLR works. The construction of the eastern island, therefore, is expected to have a much greater potential to generate cumulative impacts with the TM-CLKL+HKBCF+HKLR works than the western island. However, for the worst case scenario, the simulations will include the simultaneous construction of the seawalls for both islands.

D5-7.3 Immersed Tube Tunnel

D5-7.3.1 The immersed tube tunnel below the main navigation channel will be constructed using dredging plant and its construction will also have the potential to generate cumulative impacts on the marine environment with the construction of the TM-CLKL+HKBCF+HKLR. The HZMB OEIA (Reference 7) also assumes 2 x 4,500m^3 TSHD, 2 x 2,500 m^3/h CSD and 2 x 13 m^3 grab will be used for the dredging works for the tunnel trench. The Advance Work Coordination Group Project Office of HZMB (Reference 9), however, has also clarified that only one 10,000m^3 capacity TSHD and one 13m^3 grab dredger will be deployed for tunnel trench dredging. It was explained that dredging for tunnel will only start after the artificial islands are reclaimed and it is intended that the construction works will begin at the western island and work towards the east island. It is anticipated that the works will be divided by about 35 x 200m sections and each 200m section of tunnel is to be completed in about 1 month.

D5-7.3.2 The tunnel works are slightly farther from the TM-CLKL+HKBCF+HKLR works than the eastern artificial island and the tunnel section lies below the relatively deep main flow channel. The main tidal flows in this channel are in a North-South direction and any sediment losses to suspension are expected to be dispersed rapidly along the main axis of the estuary with a relatively low potential to generate cumulative impacts with the construction of the TM-CLKL+HKBCF+ HKLR.

D5-7.4 Piling Works for Bridge Sections

D5-7.4.1 The elevated road sections will require bored piles but it is expected that losses of sediment from the piling works will be mitigated using silt curtains or metal casting. In previous studies in Hong Kong, losses from the construction of bored piles have not been considered to be significant. However, the expected rates of sediment losses associated with the piling works will be small compared to other aspects of the construction works and remain local to the piling sites. In the OEIA for the HZMB, while a sediment loss rate during piling was specified, further modelling was not conducted because of the anticipated negligible impacts (Reference 7). Therefore, the loss due to bridge piling of the HZMB will also not be simulated for this exercise.

D5-7.5 Dredged Material Disposal

D5-7.5.1 The disposal grounds which will be used for the dredged material are shown in Figure 6 (Reference 7) and it can be seen that they are very far from the TM-CLKL+HKBCF project site. Cumulative impacts arising from the simultaneous construction of the TM-CLKL+HKBCF+HKLR, the HZMB and the disposal of dredged material are extremely unlikely and so the disposal operations for the HZMB will not be considered further.

D5-7.5.2 It is planned that some dredged material will be used in the construction of reclamations or islands at the HZMB landfalls in Macao and Zhuhai (Reference 7). However, any sediment losses associated with the reuse of the dredged material at these landfalls will be too remote from Hong Kong to result in any cumulative construction impacts with the TM-CLKL+HKBCF+HKLR works and will not be considered further.

D5-7.6 Sediment Loss Rates

D5-7.6.1 Based on this dredging programme employing only TSHDs and grab dredgers, it is expected that the TSHD will carry out the vast majority of the dredging and that the grabs would only be used for the final trimming of the tunnel trench.

D5-7.6.2 Daily dredging rates for the seawalls and tunnel section have been taken from the OEIA for the mainland section of the HZMB (Reference 3) and updated according to recent communications where relevant. The sediment loss rates for the TSHD and grab dredgers have been obtained in two ways:

(1) Based on the parameters established and used in previous studies in Hong Kong including the recent EIAs for the Backfilling of the North Brothers MBA (Reference 5), the Permanent Aviation Fuel Facility (Reference 6) and the proposed new contaminated mud pits (Reference 1); and.

(2) From the parameters which were quoted for dredging and filling in the OEIA (Reference 7) which were said to be based on previous studies and experimental results from mud dredging in the Yangtze River but no References were available.

D5-7.6.3 The rates of loss of fine sediment to suspension depends on the rate of dredging and filling. In Table 16 below, the potential loss rates during the construction of the HZMB artificial islands and tunnel section have been calculated using the dredging and filling rates specified in the HZMB OEIA (Reference 7) and the parameters taken from previous Hong Kong studies (References 1, 5, 6, 11-18) for comparison.

Table 16 Parameters Associated with Dredging and Filling in Hong Kong and in the Mainland section of HZMB

Activity / Mud Properties	Hong Kong	HZMB	REF
Grab Dredging Rate	-	6,240m^3/day	Reference 7
TSHD (10,000m^3 capacity) in-situ volume dredged		7,900m^3	Reference 8
TSHD Dredging Period	60 minutes	70 minutes	Reference 8
Mud Losses Grab Dredging	17-20kg/m^3	20 kg/m^3	Reference 7
Grab Dredging Loss Rate	Around 1kg/s	1.444kg/s	Reference 3
TSHD Draghead Losses	7kg/m^3	15kg/m^3	Reference 7
TSHD Overflow	Not permitted	1.5kg/m^3	Reference 7
Mud Losses Bottom Dumping (Barge)	3%	5%	Reference 3
Mud Losses Bottom Dumping (TSHD)	5%	5%	Reference 3
Dredged Mud Dry Density (Grab Dredged)	750kg/m^3	-	
Dredged Mud Dry Density (TSHD)	556kg/m^3	-	
Sand Fines Content	5% < 63μm	5% < 63μm	Reference 3
Sand Filling Losses (bottom dumping)	5% of fine	5% of fine	Reference 3
Dry Density of Fines Content In Sand Fill	1,600kg/m^3	-	
Leakage of fill when filling behind seawalls	-	5%	Reference 3
Bored Piling Sediment Loss Rate	0.0004kg/s	1.2kg/s	Reference 3

D5-7.6.4 In general, the assumed loss rates for the different types of dredgers are slightly higher than have been used in previous studies in Hong Kong where, in addition, TSHDs are not permitted to overflow when dredging mud.

D5-7.6.5 In the HZMB OEIA (Reference 7), it was specified that the grab dredgers would work 24 hours per day while the TSHD would work 8 hours per day and that the required average daily dredging rates would be as detailed in Table 17 below.

Table 17 Average Dredging Rates for the HZMB Tunnel and Island Seawalls

Mainland Section of HZMB	Total Daily Production Rate (m^3)
Immersed Tube Tunnel	45,500 (22,750 m^3 at each end)
Artificial Island Seawalls, Pearl Estuary	31,466 (15,733 m^3/seawall)

D5-7.6.6 Based on the required average daily dredging rates and the parameters presented in Table 17, the loss rates proposed for use in the construction impact model studies are presented below in Table 18 based on both the typical Hong Kong dredging parameters, those assumed for HZMB OEIA and also the clarification with the Advanced Work Coordination Group Project Office of HZMB. It should be noted, however, that the number of cycles for the TSHD were not specified in the EIA but it has been subsequently clarified that 2 cycles per day would be the worst case.

Table 18 Summary of Dredging and Filling Rates and Loss Rates for the Mainland Section of HZMB

Activity	Dredging, Filling Rates (m^3/cycle)	Duration	Loss Rate (kg/m^3)	Loss Rate (kg/s)	Frequency	Total Loss (kg/day)
Island Seawalls						
TSHD[1] Draghead	7,900	70 mins	15	28.2	4 hours	237,000 (2 cycles / TSHD)
TSHD Overflow		60 mins	1.5	2.82	4 hours	20,300 (2 cycles / TSHD)
Grab Dredger	6,240	24 hours	20	1.44	Continuous	124,800
Barge Filling	800	5 mins /event	3,200 kg/event	10.67	3 hours	25,600 (8 events)
TOTALS[1] (per seawall)						**922,300**
Tunnel						
TSHD[1] Draghead	7,900	70 mins	15	28.2	4 hours	237,000 (2 cycles / TSHD)
TSHD Overflow		60 mins	1.5	2.82	4 hours	20,300 (2 cycles / TSHD)
Grab Dredger	6,240	24 hours	20	1.44	Continuous	124,800
Barge Filling	800	5 mins /event	3,200 kg/event	10.67	3 hours	25,600 (8 events)
TOTALS[1] (at each end)						**922,300**
Bored Piles						
Per Pile	1.5 m^3/hour	24 hours	0.85	0.0004	Continuous	20.4

Notes

1. It has been assumed that each TSHD would complete 2 dredging cycles in an 8-hour working day and a maximum of 3 TSHDs will be deployed

D5-7.6.7 However, it is noted that the programmed average daily dredging rate for the construction of each island seawall (Table 17) is actually only 15,733m^3 compared to the worst case dredging scenario given in Table 18 of around 47,400m^3/day if 3 TSHDs complete 2 cycles per day. The average required total daily dredging rate for the tunnel section was specified as 45,500m^3/day (Table 17) which could be difficult to achieved using one TSHD and a grab dredger and it will be assumed that three 10,000m^3 TSHDs will be deployed as the worse case assumptions.

D5-7.6.8 It is considered that the production rates presented in Table 18 should not result in the potential sediment losses being underestimated and, indeed, the assumed production rates could well result in an overestimate of the worst case likely impacts from the construction works.

D5-7.6.9 The total daily loss rates presented in Table 18, however, of around 0.9M kg/day depending on the assumed stage of works, are still much less than were assessed for the backfilling of the North Brothers MBA which totaled over 2.7Mkg/day.

D5-7.6.10 It is noted that up to 60 piles could be under construction simultaneously with each pile taking 7 days to complete (Reference 7). However, it is unlikely that more than one pile could be constructed at the same location at the same time. As discussed above, the contribution of sediment loss from the bridge piling would unlikely be significant although the calculated loss rate is also presented in Table 18 above.

D5-7.6.11 When simulating the sediment losses in the water quality model, it will be assumed that draghead losses from TSHDs enter the bed layer of the model while the overflows enter the surface layer at the rates calculated above. For grab dredging, it will be assume that the sediment losses are distributed evenly over the water column.

TSHD Overflow

D5-7.6.12 Overflow losses from the TSHD will initially undergo a dynamic phase where the dense discharge from the overflow will descend rapidly under gravity through the water column mixing with the receiving waters to some small extent as it descends. It is expected that most of the overflowed material will impact the seabed where it will spread laterally as a density current and remain close to the seabed. The dynamic phase of overflow plumes is currently the subject of research and the amount of the overflowed, material which actually remains in suspension to be transport and dispersed by the tidal currents, also the subject of current research. The overflow losses to suspension will depend on many factors including trailing speed, tidal current speed, water depth, propeller wash and re-erosion and overflow design.

D5-7.6.13 It is not known how the overflow losses were calculated in the HZMB OEIA but it is noted that they are equivalent to around 10% of the draghead loss rates used in the OEIA.

Sand Filling

D5-7.6.14 Based on the OEIA, the seawalls for the two artificial islands would mainly consist of pre-cast cylindrical caissons (Reference 7) and, thus, significant filling is not anticipated. However, some initial trench preparation may still be required after the dredging, before placing the caissons and beginning of the main reclamation. It is, thus, assumed that once the trenches for the seawalls have been dredged, preparative sand filling will begin. It has been estimated that sand filling for the artificial island seawalls will require 1.18Mm^3 of sand for each seawall (Reference 3) and that 1.36Mm^3 of sand fill will be required for the two artificial islands reclamation (Reference 7). Assuming a 25-day working month and an 8 month (Reference 9) filling period results in a filling rate of 5,900m^3/day for each seawall and 6,800m^3/day for each island reclamation. As in previous studies in Hong Kong, it will be assumed that 5% of the fill material is fine (<63μm) and that, for bottom dumping from barges, 5% of the fine material will be lost to suspension evenly distributed over the water column. These same loss rates were also assumed in the HZMB OEIA (Table 16).

D5-7.6.15 It will also be assumed that the fill is placed using bottom dumping barges with a capacity of 800m^3. The loss of fine sediment to suspension would then be equivalent to 3,200kg/event using the assumptions in Table 16. To achieve the expected filling rates of 5,900m^3/day for each seawall and 6,800m^3/day for each island reclamation would require around 8 barge loads of sand per day for each seawall and 9 barges per day for each reclamation.

D5-7.6.16 The total daily loss rate would then be 25,600kg at each seawall (for 8 barge loads/day) which is around 10%-15% of the expected maximum daily losses due to the dredging work (Table 18). When filling the reclamations behind the completed seawalls containing a 100m gap, losses of fines will be greatly reduced and it will be assumed that only 15% of the potential loss of fines in open waters would result. For the filling rate of 9 barges per day, a loss rate from the reclamation would amount to 480kg/disposal event and a total daily loss rate of 4,320kg/day at each island.

D5-7.6.17 Sand filling for the tunnel trench of 5.1Mm^3 will also be required over a period of 32 months of 25 working days each month (Reference 3), equivalent to an average daily filling rate of 6,375m^3/day. This filling rate could be satisfied by 8 barges of 800m^3 capacity each day giving a total daily loss rate of 25,600kg/day based on the same assumptions as were used to calculate the loss rates for filling the seawalls. The losses of fine sediment to suspension during the filling works for the tunnel, therefore, are again expected to be much smaller than the losses of fine sediment to suspension during the dredging works. It is noted that that Advance Work Coordination Group Project Office of Hong Kong-Zhuhai-Macao Bridge (Reference 9) has clarified that the marine works for the tunnel construction would need about 35 months. Thus, the assumed higher working rate for a 32 months works period would not under estimate the potential impacts.

D5-7.7 Project Programme

D5-7.7.1 A broad brush programme of the HZMB is presented in the HZMB OEIA (Section 2.6 and Table 2.6-1 of Reference 7) which indicate the milestones of major elements. The report, however, does not include a detailed programme. During the meeting between HyD and the Advance Work Coordination Group Project Office of Hong Kong-Zhuhai-Macao Bridge (Reference 9), some details of the anticipated progress were discussed. The key information of particular relevance to the current water quality assessment is highlighted in Table 19 below.

Table 19 Milestone Programme of HZMB

Anticipated Date	Details	Reference
June 2010 – Jan 2011 (construction start in mid 2010)	Construction of seawalls for the two artificial islands at the same time.	Reference 9
Feb 2011 – Sept 2011 (Note 1)	Reclamation of filling the artificial islands (behind the seawall)	Reference 9
Oct 2011 – Aug 2014	Construction of the submarine tunnel between the two artificial islands starting from the western island. Works divided into about 35 sections each 200m. Each section completed in a month.	Reference 9
Jan 2011	Commence construction of Zhuhai and Macao BCFs	Section 2.6 of Reference 7
Feb 2011 – Jun 2011	Construction of seawall for Zhuhai and Macao BCFs using direct rock fills (no dredging)	Section 3.2.1(1) of Reference 7
Jul 2011 – Jan 2012	Reclamation filling of Zhuhai and Macao BCFs using direct rock fills (behind the seawall)	Section 3.2.1(1) of Reference 7
Jun 2011	Commence construction of the main span of the HZMB	Section 2.6 of Reference 7
Jun 2011 – Nov 2012	Bored piling of bridge piers (Note 2).	Section 3.2.4(3) of Reference 7

Note:
1. It is anticipated that reclamation filling will begin in early 2011, however, for the purpose of this study, it will be assumed that the seawall dredging and construction would still be in progress.
2. Based on Reference 7, the main span of HZMB requires about 3789 piles. A maximum of 60 piles could be concurrent at any one time and each pile take about 7 days to complete. Assuming an even spread of workloads, the 3789 piles will have to be divided into about 63 sections of works. However, the expected loss rates from the bored piles of around 0.0004kg/s remote from the TM-CLKL+HKBCF+HKLR works are considered to be insignificant and will not be simulated.

D5-8 TUEN MUN CHEK LAP KOK LINK (TM-CLKL)

D5-8.1 Background

D5-8.1.1 With respect to impacts from the construction works, the TM-CLKL can be divided into three main sections: (1) The Northern Landfall reclamation; (2) the Southern Landfall reclamation; and (3) viaduct connections to the North Lantau road system. The main tunnel section for the TM-CLKL will be a bored tunnel with no construction impacts on the marine environment.

D5-8.1.2 The main purpose of the reclamations are for construction of the launching and receiving shafts for the tunnel boring machine (TBM) as well as providing minimum soil cover of one tunnel diameter of 14m to facilitate the safe operation of the TBM. A cut-and-cover approach roads and ramps will then be connected to the TBM tunnel section at both the northern and southern reclamations. The construction of TM-CLKL requires the reclamation of about 14.9ha and 18.2ha of land at the northern and southern landfall respectively.

D5-8.1.3 The construction of the TM-CLKL will begin in November 2011, after plant mobilization in October 2011, and the construction programmes for the Northern and Southern Landfalls are presented in Figure 7a together with other works of HKBCF+HKLR. The Southern Landfall will require fully dredged seawalls and a non-dredged reclamation while the Northern Landfall will have a non-dredged reclamation and fully dredged seawalls. The dredged and SCP seawall sections are shown in Figure 8 and the construction sequence is presented in Figure 9 for both the northern and southern landfall reclamations.

D5-8.1.4 For non-dredged reclamation proposed for both the northern and southern reclamations, the marine deposits will be left in place and will be installed with band drain and loaded with surcharge to speed up consolidation of marine deposits, thus controlling the residual settlement of reclaimed land to acceptable level. This method has been successfully used in Hong Kong with proven track records in many major civil engineering projects. The primary engineering limitation of using this method is the time needed to be allowed for preloading with surcharge which normally takes 6 to 9 months but it is overall environmentally preferable.

D5-8.1.5 The southern tip of the northern reclamation seawall (Portion N-C) will be constructed first (Figure 9 (sheet 1)) as this will form the launching platform for the TBM. In line with government policy to minimise dredging, it is proposed to use sand compaction piles (SCP) for the majority of the seawall, except for this southern section adjacent to the TBM tunnel, where a tighter construction programme and increased stability for the launching of the TMB is required.

D5-8.1.6 SCPs refer to the construction of a column of dense sand through the full thickness of the sediment and broadly follows the following method:

- Possibly following the laying of a sand blanket, a steel tube, typically varying in diameter from 0.4 to 0.8 m, is pushed into the sediment to the required depth. Insertion of the tube can be assisted by vibration at the top of the tube and air/water injection at the base of the tube. The tube is blocked during insertion and there is no boring or removal of spoil as the tube is inserted;

- When the steel tube has reached the required level it is withdrawn a short distance and at the same time sand is forced out of the base of the tube by compressed air;
- The level of the sand in the tube is monitored to ensure that the tube always contains sand and that the sediment around the tube is not allowed to collapse below the tube;
- The tube is then pushed back into the sand and vibrated back on top of the sand that has been deposited in the ground below the tube in order to increase the diameter of the sand column by pushing it out against the sediment and increasing the density of the sand at the same time; and
- When the desired diameter has been achieved (determined from the known volume of sand placed in the column) more sand is added to the tube and the process of sand placement and compaction is repeated and the process is continued until the sand compaction pile has reached the desired level.

D5-8.1.7 While the extraction of the steel tube during this process has the possibility of cause minor sediment plumes due to possible adherence of fine clay material to the outside of the device, given that the works are overall undertaken with the confines of the tube, SCPs have much less potential to release sediments into the marine environment during the construction process. SCPs are therefore, environmentally preferable to the fully dredged method of seawall construction in terms of water quality. However, as mentioned above for the purpose of this assessment, the worst case fully dredged method has been assumed and the numbers of equipment and sediment loss rates assumed reflects this.

D5-8.1.8 Figure 9 (sheet 1) shows the overall sequence for the northern reclamation. Following the dredging for the southern tip (portion N-C), work on the SCPs for portion N-B continues as work on construction of the seawall itself for Portion N-C commences. Reclamation filling for the southern tip will then commence and all three activities will be undertaken concurrently.

D5-8.1.9 Figure 9 (sheet 2) shows the overall sequence for the southern reclamation. In the same way, the seawall for the northern tip (Portion S-A) will be fully dredged to allow for the TBM works. The remaining seawall is proposed to be constructed using the minimum dredge SCP method but, again, in order to assess the worst case, this assessment has assumed all the seawall will be fully dredged. Once seawall construction has commenced for Portion S-A, as shown in Stage 2 of Figure 9 (sheet 2) sandfilling for the reclamation will also commence. As the HKBCF will contain the filing on the west, the leading seawall is on the east only. The process continues, with SCPs (assumed full dredging) for the seawall progressing in advance of seawall construction in advance of reclamation filling as shown in Stage 3 and 4 of Figure 9 (sheet 2).

D5-8.1.10 The southern viaduct is proposed to be constructed between January 2012 and February 2013. The viaduct will comprise approximately 50 piers with the 3 lane pile caps comprises 12 No. 1800mm diameter piles and the 2 and 1-lane slip roads both comprising 4 No. 1800mm each. The construction will commence on two work fronts and 15 piles could be working concurrently.

D5-8.2 Sediment Loss Rates

D5-8.2.1 Figure 7a presents the dredging and filling programmes. The Northern Landfall involves two dredging operations identified in Figure 7a as DN1 & DN2 and four filling operations identified as FN1-4. Similarly, the Southern Landfall involves three dredging operations identified as DS1-3 and six filling operations identified as FS1-6.

D5-8.2.2 The fill to be used includes both sand and rock/public fill (PF). In general, for seawall filling it is expected that 50% of public fill and rock will be used. In previous studies in Hong Kong, it has been assumed that the fines content (<63μm) in sand typically (dry density of 1,680kg/m^3) used should not exceed 5% and the same assumptions will be made. Public fill will be used principally when the reclamation level reaches +2.5mPD although some public fill may be used below that level. For the northern landfall, it is anticipated reclamation filling will be mainly using public fill while the for the southern reclamation, a mix of sand and PF will be used and the ratio of the two material is about 70% sand and 30% PF.

D5-8.2.3 Public fill materials are the inert portions of construction and demolition materials generated by construction and demolition activities. The use of public fill for reclamation is an innovative solution developed by CEDD to cope with the rapid generation of the C&D surplus material. Indeed, this is an environmentally sound solution as it reduces the amount of sand fill required and also encourages the reuse of C&D material. Following the General Specification of Civil Engineering Works (CED, 2002), public fill materials can be categorised as under water fill material (Type 2) as they do not consist of natural material excavated from the seabed or a riverbed. Based on the General Specification, public fill suitable for reclamation should have less than 25% fine content (<63um) and the Port Works Design Manual further suggested that type 2 under water fill should have a bulk density of 19 kN/m3 (=1900 kg/m^3). The restriction on fines content and other properties (plasticity index) are intended to limit the clay content of the fill material which would affect the overall temporal stability of seawalls. It will, thus, be assumed that the fine content in the public fill will be 25% at the most.

D5-8.2.4 When filling above +2.5mPD, zero losses of fine material to the surrounding waters has been assumed. Similarly, when using rock fill for the seawalls, it has been assumed that any fine material present is insignificant and zero loss of fine material has been assumed. In all cases where the construction of the seawall begins before any dredging or filling takes place for the reclamation, it has been assumed that any dredging or filling for the reclamation would begin 100-200m from the ends of the seawalls. The potential for fine sediment to escape into the surrounding water would be reduced significantly and, under these circumstances, it has been assumed that only a fraction of the potential loss of fines is released into the receiving waters at the entrance to the reclamation depending on the stage of the completeness of the seawalls (Reference 11, 12, 16 and 17). The availability of the seawalls protection for reclamation dredging/filling is shown in the anticipated construction sequence drawing (Figure 9). The overall programme (Figure 7a) also indicate when the seawall protection can be assumed based on the anticipated works progress as indicated in the programme.

D5-8.2.5 It is anticipated that the dredging and filling works will proceed for 16 hours each day and that the grab dredging will be continuous throughout each working day. The sand filling will require each barge to make two deliveries per working day taking 45 minutes to offload on each trip.

D5-8.2.6 The maximum number of filling operations in any day is planned for the Northern Landfall Work Item FN1 when 6 pelican barges will make 2 trips each, a total of 12 filling operations with each lasting 45 minutes. As a result, all 12 filling operations can be accommodated with each 16-hour working day and there will be no need for more than one filling operation to take place at any one time. When simulating filling using pelican barges for each item of work, therefore, it will be assumed that the individual filling operations are spread evenly throughout the working day.

D5-8.2.7 For the bored piling works, it has been assumed that the excavation will proceed at a rate of 2,000kg/hour and that, as for grab dredging, a loss rate of conservative 20 kg/m^3 (cf. typical value used in Hong Kong ranged between 17kg/m^3 – 20 kg/m^3; References 1, 5, 6, 11-18) would apply. However, when excavating bed sediments within the pile casing, the only opportunity for fine sediment to be lost to the surrounding waters will be when transferring the excavated material to a receiving barge which has been assumed to be equivalent to 5% of the typical total grab dredging losses (Reference 12). It has been estimated that the piles would be bored at a rate of 2,000kg/hour which, assuming a typical wet density for the seabed material of 1,340kg/m^3 (Reference 12), is equivalent to a dredging rate of 1.5m^3/hour. Based on a loss rate equivalent to 5% of 20kg/m^3 dredged gives a loss rate of 0.0004kg/s.

D5-8.2.8 The numbers of dredgers and filling barges (pelican barges for sand fill and bottom dumping barges for public fill) for each dredging and filling operation at each landfall are presented in Tables 20 and 21. These tables also present the working rates (in-situ and un-bulked volumes) and expected sediment loss rates for each dredging and filling operation.

Table 20 TM-CLKL Northern Landfall: Summary of Losses of Sediment to Suspension (Dredging and Filling)

Work Item	Plant	No. of Plant	Working Rate (Note 1)	Loss Rate (kg/m^3)	Reduction Due to Seawalls	Sediment Losses (kg/s) (Note 2)	No. of barge events per day	Total Losses (kg/day) all plant	Material Assumed	No. of Active Plants	Daily No. of Plants Trips	Operation Time (min)	Daily Production Rate (Bulk volume, m3/day)
DN1	grab dredger	1	6,000	20	0%	2.08	-	120,000	-	1	1	960	7,200
FN1	dump barge (PF)	2	769	5% of 25% fines	0%	60.90	2	73,077	PF	1	4	5	4,000
FN2	dump barge (behind partial seawall)	6	769	5% of 25% fines	45%	33.49	2	120,577	PF	1	12	5	12,000
DN2	grab dredger	1	6,000	20	0%	2.08	-	120,000	-	1	1	960	7,200
FN3	dump barge (PF)	2	769	5% of 25% fines	0%	60.90	2	73,077	PF	1	4	5	4,000
FN4	dump barge (behind partial seawall)	6	769	5% of 25% fines	45%	33.49	2	120,577	PF	1	12	5	12,000
FN4	dump barge (behind full seawall)	6	769	5% of 25% fines	80%	12.18	2	43,846	PF	1	12	5	12,000
	Filling above +2.5mPD	-	-	0	-	-	-	-	-	-	-	-	-

Notes:

1. *All volumes mentioned are in situ volume except production rate which is based on bulked volume. The assumed bulking factor is 1.2 for grab dredging, 1.3 for filling barge and 1.5 for TSHD (if any). The working rate is per grab (m^3/day) or per barge/event (m^3).*
2. *The loss rate is per plant per event.*
3. *All plants assume daily working for 16 hour. Each pelican barge assume unloads in 45 minutes and dump barge assume unload in 5 minutes.*
4. *Partial Seawall = substantially completed seawall with 100-200m leading edge. Full Seawall = completed seawall with 50-100m opening gap for marine access.*
5. *When a mixture of public fill and rock (PF/Rock) are specified, only the portion of PF is included in the above calculation table. When a mixture of public fill and sand fill (PF/Sand) are specified, it is assumed to consist of 30% PF at the most. For calculation purpose, the filling barges for PF and sand is calculated separately using the ratio of 30/70, but rounded up for the PF barges to give a reasonable worse case estimate. The same principle applies to 50/50 PF/Rock fill calculation.*
6. *Operation time for grab dredgers is the total available time; for other plants is per event time.*
7. *The grab dredgers are assumed to be worked on site at all times.*
8. *The max. number of active filling barges is generally estimated as = (operation time x total no. of plant trips / 960) and rounded up to whole number.*

Table 21 TM-CLKL Southern Landfall: Summary of Losses of Sediment to Suspension Sediment (Dredging and Filling)

Work Item	Plant	No. of Plant	Working Rate (Note 1)	Loss Rate (kg/m³)	Reduction Due to Seawalls	Sediment Losses (kg/s) (Note 2)	No. of barge events per day	Total Losses (kg/day) all plant	Material Assumed	No. of Active Plants	Daily No. of Plants Trips	Operation Time (min)	Daily Production Rate (Bulk volume, m3/day)
DS1	grab dredger	2	6,000	20	0%	2.08	-	240,000	-	2	2	960	14,400
FS1	dump barge (PF)	3	769	5% of 25% fines	0%	60.90	2	109,615	PF	1	6	5	6,000
FS2	filling barge (behind partial seawall)	3	769	-	45%	11.60	2	27,204	-	2	6	-	6,000
	dump barge	1	769	5% of 25% fines	45%	33.49	2	20,096	PF	1	2	5	2,000
	pelican barge	2	769	5% of 5% fines	45%	0.66	2	7,108	Sand	1	4	45	4,000
DS2	grab dredger	2	6,000	20	0%	2.08	-	240,000	-	2	2	960	14,400
FS3	dump barge (PF)	2	769	5% of 25% fines	0%	60.90	2	73,077	PF	1	4	5	4,000
FS4	filling barge (behind partial seawall)	3	769	-	45%	11.60	2	27,204	-	2	6	-	6,000
	dump barge	1	769	5% of 25% fines	45%	33.49	2	20,096	PF	1	2	5	2,000
	pelican barge	2	769	5% of 5% fines	45%	0.66	2	7,108	Sand	1	4	45	4,000
DS3	grab dredger	1	6,000	20	0%	2.08	-	120,000	-	1	1	960	7,200
FS5	dump barge (PF)	2	769	5% of 25% fines	0%	60.90	2	73,077	PF	1	4	5	4,000
FS6	pelican barge (behind partial seawall)	2	769	5% of 5% fines	45%	0.66	2	7,108	Sand	2	4	45	4,000
FS6	filling barge (behind full seawall)	3	769	-	45%	11.60	2	27,204	-	2	6	-	6,000
	dump barge	1	769	5% of 25% fines	45%	33.49	2	20,096	PF	1	2	5	2,000
	pelican barge	2	769	5% of 5% fines	45%	0.66	2	7,108	Sand	1	4	45	4,000
	Filling above +2.5mPD (public fill)	-	-	0	-	-	-	-	-	-	-	-	-
P	Piling for Viaducts	15	24	5% of 20	0%	0.0004	-	360	-	15	15	960	432

Notes:

1. *All volumes mentioned are in situ volume except production rate which is based on bulked volume. The assumed bulking factor is 1.2 for grab dredging, 1.3 for filling barge and 1.5 for TSHD (if any). The working rate is per grab (m^3/day) or per barge/event (m^3).*
2. *The loss rate is per plant per event.*
3. *All plants assume daily working for 16 hour. Each pelican barge assume unloads in 45 minutes and dump barge assume unload in 5 minutes.*
4. *Partial Seawall = substantially completed seawall with 100-200m leading edge. Full Seawall = completed seawall with 50-100m opening gap for marine access.*
5. *When a mixture of public fill and rock (PF/Rock) are specified, only the portion of PF is included in the above calculation table. When a mixture of public fill and sand fill (PF/Sand) are specified, it is assumed to consist of 30% PF at the most. For calculation purpose, the filling barges for PF and sand is calculated separately using the ratio of 30/70, but rounded up for the PF barges to give a reasonable worse case estimate. The same principle applies to 50/50 PF/Rock fill calculation.*

6. Operation time for grab dredgers is the total available time; for other plants is per event time.
7. The grab dredgers are assumed to be worked on site at all times.
8. The max. number of active filling barges is generally estimated as = (operation time x total no. of plant trips / 960) and rounded up to whole number.

D5-8.2.9 In Tables 20 and 21, it has been assumed that no mitigation measures, other than integrated advanced seawalls. The generally accepted sediment loss reduction rate by seawalls ranged between 75% - 100% (References 11, 12, 16 and 17). Based on a conservative assessment, it was proposed the reduction factor by a substantially completed seawall (with at least 100-200m leading edge) should be at least 45%. However, for a nearly completed seawall (with only 50-100m access opening), a 80% reduction should be assumed while that for a fully enclosed seawall without opening access, 100% reduction should be assumed. This is also inline with the generally accepted assumptions in the approved EIAs

D5-8.2.10 Based on the construction programme, the plant inventory for the construction works and the daily loss rates presented above, Figure 7a presents the total daily loss rates in kg/day for each month during the construction of the TM-CLKL. The daily production rate (bulk volume), daily no of plants trips and number of active plants (dredging and filling) on site are also included Table 20 and Table 21. Figures 7b, 7c and 7d present the overall programmes for the maximum daily production rate (bulk volume), the maximum daily number of plant trips and maximum number of active plants (dredging and filling) for the concurrent TM-CLKL+HKBCF+HKLR projects.

D5-9 HONG KONG BORDER CROSSING FACILITY (HKBCF)

D5-9.1 Background

D5-9.1.1 The proposed location of HKBCF is at the waters off the north-east of the Airport. In order to provide land for the various boundary crossing facilities, the reclamation area of HKBCF is about 130ha (excluding the area of about 18 ha for the southern landfall of TM-CLKL).

D5-9.1.2 It is anticipated that HKBCF would start construction in September 2010. In view of the tight construction programme to match with HZMB Main Bridge, the current planning is to complete the HKBCF in 2 phases. Phase 1 comprises a reclamation of about 100 ha to accommodate facilities for the operation of first few years and will be operational in 2014 or earlier and then Phase 2, comprising a reclamation of about 30 ha will be completed in 2016 to accommodate facilities for the long term needs of HKBCF.

D5-9.1.3 The dredging and filling works for both phases of the HKBCF, however, will begin in September 2010 and will finish in November 2013 and the programme for the reclamation is presented in Figure 7a with other projects.

D5-9.1.4 The HKBCF will include dredged and non-dredged reclamations and an immersed tube tunnel for the Automated Passenger Mover (APM) from the BCF to the airport island. One seawall may be constructed using Sand Compaction Piles (SCP) but while SCP has been successfully deployed overseas, it is still new to Hong Kong and, therefore, this method is subject to further review before its implementation. As SCPs are new to Hong Kong, a pilot study to confirm the local environmental performance shall be carried out during the initial stage of the consturcion in order to deterime whether additional mitigation measures are necessary in order to minimise all potential water quality impact. Also, as described in Section for TM-CLKL, SCP would have the potential to release less sediment into the water column. For these reasons, for the purposes of assessing worst case construction impacts, it will be assumed that all seawalls are fully dredged.

D5-9.1.5 In order to minimise the disposal of dredged material, priority has been given to consider non-dredged methods. For the seawall, the non-dredge method of Sand Compaction Piles (SCP) is proposed and band drains for the reclamation where possible. However, as both these methods are more time intensive, full dredging is required at some reclamation and seawalls in the HKBCF in order to meet the tight programme requirements and site constraints. The other site constraints for the HKBCF include the Airport Height Restriction which does not allow the use at some locations of the tall band drains machine for reclamation and the tall SCP machine for seawalls. Moreover, the shallow water depth at some site locations also prevents the use of SCP due to the up-heaving effect.

D5-9.1.6 The extent of dredged and non-dredged areas in HKBCF is shown in Figure 10. Based on the available site investigation results, the estimated quantity of the dredging and filing works in HKBCF is about 22.3 Mm^3 (in-situ volume) and 41.5 Mm^3 (in-situ volume) respectively.

D5-9.1.7 The reclamation sequence and envisaged construction programme of HKBCF is shown in Figures 10 to and the anticipated construction sequence in Figure 12. In general, it is envisaged that the reclamation works would start at Portion A of HKBCF Phase 1 first. In order to minimise the impact to the water quality, Portion A of HKBCF Phase 1 would be enclosed by the temporary seawall with a gap on the west side of about 100m for marine access before the reclamation filling. After completion of the reclamation filling in Portion A of HKBCF Phase 1, substantial length of seawalls would have been completed in Portions B and C of HKBCF Phase 1. Then the reclamation would be carried out in the sequence of Portion B, Portion C and finally Portion D of HKBCF Phase 1 and HKBCF Phase 2. The general reclamation sequence is as follows:

- Construct the temporary seawall and then reclamation filling in Portion A of HKBCF;
- Construct the seawalls at Portions B and C and start the reclamation filling in these areas;
- Start the construction of seawalls in HKBCF Phase 1;
- Dredging and filling for reclamation in Portion D; and
- Dredging and filling for reclamation in HKBCF Phase 2 after completion of the seawalls in HKBCF Phase 2.

D5-9.1.8 Assuming the reclamation of HKBCF commence in Aug 2010, the envisaged reclamation sequence is as follows:

1) Commence dredging for the temporary seawall at the north-west corner of Portion A in HKBCF Phase 1 and then along the perimeter of Portion A in the clockwise direction as shown in Stage 1 of Figure 12 (Sheet 1). This dredging activity is anticipated to be carried out from Sept 2010 to Mar 2011. After a portion of seawall trench is dredged, filling for seawall would also start from the north-west corner of Portion A and in the clockwise direction. A gap of about 100m seawall as shown in Stage 3 of Figure 12 (Sheet 2) would be left for the temporary marine access to enable the reclamation activities in Portion A. This section of seawall would be completed after the dredging and filling for reclamation in Portion A.

2) The dredging and filling for the seawall and reclamation of FSD rescue berth at the western side of HKBCF site would be carried out concurrently with Portion A as shown in Stages 1 and 2 of Figure 12 (Sheet 1).

3) Following completion of seawall dredging in Portion A, dredging for the reclamation in Portion A is anticipated to be commenced in Mar 2011. This dredging activity is anticipated to be commenced at the south-east corner of Portion A and in the direction of north-west towards the temporary access at the seawall. Meanwhile, seawall filling is continued at the western side of Portion A. As Portion A is small in area (about 500m X 250m), it is considered that the reclamation dredging and seawall filling in Portion A are carried out at the same time and no leading edge of seawall is assumed in this case.

4) As shown in Stage 3 of Figure 12 (Sheet 2), reclamation filling of Portion A is anticipated to be commenced in June 2011 after completion of the seawall filling in Portion A. Therefore, the reclamation filling of Portion A would be carried out within the area enclosed by seawall (except the 100m gap). Reclamation filling of Portion A would start at the south-east corner of Portion A and in the direction of north-west similar to the reclamation dredging of Portion A. The reclamation of Portion A is anticipated to be completed in Aug 2011.

5) While the seawall dredging and filling in Portion A is on-going, the dredging and filling for seawall in Portions B and C are also carried out concurrently. The direction of these activities is from the north-east corner of Portion A and in clockwise direction as shown in Stages 1 to 3 of Figure 12 (Sheets 1 and 2). In addition, a short section of seawall in Portion C at the western edge (i.e underneath Portion A) would also be constructed between Jan 2011 to Mar 2011.

6) After completion of the seawall in Portion C and the seawall up to nearly half of the southern edge of HKBCF site in Portion B, the reclamation filling in Portion C and reclamation dredging in Portion B would start at the north-east corner of Portions C and B respectively. The locations and directions of above reclamation dredging and filling are shown in Stage 3 of Figure 12 (Sheet 2). In this case, the leading edge of seawall is about 200m for the above activities.

7) The seawall in Portion B is anticipated to be completed in Jul 2011 leaving a gap for the temporary marine access at the south-west corner of Portions B and C as shown in Stage 4 of Figure 12 (Sheet 2). Then the reclamation dredging of Portion B would complete in Sept 2011 and the reclamation filling of Portions B and C would continue in the direction of south-west towards the above temporary marine access. After the completion of seawall in Jul 2011, the reclamation filling of Portions B and C would be carried out in the area enclosed by the seawall (except the 100m gap). The reclamation filling of Portions B and C are anticipated to be completed in Nov 2011 and Mar 2012 respectively.

8) After completion of the seawall in Portions B and C, the seawall dredging of HKBCF Phase 2 would start at the south-west corner of HKBCF Phase 2 and proceed in the clockwise direction. The seawall filling of HKBCF Phase 2 would also start when a portion of seawall trench is dredged and ready to receive the seawall fill. The location and direction of above reclamation dredging and filling are shown in Stage 4 of Figure 12 (Sheet 2).

9) Dredging and filling for the installation of immerse tube tunnel of Automatic People Mover (APM) are anticipated to be carried out from Feb 2012 to Jan 2013 which overlaps with the dredging and filling of seawall in HKBCF Phase 2 in Mid 2012.

10) After completion of dredging and filling for the immerse tube tunnel, the construction plant are anticipated to be moved to Portion D of HKBCF Phase 1. The seawall dredging would start at the south-east corner of Portion D and in the clockwise direction. The seawall filling is to follow when a portion of seawall trench is dredged and ready to receive the seawall fill. The seawall at Portion D is anticipated to be completed in May 2013. The temporary marine access mentioned in 7) above is moved to the south-east corner of Portion D. This 100m gap of seawall would be completed after the reclamation fill of Portion D is completed.

11) The reclamation dredging in Portion D is from the west to east with some overlapping with the seawall filling activity in Portion D. In this case, no leading edge of seawall is assumed. After completion of the seawall (except the above gap for temporary marine access), the reclamation filling would be carried out in the enclosed area of Portion D.

12) The seawall in HKBCF Phase 2 is anticipated to be completed in August 2012 leaving a gap of about 100m at the north-east corner to allow for the temporary marine access for the reclamation activities in HKBCF Phase 2. After the area of HKBCF Phase 2 is enclosed by the seawall (except the 100m gap), the reclamation dredging for the APM tunnel and underground station within HKBCF Phase 2 would be carried out . The reclamation filling would also be carried out within the area enclosed by the seawall as shown in Stage 7 of Figure 12 (Sheet 4).

13) The reclamation of HKBCF is completed after the filling in Phase 2 and completion of remaining section of seawall allow for the temporary marine access.

D5-9.1.9 As the landscape bund and other facilities for HKBCF are being considered, it is possible that the final layout of HKBCF would be larger than the current layout. In this case, in order to sasses the worst case situation, for the purposes of the water quality assessment and modelling, a 10% bigger reclamation and 10% increase in the plant for reclamation works has been assumed for the HKBCF, so as to take account of the above situation.

D5-9.1.10 The road viaduct stretching from the north-western corner of the HKBCF to the Airport Island will comprise 50m span piers which will be constructed using bored piling. The Immersed Tube Tunnel for the APM will require full dredging, followed by backfilling with sand and rock amour protection once the tunnel unit has been placed.

D5-9.2 Sediment Loss Rates

D5-9.2.1 Figure 7a presents the dredging and filling programme and it can be seen that there are seven separate dredging operations identified as (1) to (7) and six filling operations identified as (a) to (f).

D5-9.2.2 The fill to be used includes both sand and rock/public fill. The characteristics of the fill material is generally similar to those discussed for TM-CLKL although the material for seawall filling is generally assumed to be 70/30 of sand and public fill, except the very late stage when only rock fill is assumed.

D5-9.2.3 When filling above +2.5mPD, zero losses of fine material to the surrounding waters has been assumed. Similarly, when using rock fill for the seawalls, it has been assumed that any fine material present is insignificant and zero loss of fine material has been assumed. In all cases where the construction of the seawall begins before any dredging or filling takes place for the reclamation, it has been assumed that any dredging or filling for the reclamation would begin 100-200m from the ends of the seawalls. The potential for fine sediment to escape into the surrounding water would be reduced significantly and, under these circumstances, it has been assumed that only a fraction of the potential loss of fines is released into the receiving waters at the entrance to the reclamation depending on the stage of the completeness of the seawalls (Reference 11, 12, 16 and 17). The availability of the seawalls protection for reclamation dredging/filling is shown in the anticipated construction sequence drawing (Figure 12). The overall programme (Figure 7a) also indicate when the seawall protection can be assumed based on the anticipated works progress as indicated in the programme.

D5-9.2.4 It is anticipated that the dredging and filling works will proceed for 16 hours each day and that the grab dredging will be continuous throughout each working day. A TSHD may be used for dredging operation (2 and 7) and it is assumed that it will work 24 hours per day and make 3 trips per day. The sand filling will require each barge to make two deliveries per working day taking 45 minutes to offload on each trip.

D5-9.2.5 The numbers of dredgers and filling barges for each dredging and filling operation are presented in Table 22. This table also presents the working rates (in-situ and un-bulked volumes) and expected sediment loss rates for each dredging and filling operation.

Table 22 HKBCF: Summary of Losses of Sediment to Suspension

Work Item	Plant	No. of Plant	Working Rate (Note 1)	Loss Rate (kg/m^3)	Reduction Due to Seawalls	Sediment Losses (kg/s) (Note 2)	No. of barge events per day	Total Losses (kg/day) all plant	Material Assumed	No. of Active Plants	Daily No. of Plants Trips	Operation Time (min)	Daily Production Rate (Bulk volume, m3/day)
Dredging													
(1)	grab dredger	7	6,000	20	0%	2.08	-	840,000	-	7	7	960	50,400
(1)	grab dredger (behind partial seawall)	7	6,000	20	45%	1.15	-	462,000	-	7	7	960	50,400
(2)	TSHD (9,000m^3) (behind partial seawall)	1	27,000	7	45%	9.6	3	103,950	-	1	3	60	40,500
	grab dredger (behind partial seawall)	3	6,000	20	45%	1.15	-	198,000	-	3	3	960	21,600
(3)	grab dredger	5	6,000	20	0%	2.08	-	600,000	-	5	5	960	36,000
(3)	grab dredger (behind partial seawall)	5	6,000	20	45%	1.15	-	330,000	-	5	5	960	36,000
(4)	grab dredger	4	6,000	20	0%	2.08	-	480,000	-	4	4	960	28,800
(5)	grab dredger (behind full seawall)	3	6,000	20	80%	0.42	-	72,000	-	3	3	960	21,600
(6)	grab dredger	2	6,000	20	0%	2.08	-	240,000	-	2	2	960	14,400
(7)	TSHD (9,000m^3)	1	27,000	7	0%	17.5	3	189,000	-	1	3	60	40,500
	grab dredger	7	6,000	20	0%	2.08	-	840,000	-	7	7	960	50,400
Filling													
(a)	filling barge	44	769	-	0%	20.19	2	705,385	-	4	88	-	88,000
	dump barge	14	769	5% of 25% fines	0%	60.90	2	511,538	PF	1	28	5	28,000
	pelican barge	30	769	5% of 5% fines	0%	1.20	2	193,846	Sand	3	60	45	60,000
(a)	filling barge (behind partial seawall)	44	769	-	45%	11.11	2	387,962	-	4	88	-	88,000
	dump barge	14	769	5% of 25% fines	45%	33.49	2	281,346	PF	1	28	5	28,000
	pelican barge	30	769	5% of 5% fines	45%	0.66	2	106,615	Sand	3	60	45	60,000
(a)	filling barge (behind full seawall)	44	769	-	80%	4.04	2	141,077	-	4	88	-	88,000
	dump barge	14	769	5% of 25% fines	80%	12.18	2	102,308	PF	1	28	5	28,000
	pelican barge	30	769	5% of 5% fines	80%	0.24	2	38,769	Sand	3	60	45	60,000
(b)	filling barge	44	769	-	0%	20.19	2	705,385	-	4	88	-	88,000
	dump barge	14	769	5% of 25% fines	0%	60.90	2	511,538	PF	1	28	5	28,000
	pelican barge	30	769	5% of 5% fines	0%	1.20	2	193,846	Sand	3	60	45	60,000
(b)	filling barge (behind partial seawall)	44	769	-	45%	11.11	2	387,962	-	4	88	-	88,000
	dump barge	14	769	5% of 25% fines	45%	33.49	2	281,346	PF	1	28	5	28,000
	pelican barge	30	769	5% of 5% fines	45%	0.66	2	106,615	Sand	3	60	45	60,000
(b)	filling barge (behind full seawall)	44	769	-	80%	4.04	2	141,077	-	4	88	-	88,000
	dump barge	14	769	5% of 25% fines	80%	12.18	2	102,308	PF	1	28	5	28,000

Work Item	Plant	No. of Plant	Working Rate (Note 1)	Loss Rate (kg/m^3)	Reduction Due to Seawalls	Sediment Losses (kg/s) (Note 2)	No. of barge events per day	Total Losses (kg/day) all plant	Material Assumed	No. of Active Plants	Daily No. of Plants Trips	Operation Time (min)	Daily Production Rate (Bulk volume, m3/day)
	pelican barge	30	769	5% of 5% fines	80%	0.24	2	38,769	Sand	3	60	45	60,000
(c)	filling barge	20	769	-	0%	19.11	2	309,692	-	3	40	-	40,000
	dump barge	6	769	5% of 25% fines	0%	60.90	2	219,231	PF	1	12	5	12,000
	pelican barge	14	769	5% of 5% fines	0%	1.20	2	90,462	Sand	2	28	45	28,000
(c)	filling barge (behind full seawall)	20	769	-	80%	3.82	2	61,938	-	3	40	-	40,000
	dump barge	6	769	5% of 25% fines	80%	12.18	2	43,846	PF	1	12	5	12,000
	pelican barge	14	769	5% of 5% fines	80%	0.24	2	18,092	Sand	2	28	45	28,000
(d)	filling barge (behind full seawall)	17	769	-	80%	4.45	2	58,062	-	3	34	-	34,000
	dump barge	6	769	5% of 25% fines	80%	12.18	2	43,846	PF	1	12	5	12,000
	pelican barge	11	769	5% of 5% fines	80%	0.24	2	14,215	Sand	2	22	45	22,000
(e)	filling barge	11	769	-	0%	22.91	2	191,385	-	2	22	-	22,000
	dump barge	4	769	5% of 25% fines	0%	60.90	2	146,154	PF	1	8	5	8,000
	pelican barge	7	769	5% of 5% fines	0%	1.20	2	45,231	Sand	1	14	45	14,000
(e)	filling barge (behind partial seawall)	11	769	-	45%	12.60	2	105,262	-	2	22	-	22,000
	dump barge	4	769	5% of 25% fines	45%	33.49	2	80,385	PF	1	8	5	8,000
	pelican barge	7	769	5% of 5% fines	45%	0.66	2	24,877	Sand	1	14	45	14,000
(f)	filling barge	66	769	-	0%	19.29	2	1,028,000	-	6	132	-	132,000
	dump barge	20	769	5% of 25% fines	0%	60.90	2	730,769	PF	1	40	5	40,000
	pelican barge	46	769	5% of 5% fines	0%	1.20	2	297,231	Sand	5	92	45	92,000

Notes:

1. *All volumes mentioned are in situ volume except production rate which is based on bulked volume. The assumed bulking factor is 1.2 for grab dredging, 1.3 for filling barge and 1.5 for TSHD (if any). The working rate is per grab or TSHD (m^3/day) or per barge/event (m^3).*
2. *The loss rate is per plant per event.*
3. *All plants assume daily working for 16 hour, except TSHD in which 24 hour is assumed. Each pelican barge assume unloads in 45 minutes and dump barge assume unload in 5 minutes.*
4. *Partial Seawall = substantially completed seawall with 100-200m leading edge. Full Seawall = completed seawall with 50-100m opening gap for marine access.*
5. *When a mixture of public fill and rock (PF/Rock) are specified, only the portion of PF is included in the above calculation table. When a mixture of public fill and sand fill (PF/Sand) are specified, it is assumed to consist of 30% PF at the most. For calculation purpose, the filling barges for PF and sand is calculated separately using the ratio of 30/70, but rounded up for the PF barges to give a reasonable worse case estimate.*
6. *Operation time for grab dredgers is the total available time; for other plants is per event time.*
7. *The grab dredgers are assumed to be worked on site at all times.*
8. *The max. number of active filling barges is generally estimated as = (operation time x total no. of plant trips / 960) and rounded up to whole number.*

D5-9.2.6 Based on the calculated loss rates for each dredging and filling operation, Figure 7a also presents the total daily loss rates for each month during the construction programme. The daily production rate (bulk volume), daily no of plants trips and number of active plants (dredging and filling) on site are also included Table 20 and Table 21. Figures 7b, 7c and 7d present the overall programmes for the maximum daily production rate (bulk volume), the maximum daily number of plant trips and maximum number of active plants (dredging and filling) for the concurrent TM-CLKL+HKBCF+HKLR projects.

D5-9.2.7 In Table 22, it has been assumed that no mitigation measures, other than integrated advanced seawalls. The generally accepted sediment loss reduction rate by seawalls ranged between 75% - 100% (References 11, 12, 16 and 17). Based on a conservative assessment, it was proposed the reduction factor by a substantially completed seawall (with at least 100-200m leading edge) should be at least 45%. However, for a nearly completed seawall (with only 50-100m access opening), a 80% reduction should be assumed while that for a fully enclosed seawall without opening access, 100% reduction should be assumed. This is also inline with the generally accepted assumptions in the approved EIAs

D5-9.2.8 If each pelican barge filling event takes 45 minutes, the maximum number of filling events which can be carried out during each 16 hour working day without any concurrent filling from more than one barge is 21, equivalent to 10 barges making 2 trips per day. As a result, all pelican barge filling operations, except (e), required for the HKBCF will involve two or more barges offloading simultaneously for at least part of each filling event. In the model studies, the sediment loss for these pelican barges filling will be assumed to be continuous at a constant rate (total loss by all plants divided by the duration of works) through out the working time.

D5-9.2.9 For some dredging works, the dredging plant could be distributed over more than one item of work. For example, seawall dredging for Portions B & C. In these cases, the dredging plant will be assumed to be evenly distributed over the concurrent items of work.

D5-10 HZMB HONG KONG LINK ROAD (HKLR)

D5-10.1 Background

D5-10.1.1 The HKLR is a dual 3-lane carriageway of about 12km long connecting the HKBCF with the HZMB Main Bridge at the HKSAR boundary. The section of HKLR from the HKSAR boundary to Scenic Hill at the Airport is in the form of viaducts. The section of the HKLR between Scenic Hill and the HKBCF comprises a tunnel through Scenic Hill and the tunnel/at-grade road at the reclamation of about 19ha along the east coast of the Airport with viaducts at the end for final connection with HKBCF.

D5-10.1.2 The reclamation layout and construction sequencing of the HKLR is shown in Figures 13 and 14. Based on the available site investigation results, the estimated quantity of the dredging and filing works in HKBCF is about 4.0 Mm^3 (in-situ volume) and 5.0 Mm^3 (in-situ volume) respectively.

D5-10.1.3 The dredging and filling works required for the seawalls and reclamation for the HKLR are programmed to begin in February 2011 and end in January 2013 while the piling works for the bridge sections are programmed to begin in June 2011 and finish in December 2013. The construction programme is presented in Figure 7a with other projects.

D5-10.1.4 In general, the reclamation works of HKLR would be carried out in 3 portions. The general reclamation sequence is as follows:

- Construct the seawall at Portion 1 of HKLR. A gap of about 100m will be allows at the seawall for marine access during the reclamation works. The seawall at this small gap will be completed after the reclamation filling;
- Dredging and filling of the reclamation in Portion 1;
- Dredging and filling of the reclamation and seawalls in Portion 2. The reclamation in Portion 2 is small and, therefore, it is envisaged that the dredging and filling works of reclamation and seawall would be carried out at the same time; and
- Dredging and filling of the reclamation and seawalls in Portion 3. Similar to the case in Portion 2, the dredging and filling works of reclamation and seawall would be carried out at the same time.

D5-10.1.5 For the piled foundation of viaduct, bored piles would be adopted and, therefore, the excavated materials within the bored piles will need to be disposed. The envisaged construction sequence and programme of the piling works of the viaducts in HKLR is shown in Figures 7, 13 and 14. In general, it is anticipated that the piling works would be carried out on two work fronts, in the direction from west to east in the Airport channel and the area between HKSAR boundary and San Shek Wan. For the San Shek Wan section, the engineer advised that there are 105 piers and 35 consecutive piers could be working concurrently at time. For the Airport Channel Section, the engineer advised that there are 30 piers and 10 piers could be working concurrently at time.

D5-10.1.6 Similar to HKBCF, it is assumed that a 10% bigger reclamation and 10% increase in the plant for reclamation works in the water quality modelling of HKLR. This assumption is made to take account of the possible widening of the existing East Coast Road at Airport Island and, thus, the reclamation in HKLR need to be enlarged to accommodate it in this case.

D5-10.2 Sediment Loss Rates

D5-10.2.1 The reclamation works have been divided into 3 portions and, in each portion, the same dredging and filling plant (3 grab dredgers and 14 filling barges) and working rates will be employed for the construction of the seawalls and reclamations. The characteristics of the fill material is generally similar to those discussed for TM-CLKL although the material for seawall filling is generally assumed to be 70/30 of sand and public fill, except the very late stage when only rock fill is assumed.

D5-10.2.2 When filling above +2.5mPD, zero losses of fine material to the surrounding waters has been assumed. Similarly, when using rock fill for the seawalls, it has been assumed that any fine material present is insignificant and zero loss of fine material has been assumed. In all cases where the construction of the seawall begins before any dredging or filling takes place for the reclamation, it has been assumed that any dredging or filling for the reclamation would begin 100-200m from the ends of the seawalls. The potential for fine sediment to escape into the surrounding water would be reduced significantly and, under these circumstances, it has been assumed that only a fraction of the potential loss of fines is released into the receiving waters at the entrance to the reclamation depending on the stage of the completeness of the seawalls (Reference 11, 12, 16 and 17). The availability of the seawalls protection for reclamation dredging/filling is shown in the anticipated construction sequence drawing (Figure 14). The overall programme (Figure 7a) also indicate when the seawall protection can be assumed based on the anticipated works progress as indicated in the programme.

D5-10.2.3 Based on a 16-hour working day and assuming the grab dredgers work continuously and that each filling barge makes two trips per day, the calculated loss rates are presented in Figure 7a and Table 23. The daily production rate (bulk volume), daily no of plants trips and number of active plants (dredging and filling) on site are also included Table 20 and Table 21. Figures 7b, 7c and 7d present the overall programmes for the maximum daily production rate (bulk volume), the maximum daily number of plant trips and maximum number of active plants (dredging and filling) for the concurrent TM-CLKL+HKBCF+HKLR projects.

D5-10.2.4 For the bored piling works, it has been assumed that the excavation will proceed at a rate of 2,000kg/hour and that, as for grab dredging, a loss rate of 20kg/m^3 would apply. However, when excavating bed sediments within the pile casing, the only opportunity for fine sediment to be lost to the surrounding waters will be when transferring the excavated material to a receiving barge which has been assumed to be equivalent to 5% of the typical total grab dredging losses (Reference 12). It has been estimated that the piles would be bored at a rate of 2,000kg/hour and, assuming a typical wet density of 1,340kg/m^3 (Reference 12), is equivalent to a dredging rate of 1.5m^3/hour. Based on a loss rate equivalent to 5% of 20kg/m^3 dredged gives a loss rate of 0.0004kg/s.

Table 23 HKLR: Summary of Losses of Sediment to Suspension (Dredging and Filling)

Work Item	Plant	No. of Plant	Working Rate (Note 1)	Loss Rate (kg/m^3)	Reduction Due to Seawalls	Sediment Losses (kg/s) (Note 2)	No. of barge events per day	Total Losses (kg/day) all plant	Material Assumed	No. of Active Plants	Daily No. of Plants Trips	Operation Time (min)	Daily Production Rate (Bulk volume, m3/day)
(1)	grab dredger	3	6,000	20	0%	2.08	-	360,000	-	3	3	960	21,600
(1)	grab dredger (behind partial seawall)	3	6,000	20	45%	1.15	-	198,000	-	3	3	960	21,600
(1)	grab dredger (behind full seawall)	3	6,000	20	80%	0.42	-	72,000	-	3	3	960	21,600
(a)	filling barge	14	769	-	0%	22.52	2	240,846	-	2	28	-	28,000
	dump barge	5	769	5% of 25% fines	0%	60.90	2	182,692	PF	1	10	5	10,000
	pelican barge	9	769	5% of 5% fines	0%	1.20	2	58,154	Sand	1	18	45	18,000
(b)	filling barge (behind partial seawall)	14	769	-	45%	12.39	2	132,465	-	2	28	-	28,000
	dump barge	5	769	5% of 25% fines	45%	33.49	2	100,481	PF	1	10	5	10,000
	pelican barge	9	769	5% of 5% fines	45%	0.66	2	31,985	Sand	1	18	45	18,000
(b)	filling barge (behind full seawall)	14	769	-	80%	4.50	2	48,169	-	2	28	-	28,000
	dump barge	5	769	5% of 25% fines	80%	12.18	2	36,538	PF	1	10	5	10,000
	pelican barge	9	769	5% of 5% fines	80%	0.24	2	11,631	Sand	1	18	45	18,000
(p1)	Bored Piling (Marine)	35	24	1	0%	0.0004	-	836	-	35	35	960	1,003
(p2)	Bored Piling (Marine)	10	24	1	0%	0.0004	-	239	-	10	10	960	287
(p3)	Bored Piling (Non Marine)	-	-	-	-	-	-	-	-	-	-	-	-

Notes:

1. *All volumes mentioned are in situ volume except production rate which is based on bulked volume. The assumed bulking factor is 1.2 for grab dredging, 1.3 for filling barge and 1.5 for TSHD (if any). The working rate is per grab or TSHD (m^3/day) or per barge/event (m^3).*
2. *The loss rate is per plant per event.*
3. *All plants assume daily working for 16 hour, except TSHD in which 24 hour is assumed. Each pelican barge assume unloads in 45 minutes and dump barge assume unload in 5 minutes.*
4. *Partial Seawall = substantially completed seawall with 100-200m leading edge. Full Seawall = completed seawall with 50-100m opening gap for marine access.*
5. *When a mixture of public fill and rock (PF/Rock) are specified, only the portion of PF is included in the above calculation table. When a mixture of public fill and sand fill (PF/Sand) are specified, it is assumed to consist of 30% PF at the most. For calculation purpose, the filling barges for PF and sand is calculated separately using the ratio of 30/70, but rounded up for the PF barges to give a reasonable worse case estimate.*
6. *Operation time for grab dredgers is the total available time; for other plants is per event time.*
7. *The grab dredgers are assumed to be worked on site at all times.*
8. *The max. number of active filling barges is generally estimated as = (operation time x total no. of plant trips / 960) and rounded up to whole number.*

D5-10.2.5 In Table 23, it has been assumed that no mitigation measures, other than integrated advanced seawalls. The generally accepted sediment loss reduction rate by seawalls ranged between 75% - 100% (References 11, 12, 16 and 17). Based on a conservative assessment, it was proposed the reduction factor by a substantially completed seawall (with at least 100-200m leading edge) should be at least 45%. However, for a nearly completed seawall (with only 50-100m access opening), a 80% reduction should be assumed while that for a fully enclosed seawall without opening access, 100% reduction should be assumed. This is also inline with the generally accepted assumptions in the approved EIAs.

D5-11 SUMMARY

D5-11.1 Introduction

D5-11.1.1 With respect to the potential construction impacts, principally elevations in suspended solids concentrations in Hong Kong coastal waters, which could arise during the construction of the TM-CLKL+HKBCF+HKLR, there are a number of concurrent construction projects which could give rise to cumulative impacts as discussed in preceding chapters of this Appendix.

D5-11.1.2 In this Chapter, each of the TM-CLKL, HKBCF, HKLR and all concurrent projects are re-assessed with respect to the worst case dredging and filling scenarios.

D5-11.1.3 The construction of the HKBCF will begin in September 2010 with the construction of the HKLR beginning in February 2011 and the TM-CLKL in November 2011.

D5-11.1.4 Once construction begins for the HKBCF, the construction of the first seawalls will proceed relatively rapidly. The works will begin with the dredging of trenches for the seawalls. This will then be followed by sand filling of the trenches followed by rock filling for the seawalls. As the works progress, the number of concurrent works for the TM-CLKL, HKBCF and HKLR will increase and, with respect to the models studies, it is intended to simulate construction impacts for three scenarios representative of:

1) The initial construction works when dredging and filling rates are at their maximum but when the construction works will have had little impact on existing tidal flows;
2) An intermediate stage when dredging and filling rates are still large and significant changes to local tidal flows can be expected due to the completion of large parts of the reclamations;
3) The final stages of construction when dredging and filling rates are still large and it can be expected that any major changes to the local tidal flow patterns which the completed reclamations might generate will have already become established.

D5-11.1.5 These scenarios will be simulated for wet and dry season conditions and the impacts due to the construction of the TM-CLKL+HKBCF+HKLR will be simulated when no mitigation measures is applied (i.e., unmitigated projects only), when appropriate mitigation measures (i.e., mitigated projects only) are applied and when concurrent projects are also included in the mitigated situation. Therefore, a total of nine construction scenarios for wet and dry season conditions will be simulated (i.e., 18 cases).

D5-11.2 Proposed Construction Phases to be Simulated in the Model Studies

D5-11.2.1 Based on the anticipated works progress for the TM-CLKL, HKBCF and HKLR as illustrated in Figures 8 to 23, the tentative plant inventory for each construction activities, the anticipated production rate and the potential sediment loss associated with them have as calculated and shown in Tables 20 to 23. The potential sediment loss for these activities are put in the programme timeline as shown in Figure 24 (this is the same as Figure 7a, but repeated here for clarity). Figure 24 also include consideration of the construction activities in relation to the progress of seawalls construction and where application, potential reduction in sediment loss due to the presences of the seawalls are incorporated. With Figure 24, the total daily loss rate for all three projects can be determined and the montly total sediment loss rate are presented in Figure 25.

D5-11.2.2 It should be note that there are several built-in conservative mechanisms to ensure the Figures 24 and 25 will not underestimate the potential sediment loss and these are summarised below:

- The engineering programme provided are weekly (TM-CLKL) or bi-weekly (HKBCF and HKLR). For the purpose of this exercise, however, monthly programme is used and, thus, allow for certain degree of variation in the works progress. All activities scheduled in a month are assumed to be concurrent within that month. One exception to this is when the engineer indicate the same set of plants would be required for different activities. In this case, the set of plants are either split by half (indicated with "/2" in Figure 24) or assigned to the works that could potentially leading to a higher sediment loss rate (e.g., area without seawall protection) (marked as "linked activities" in Figure 24);
- In assigning the fleets of filling barges for various fill material, instead of a simple pro-rata calculation, the number of barge for each fill material is calculated separately using the ratio of fill material, but rounded up for the public fill barges to give a conservative estimate as the fine contents of public fill materials is generally higher (see Tables 20-23);
- A 10% increase in the plant and, hence, the production rate for reclamation works has been assumed for the HKBCF and HKLR;
- The potentially more environmental friendly sand compaction piles (SCP) seawall is assumed to have the same potential of sediment release as a fully dredged seawall;
- The assumed sediment loss rate for grab dredger (20 kg/m^3) is highly conservative compared with other studies in this area; and
- The assumed potential reduction by advanced seawalls are conservative.

D5-11.2.3 Based on Figure 25, it can be seen that loss rates peak shortly after the start of construction of the HKBCF in February 2011, peak again in April 2012 before decreasing rapidly after April 2013.

D5-11.2.4 The extent of completed construction and construction and activities in progress for the TM-CLKL, HKBCF and HKLR in February 2011, April 2012 and April

2013 are summarised in Figures 15 to 23. It should be noted there these Figures are prepared based on the anticipated works progress at the selected scenario time frame provided by the engineers. As such, it is a reasonable accurate reflection of the anticipated construction progress and planned activities of the scenario time.

D5-11.2.5 In February 2011 (Figures 15, 18 and 21), construction of the TM-CLKL will not have begun but dredging for the seawall (Portion 1) of the HKLR will be about to begin. Some seawall sections for the HKBCF will have been completed in Portion A and C which will have some impacts on local tidal flows. However, concern has been expressed over possible siltation in the airport sea channel as a result of sediment losses during the construction works for the TM-CLKL+HKBCF+HKLR and, in February 2011, the potential loss rates are at their maximum near the start of the project at locations close to the eastern entrance to the sea channel.

D5-11.2.6 In April 2012 (Figures 16, 19 and 22), most of the seawalls for the HKBCF will have been completed and it is expected that local tidal flows will have changed significantly compared to existing conditions. Dredging and filling for the seawalls at the north east extent of the HKBCF will be underway and dredging and filling for the seawall at the north east tip of the southern reclamation for the TM-CLKL will also be underway Filling of the TM-CLKL southern reclamation will also have begun and bored piling works for the viaduct connections will have begun. Any sediment lost to suspension in the north eastern extent of the southern reclamations will be exposed to the relatively strong tidal currents between the new reclamations and Tai Mo To and are likely to be transported from the dredging and filling areas along the northern side of the airport where sensitive receivers (artificial reefs and the Sha Chau and Lung Kwu Chau Marine Park) may be impacted.

D5-11.2.7 Dredging for the HKLR seawalls in Portions 2 and 3 will also be underway in April 2012 and, at the TM-CLKL northern landfall, the seawalls and reclamation in Portion N-C will be being filled and the seawalls in Portions N-A and N-B will be being dredged.

D5-11.2.8 In April 2013 (Figures 17, 20 and 23), dredging and filling for the seawalls and reclamation for the HKBCF Portion D and filling for the Phase 2 reclamation will be underway. The TM-CLKL northern land fall reclamation (Portions N-A and N-B) will be being filled but behind completed seawalls and so no significant sediment losses are anticipated. At the TM-CLKL southern reclamation, sand filling of Portions S-B and seawall dredging and filling for Portion S-C will be underway. All seawalls and reclamations will be nearing completion and any changes to the tidal flow regime as a result of the completed reclamations will have become established. After April 2013, dredging and filling rates reduce rapidly and it is proposed that April 2013 should be simulated in the model studies as the scenario towards the end of the construction works when there remains the potential for significant impacts from sediment losses to suspension.

D5-11.2.9 The overall programme for the construction of the TM-CLKL+HKBCF+HKLR and all concurrent projects is presented in Figure 24. For the proposed target dates of February 2011 and April 2012, all relevant concurrent projects will be underway. In April 2012, the Lantau Logistics park dredging and filling works will be fully protected with advanced seawalls and silt curtain and no sediment loss will be assumed but all other concurrent projects will still be underway and, apart from the HZMB (which is discussed further below), the expected sediment loss rates for these concurrent projects are not expected to change significantly during the course of the construction of the TM-CLKL+HKBCF+HKLR. One exception might be the new contaminated mud pit at East of Sha Chau / South Brothers where backfilling of one pit may coincide with the excavation of the next pit.

D5-11.2.10 The proposed target dates for the simulations fall in February and April. In February each year, it is expected that dry season conditions will prevail. In April, however, local tidal hydraulic conditions could be representative of either wet or dry season conditions depending on the freshwater discharge from the Pearl River Delta. While it is expected that the construction programme will begin in September 2010, and so the start of the dredging and filling works will coincide with dry season conditions, it is proposed that all scenarios are simulated for both wet and dry season conditions.

D5-11.2.11 In summary, it is proposed that the three target dates of February 2011, April 2012 and April 2013 are used as the basis for the simulations of construction impacts.

D5-11.3 Proposed Modelling scenarios

D5-11.3.1 For the three target dates selected above, construction impacts for each of the target dates for the TMCLKL+HKBCF+HKLR are simulated both with and without special mitigation measures (apart from the integrated advanced seawalls) and then the mitigated scenario with the concurrent projects. These simulations will allow an assessment to be made of both the cumulative impacts which might arise during the construction works and the construction impacts which might be generated by the TMCLKL+HKBCF+HKLR works on their own. This would give a total of 9 construction scenarios (identified as P1-P9) to be simulated for wet and dry season conditions. While it is common practice to employ silt curtains around grab dredgers and when filing reclamations, initially the simulations do not include these mitigation measures to allow identification of potential extend of the construction impacts.

D5-11.3.2 For the 3 selected scenario years, not all the construction activities indicated in Tables 20-23 are relevant to the modelling. Those relevant activities and the corresponding daily sediment loss rate can be directly read from Figure 24. As a summary, the relevant activities and modelling parameters for the 3 scenario year are presented in Tables 24-26 below.

Table 24 Summary of Relevant Project Works Item and Loss Rate for 2011 Scenario

Works Items	Works Description	Plant	No. of Plant	Working Rate (Note 1)	Loss Rate (kg/m^3) (Note 2)	Reduction due to Seawalls	No. of barge events per day	Total Losses (kg/day) - All Plants	Material	Plant ID	Sediment Loss Rate (kg/s)	Frequency	Duration of Each Operation
BCF (f)	Filling with public fill	dump barge	20	769	5% of 25% fines	-	2	730,769	PF	BCFfd	60.9	19.5 minutes	5 minutes
BCF (f)	Filling with sand	pelican barge	46	769	5% of 5% fines	-	2	297,231	Sand	BCFfp	5.2	continuous	-
BCF (7)	Dredging	grab dredger	7	6,000	20	-	-	840,000	-	BCF7	14.6	continuous	-
BCF (7)	Dredging	TSHD (9,000m3)	1	27,000	7	-	3	189,000	-	BCF7t	17.5	7 hours	1 hour
BCF (a)	Filling with public fill	dump barge	14	769	5% of 25% fines	-	2	511,538	PF	BCFad	60.9	30 minutes	5 minutes
BCF (a)	Filling with sand	pelican barge	30	769	5% of 5% fines	-	2	193,846	Sand	BCFap	3.4	continuous	-
BCF (1)	Dredging	grab dredger	7	6,000	20	-	-	840,000	-	BCF1	14.6	continuous	-
BCF (e)	Filling with public fill	dump barge	4	769	5% of 25% fines	-	2	146,154	PF	BCFed	60.9	131 minutes	5 minutes
BCF (e)	Filling with sand	pelican barge	7	769	5% of 5% fines	-	2	45,231	Sand	BCFep	1.2	25 minutes	-
BCF (6)	Dredging	grab dredger	2	6,000	20	-	-	240,000	-	BCF6	4.2	continuous	-
LR (1)	Dredging	grab dredger	3	6,000	20	-	-	360,000	-	LR1	6.3	continuous	-

Notes:
1. The working rate is per grab or TSHD (m^3/day) or per barge/event (m^3).
2. The loss rate is per plant per event.
3. All plants assume daily working for 16 hour, except TSHD in which 24 hour is assumed. Each pelican barge assume unloads in 45 minutes and dump barge assume unload in 5 minutes.
4. The last 4 columns (grey) provided specific details about the model input.

Table 25 Summary of Relevant Project Works Item and Loss Rate for 2012 Scenario

Works Items	Works Description	Plant	No. of Plant	Working Rate (Note 1)	Loss Rate (kg/m^3) (Note 2)	Reduction due to Seawalls	No. of barge events per day	Total Losses (kg/day) - All Plants	Material	Plant ID	Sediment Loss Rate (kg/s)	Frequency	Duration of Each Operation
BCF (e)	Filling with public fill	dump barge	4	769	5% of 25% fines	-	2	146,154	PF	BCFed	60.9	131 minutes	5 minutes
BCF (e)	Filling with sand	pelican barge	7	769	5% of 5% fines	-	2	45,231	Sand	BCFep	1.2	25 minutes	45 minutes
BCF (6)	Dredging	grab dredger	2	6,000	20	-	-	240,000	-	BCF6	4.2	continuous	-
BCF (4)	Dredging	grab dredger	4	6,000	20	-	-	480,000	-	BCF4	8.3	continuous	-
BCF (c)	Filling with public fill	dump barge	6	769	5% of 25% fines	-	2	219,231	PF	BCFcd	60.9	81.5 minutes	5 minutes
BCF (c)	Filling with sand	pelican barge	14	769	5% of 5% fines	-	2	90,462	Sand	BCFcp	1.6	continuous	-
LR (b)	Filling with public fill	dump barge	5	769	5% of 25% fines	80%	2	36,538	PF	LRbd	12.2	101 minutes	5 minutes
LR (b)	Filling with sand	pelican barge	9	769	5% of 5% fines	80%	2	11,631	Sand	LRbp	0.2	8.5 minutes	45 minutes
LR (1)	Dredging	grab dredger	3	6,000	20	-	-	360,000	-	LR1	6.3	continuous	-
TM (FN2)	Filling with public fill	dump barge	6	769	5% of 25% fines	45%	2	120,577	PF	TMFN2	33.5	81.5 minutes	5 minutes
TM (DN2)	Dredging	grab dredger	1	6,000	20	-	-	120,000	-	TMDN2	2.1	continuous	-
TM (FS2)	Filling with public fill	dump barge	1	769	5% of 25% fines	45%	2	20,096	PF	TMFS2d	33.5	8 hours	5 minutes
TM (FS2)	Filling with sand	pelican barge	2	769	5% of 5% fines	45%	2	7,108	Sand	TMFS2p	0.7	4 hours	45 minutes
TM (FS1)	Filling with public fill	dump barge	3	769	5% of 25% fines	-	2	109,615	PF	TMFS1	60.9	3 hours	5 minutes
TM (P)	Bored Piling	grab dredger	15	24	5% of 20	-		360		TMPx	6.3E-03	continuous	-
LR (p1)	Bored Piling	grab dredger	35	24	5% of 20	-	-	836		LRpx	1.5E-02	continuous	-
LR (p2)	Bored Piling	grab dredger	10	24	5% of 20	-	-	239		LRpx	4.1E-03	continuous	-

Notes:
1. The working rate is per grab or TSHD (m^3/day) or per barge/event (m^3).
2. The loss rate is per plant per event.
3. All plants assume daily working for 16 hour, except TSHD in which 24 hour is assumed. Each pelican barge assume unloads in 45 minutes and dump barge assume unload in 5 minutes.

4. The last 4 columns (grey) provided specific details about the model input.

Table 26 Summary of Relevant Project Works Item and Loss Rate for 2013 Scenario

Works Items	Works Description	Plant	No. of Plant	Working Rate (Note 1)	Loss Rate (kg/m^3) (Note 2)	Reduction due to Seawalls	No. of barge events per day	Total Losses (kg/day) - All Plants	Material	Plant ID	Sediment Loss Rate (kg/s)	Frequency	Duration of Each Operation
BCF (d)	Filling with public fill	dump barge	6	769	5% of 25% fines	80%	2	43,846	PF	BCFdd	12.2	81.5 minutes	5 minutes
BCF (d)	Filling with sand	pelican barge	11	769	5% of 5% fines	80%	2	14,215	Sand	BCFdp	0.2	continuous	-
BCF (3)	Dredging	grab dredger	5	6,000	20	-	-	600,000	-	BCF3	10.4	continuous	-
BCF (b)	Filling with public fill	dump barge	14	769	5% of 25% fines	-	2	511,538	PF	BCFbd	60.9	30 minutes	5 minutes
BCF (b)	Filling with sand	pelican barge	30	769	5% of 5% fines	-	2	193,846	Sand	BCFbp	3.4	continuous	-
TM (FN4)	Filling with sand	dump barge	6	769	5% of 25% fines	45%	2	120,577	PF	TMFN4	33.5	81.5 minutes	5 minutes
TM (FS4)	Filling with public fill	dump barge	1	769	5% of 25% fines	45%	2	20,096	PF	TMFS4d	33.5	8 hours	5 minutes
TM (FS4)	Filling with sand	pelican barge	2	769	5% of 5% fines	45%	2	7,108	Sand	TMFS4p	0.7	4 hours	-
TM (FS5)	Filling with public fill	dump barge (PF)	2	769	5% of 25% fines	-	2	73,077	-	TMFS5	60.9	5 hours	5 minutes
TM (DS3)	Bored Piling	grab dredger	1	6,000	20	-	-	120,000	-	TMDS3	2.1	continuous	-
LR (p1)	Bored Piling	grab dredger	35	24	5% of 20	-	-	836		LRpx	1.5E-02	continuous	-

Notes:

1. The working rate is per grab or TSHD (m^3/day) or per barge/event (m^3).

2. The loss rate is per plant per event.

3. All plants assume daily working for 16 hour, except TSHD in which 24 hour is assumed. Each pelican barge assume unloads in 45 minutes and dump barge assume unload in 5 minutes.

4. The last 4 columns (grey) provided specific details about the model input.

D5-11.3.3 As noted in previous section, the rate at which the contaminated mud pits are backfilled depends on the rate of supply of contaminated material and so is uncertain. In order to ensure that the worst case scenario with respect to the contaminated mud pits is simulated, it was previously proposed to assumed that, for each simulation period, one pit is being backfilled while another is being excavated at the same time (Reference 1). However, based on further discussion with CEDD, it was advised it could be more likely that Pit Va be developed earlier and both Pit IVc and Va be backing in early 2011. At early 2012, both Pit Va and Vb could be backfilling while Vc being constructed. At early 2013, Pit Vc backfilling while Pit Vd and also the South Brothers Pit A and Pit B be constructed. As the number of plants involved and concurrent work sites based on this anticipated progress is higher, it is considered more appropriate to assume this as the worse case for the CMPs.

D5-11.3.4 Based on the anticipated programme from Advanced Work Coordination Group Project Office of HZMB (Reference 9) , the seawalls for the artificial islands will have been completed in January 2011 and filling of the reclamations will be underway. As a result, the cumulative construction impact scenario for February 2011 will include the expected losses of fine sediment to suspension during the filling operation behind almost completed seawalls. It is assumed that 5% of the sand fill will be fine (<63μm) and it is normally assumed that, in unconfined waters, 5% of that fine material will be lost to suspension. However, when filling behind the almost completed seawalls, it will be assumed that only 15% of that potential loss rate would be achieved. The filling rate is anticipated to be equivalent to 23 barges of 800m^3 capacity per day with a total daily loss rate of 17,940m3/day at each island. As a result, for the simulation of February 2011, it will be assumed that 23 bottom dumping barges arrive at 1-hour intervals at each island with a loss of 780kg/fill event.

D5-11.3.5 As explained before, however, to allow for possible programme slippage, it will be assumed that the seawall construction is still in progress at early 2011. A fleet of 3 TSHDs dredging at the side of the island closer to Hong Kong and each making 2 cycles per day will be assumed. As the mainland authority has confirmed the 3 TSHDs will not be working concurrently and the daily working hour is 8, it will be assumed that the 3 TSHDs will be working sequentially and the first cycle start in the morning while the second cycle start in the afternoon. As discussed before, each dredging cycle will last 70 minutes and it will be assumed that sediment losses are 28.2kg/s for the first 10 minutes of each cycle increasing to 31kg/s (28.2 kg/s draghead + 2.8 kg/s for overflow) for the remaining 60 minutes of each cycle. For the tunnel filling, it will be assumed that the fill is placed using bottom dumping barges with a capacity of 800m^3. The loss of fine sediment to suspension would then be equivalent to 3,200kg/event using the assumptions in Table 16. To achieve the expected filling rates of 6,375m^3/day around 8 barge loads of sand per day will be assumed.

D5-11.3.6 In April 2012 and April 2013, filling the artificial island reclamations will have been completed and dredging for the tunnel trench will be underway. The tunnel dredging will begin at the western end of the tunnel and proceed at around 200m/month beginning in October 2011. As a result, dredging should be taking place approximately 1.5km from the western end of the tunnel in April 2012.

D5-11.3.7 It is proposed, therefore, that the cumulative construction impact scenario for the HZMB in April 2012 includes 3 TSHDs each completing 2 dredging cycles in an 8 hour working day are simulated 1.5km from the western end of the HZMB tunnel section. If the time taken to complete a dredging and disposal cycle for the tunnel dredging is similar to that for the nearby dredging in Zone III of the Tonggu Channel, a complete cycle could take just over 4 hours (282 minutes). However, for the worst case, it will be assumed that 2 dredging cycles can be completed by each of the three TSHD each day. Similar to the seawall trench dredging for artificial island, it will be assumed the 3 TSHDs will be working sequentially and each dredging cycle will last 70 minutes. It will also be assumed that sediment losses are 28.2kg/s for the first 10 minutes of each cycle increasing to 31kg/s for the remaining 60 minutes of each cycle. For the tunnel filling, it will be assumed that the fill is placed using bottom dumping barges with a capacity of 800m^3. The loss of fine sediment to suspension would then be equivalent to 3,200kg/event using the assumptions in Table 16. To achieve the expected filling rates of 6,375m^3/day around 8 barge loads of sand per day will be assumed.

D5-11.3.8 In April 2013, dredging of the tunnel will be continuing and, after 19 months work, the dredging site should be around 4km from the western end of the trench. For the simulation of cumulative impacts in April 2013, therefore, the dredging losses described above for April 2012 will be simulated 4km from the western end of the tunnel trench.

D5-11.3.9 Once each tunnel section has been put in position, the trench will be backfilled with sand at a rate of 6,375m^3/day with a potential loss rate of fine material of 5,200kg/event. In the cumulative impact simulations for April 2012 and April 2013, it will be assumed that sand filling takes place 200m behind the dredging site with 8 barges arriving at 3-hourly intervals each day.

D5-11.3.10 In setting up the scenarios, it will be necessary to select locations at which it will be assumed the dredgers and sand barges are working. Based on the expected construction programmes for the TM-CLKL, HKBCF, HKLR and all concurrent projects and the dredging and filling plant to be used for each item of work, Figures 26 to 31 present the working locations for each piece of plant in the selected target years.

D5-11.3.11 Figures 32 and 33 also presents a summary of all the tidal flow and construction impact simulations which are planned to be carried out.

D5-12 REFERENCES

1 Detailed Site Selection Study for a Proposed Contaminated Mud Disposal Facility within the Airport East/East of Sha Chau Area Agreement No. CE 12/2002(EP), ERM May 2005

2 Environmental Impact Assessment Report for Tonggu Channel of Shenzhen Port, December 2005. CINOTECH Consultants Ltd in association with Black & Veatch Hong Kong Ltd

3 Communication between HDPI and ARUP

4 Scoping the Assessment of Sediment Plumes from Dredging. Construction Industry Research and Information Association (CIRIA) Publication C547, 2000.

5 Environmental Assessment Study for Backfilling of Marine Borrow Pits at North of the Brothers, Agreement No GEO 01/2001

6 Permanent Aviation Fuel Facility. EIA Report. Environmental Permit EP-139/200, Mouchel, 2002.

7 港珠澳大橋工程海洋環境影響報告書(2008 年十月)(HZMB OEIA).

8 Communication between HyD and HDPI.

9 Meeting between HyD and the Advance Work Coordination Group Project Office of Hongkong-Zhuihai-Macao Bridge.

10 Silt Protector, Taiyo Kogyo Corporation

11 Agreement No. CE 87/2001 (CE) Further Development of Tseung Kwan O Feasibility Study, Environmental Impact Assessment.

12 Agreement No. CE 39/2001Shenzhen Western Corridor - Investigation and Planning Environmental Impact Assessment Report, September 2002.

13 Agreement No. CE 74/98: Wan Chai Development Phase II Comprehensive Feasibility Study. Environmental Impact Assessment.

14 Agreement No. CE 42/2005 (WS) Laying of Western Cross Harbour Main and Associated Land Mains From West Kowloon to Sai Ying Pun – Investigation.

15 Agreement No. CE 35/2006(CE) Kai Tak Development Engineering Study cum Design and Construction of Advance Works – Investigation, Design and Construction. Dredging Works for Proposed Cruise Terminal at Kai Tak.

16 Liquefied Natural Gas (LNG) Receiving Terminal and Associated Facilities

17 Agreement No. CE 60/96). Northshore Lantau Development Feasibility Study

Figure 1 Existing and Proposed Mud Pits at East of Sha Chau and South Brothers

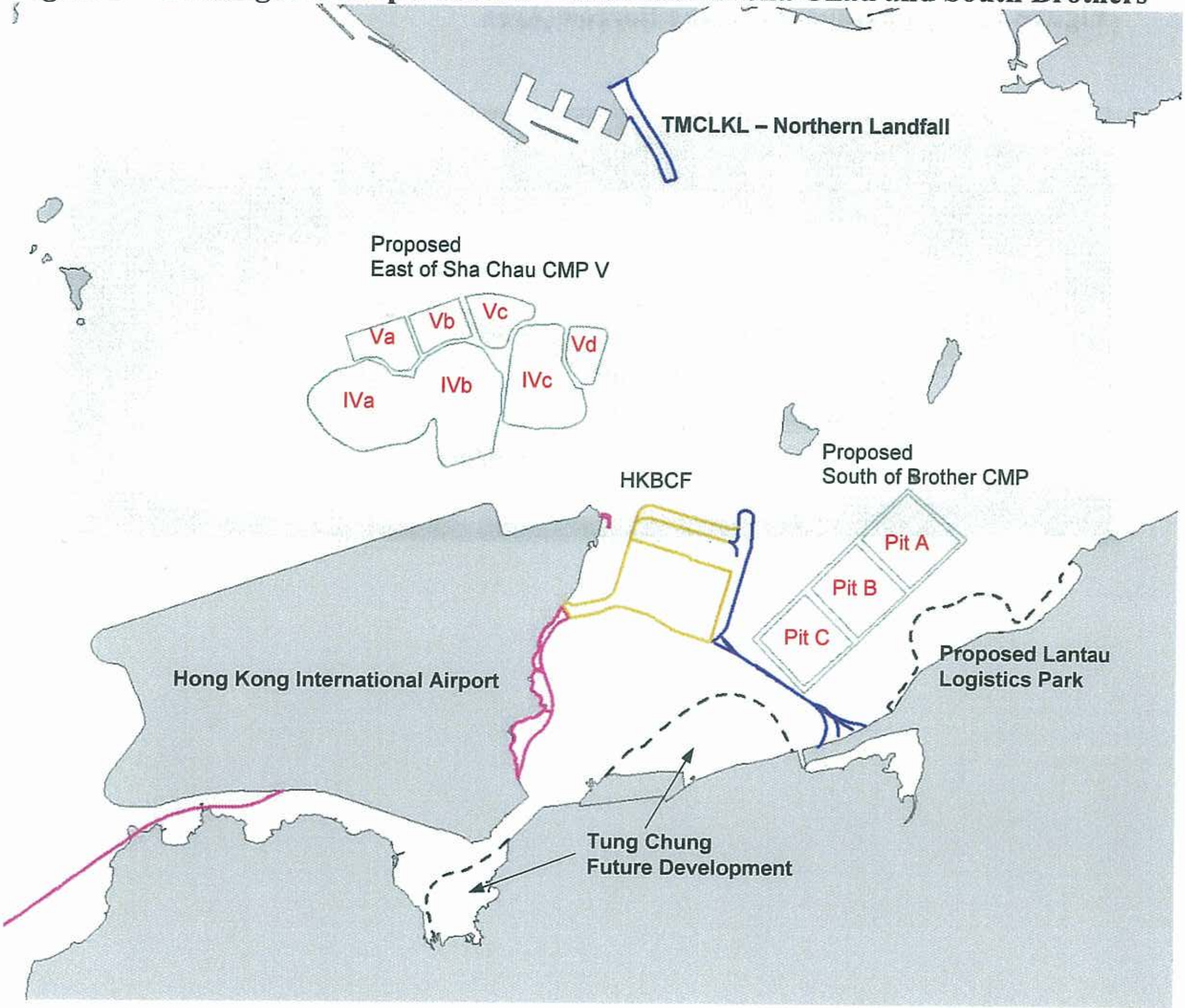


Figure 2 North Brothers Marine Borrow Area

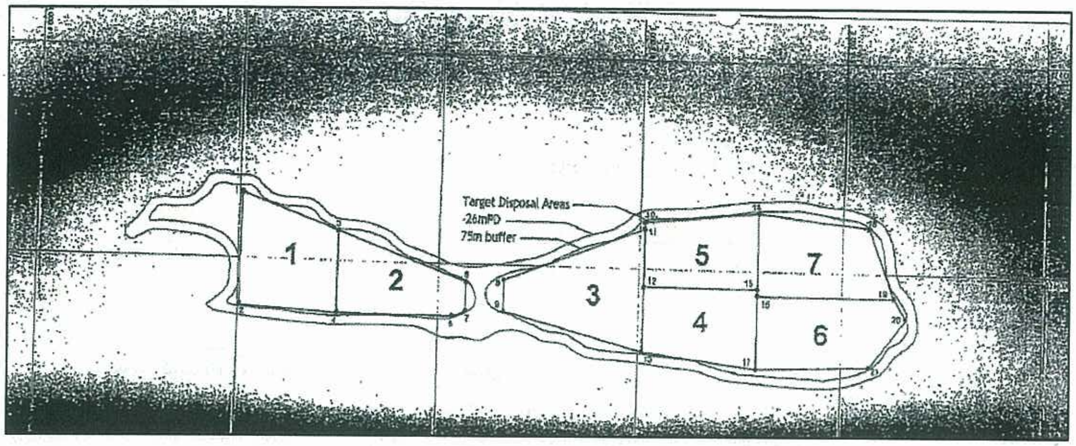


Figure 3 Location of the Tonggu Channel and Disposal Grounds for Tonggu Channel Maintenance Dredging

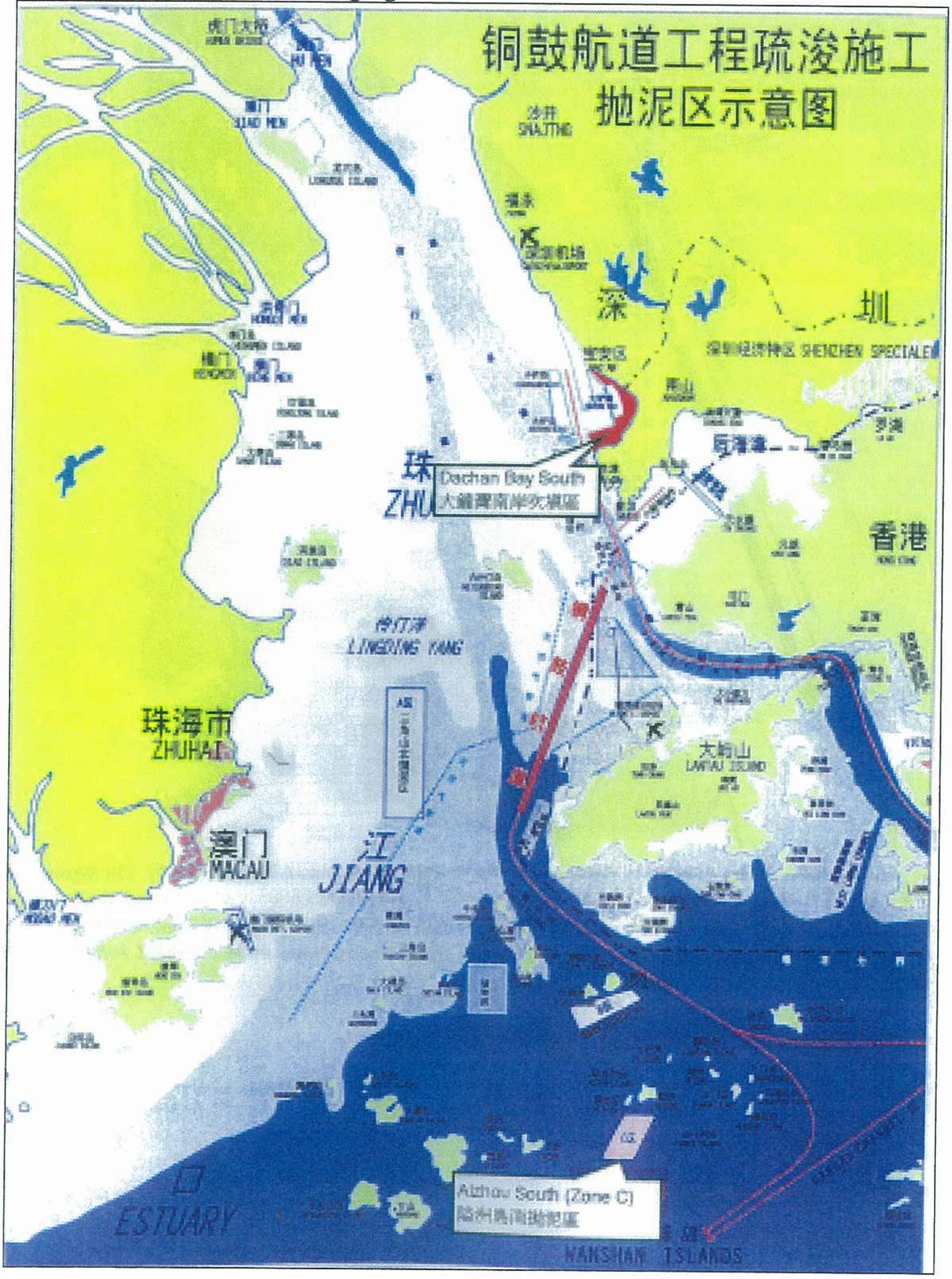
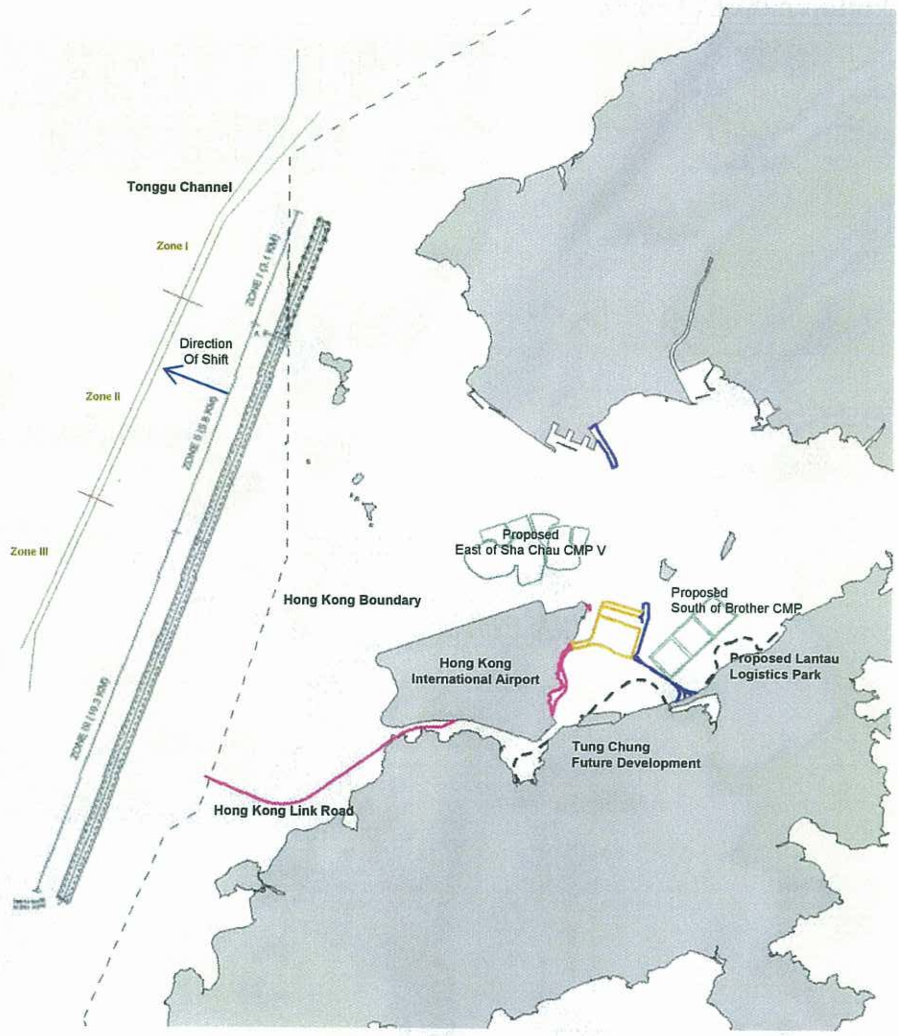


Figure 4 Tonggu Channel Showing Dredging Zones I to III



The grey lines indicate the alignment and zones as per the Tonggu Channel EIA Report (2005). The brown lines indicate the actual location of Tonggu Channel based on the marine chart (80831) of the Pearl River Estuary updated to 2008 produced by the Maritime Safety Administration of the PRC. The actual alignment is parallel to the one indicated in the Tonggu Channel EIA Report and the delineation the three dredging zones are shift accordingly.

Figure 5 Proposed Hong Kong Zhuhai Macau Bridge

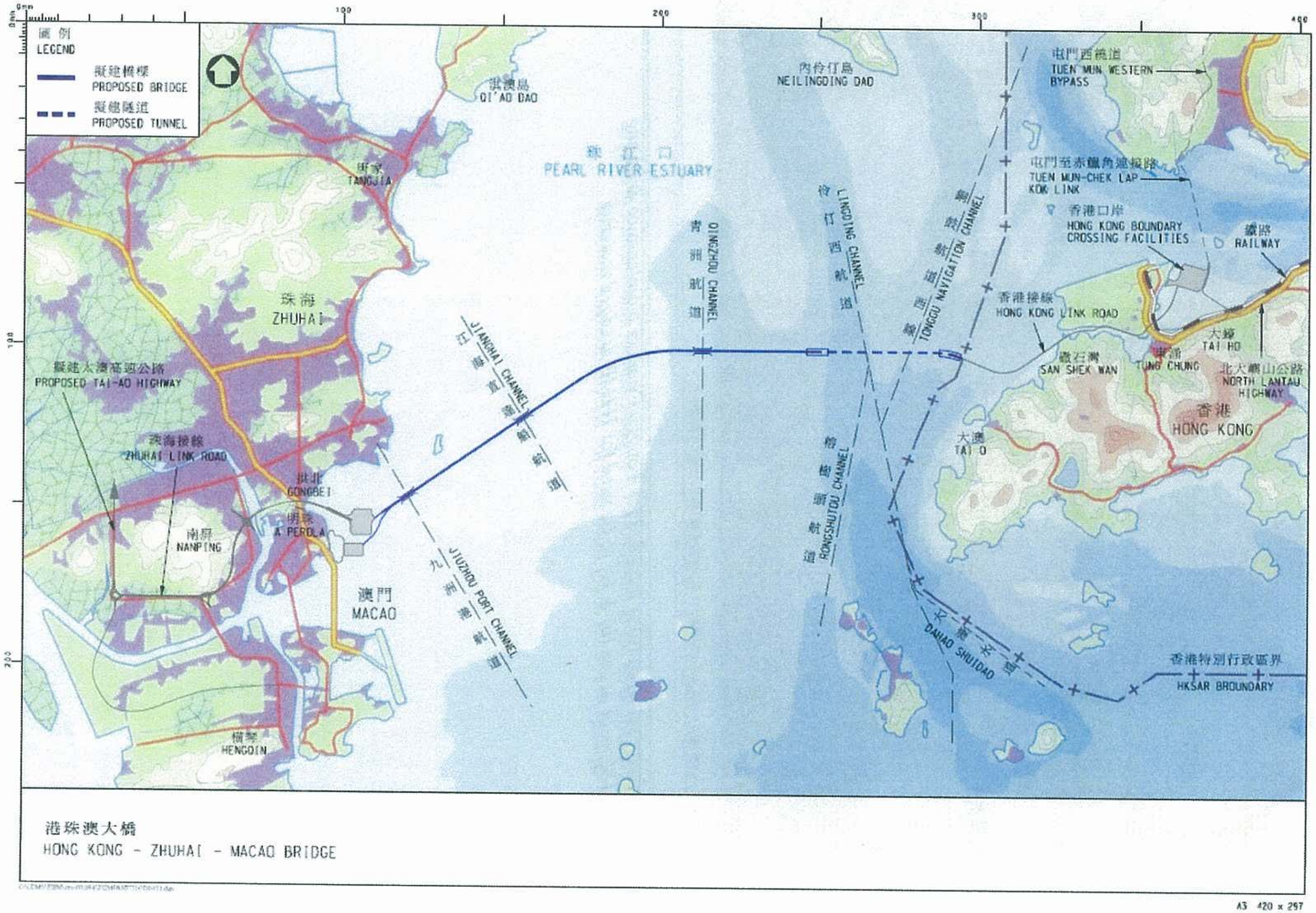
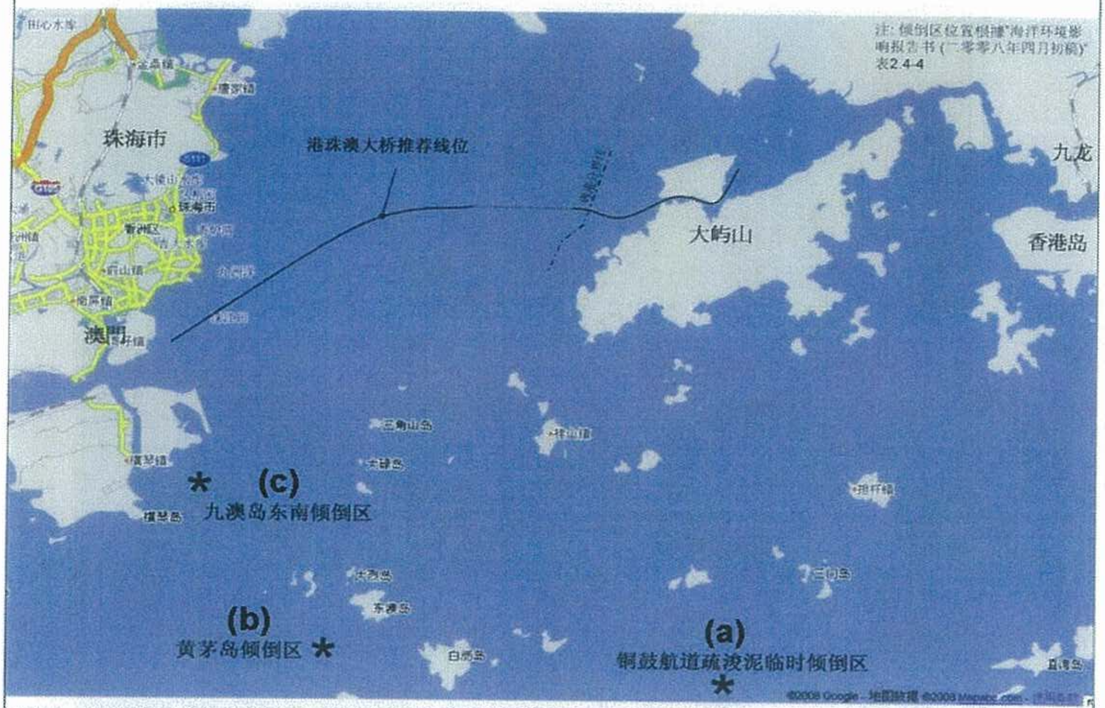
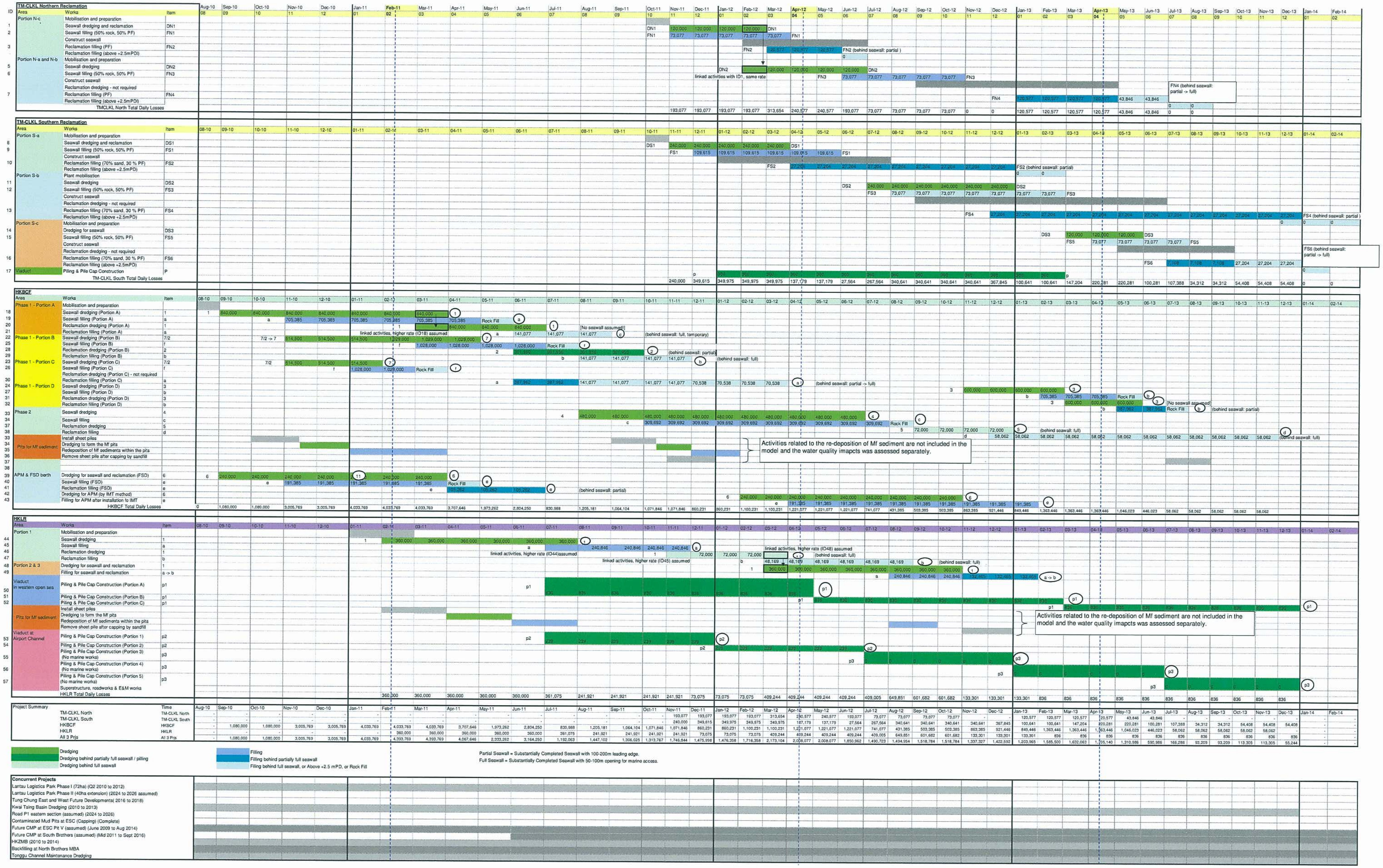


Figure 6 Location of Disposal Grounds for HZMB Dredged Material



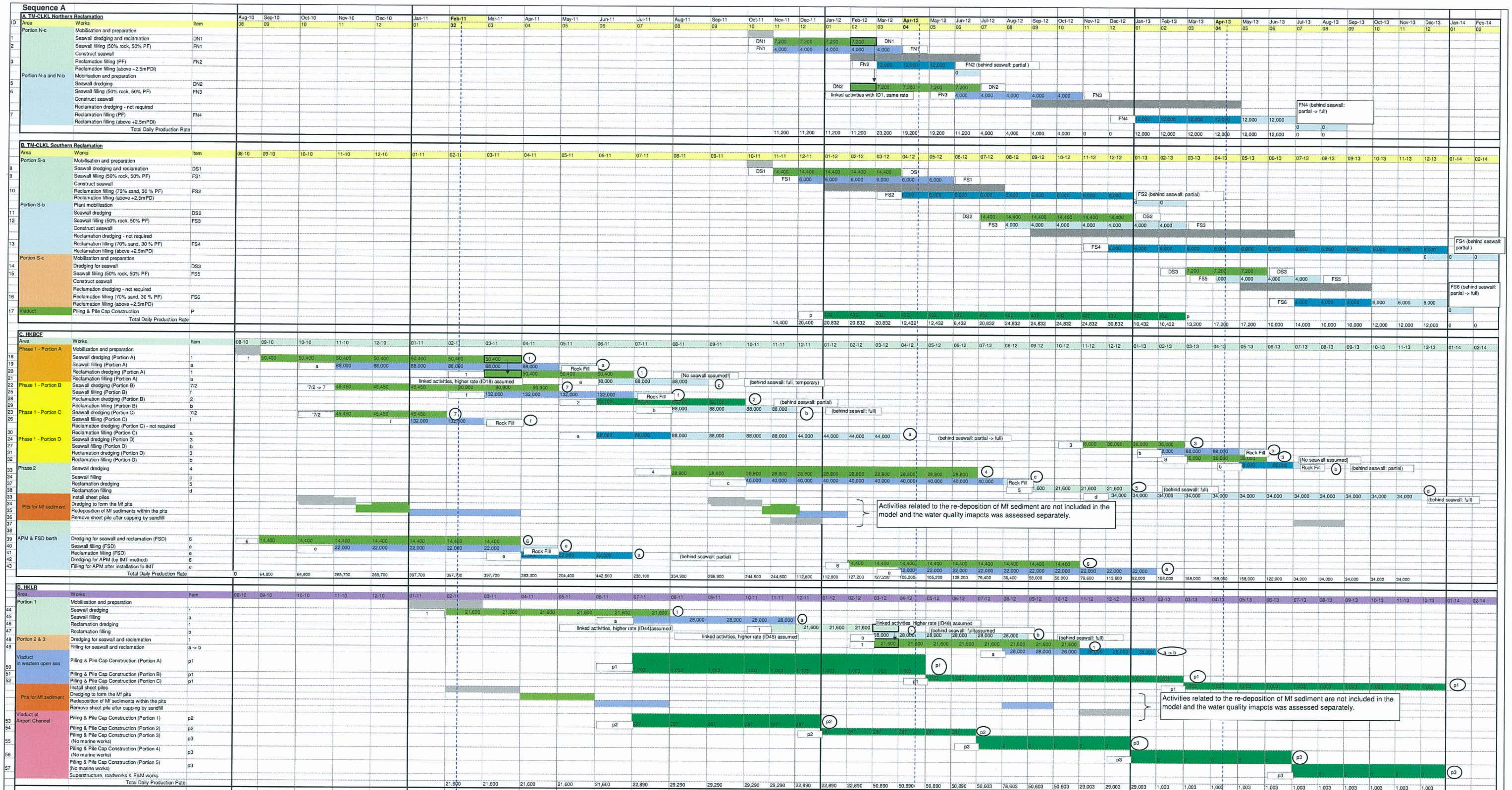
附图 - 港珠澳大桥(主桥段)工程海域附近主要倾倒区

Notes: 1 *Disposal Area (a) is intended for Tonggu Channel maintenance dredging*
2 *Disposal Areas (b) & (c) to be used for HZMB dredged material*



Envisaged Programme of Reclamation and Sediment Loss Rates for TM-CLKL+HKBCF+HKLR (Sequence A)

Figure 7a



E. Project Summary

Time	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
TM-CLKL North	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	11,200	11,200
TM-CLKL South	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14,400	20,400
HKBCF	-	64,800	64,800	265,700	265,700	397,700	397,700	397,700	383,300	204,400	442,500	238,100	354,900	266,900	244,800	244,800	112,800
HKLR	-	-	-	-	-	-	21,600	21,600	21,600	21,600	21,600	22,890	29,290	29,290	29,290	29,290	22,890
All 3 Prjs	-	64,800	64,800	265,700	265,700	397,700	419,300	419,300	404,900	226,000	464,100	260,990	384,190	296,190	274,090	299,690	167,290

Time	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
TM-CLKL North	11,200	11,200	23,200	19,200	19,200	11,200	4,000	4,000	4,000	4,000	-	-
TM-CLKL South	20,832	20,832	20,832	12,432	12,432	6,432	20,832	24,832	24,832	24,832	24,832	30,832
HKBCF	112,800	127,200	127,200	105,200	105,200	105,200	76,400	36,400	58,000	58,000	79,600	113,600
HKLR	22,890	22,890	50,890	50,890	50,890	50,890	50,603	78,603	50,603	50,603	29,003	29,003
All 3 Prjs	167,722	182,122	222,122	187,722	187,722	173,722	151,835	143,835	137,435	137,435	133,435	173,435

Time	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14
TM-CLKL North	12,000	12,000	12,000	12,000	12,000	12,000	-	-	-	-	-	-	-	-
TM-CLKL South	10,432	10,432	13,200	17,200	17,200	10,000	14,000	10,000	10,000	12,000	12,000	12,000	-	-
HKBCF	92,000	158,000	158,000	158,000	158,000	122,000	34,000	34,000	34,000	34,000	34,000	-	-	-
HKLR	29,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003	1,003	-	-
All 3 Prjs	143,435	181,435	184,203	188,203	188,203	145,003	49,003	45,003	45,003	47,003	47,003	13,003	-	-

Legend:
- Dredging
- Dredging behind partially full seawall / piling
- Dredging behind full seawall
- Filling
- Filling behind partially full seawall
- Filling behind full seawall, or Above +2.5 mPD, or Rock Fill

Partial Seawall = Substantially Completed Seawall with 100-200m leading edge.
Full Seawall = Substantially Completed Seawall with 50-100m opening for marine access.

F. Summary of Project Activities

Project	Activity	Max rate	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11
TM-CLKL North	Dreding	7,200	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	7,200	7,200
	Filling	16,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4,000	4,000
TM-CLKL South	Dreding	14,400	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14,400	14,400
	Filling	16,000	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6,000
HKBCF	Dreding	155,700	-	64,800	64,800	155,700	155,700	155,700	155,700	155,700	141,300	50,400	112,500	62,100	90,900	90,900	28,800	28,800	28,800
	Filling	330,000	-	-	-	110,000	110,000	242,000	242,000	242,000	242,000	154,000	330,000	176,000	264,000	176,000	216,000	216,000	84,000
HKLR	Dreding	21,600	-	-	-	-	-	-	21,600	21,600	21,600	21,600	21,600	21,600	-	-	-	-	21,600
	Filling	56,000	-	-	-	-	-	-	-	-	-	-	-	-	28,000	28,000	28,000	28,000	-

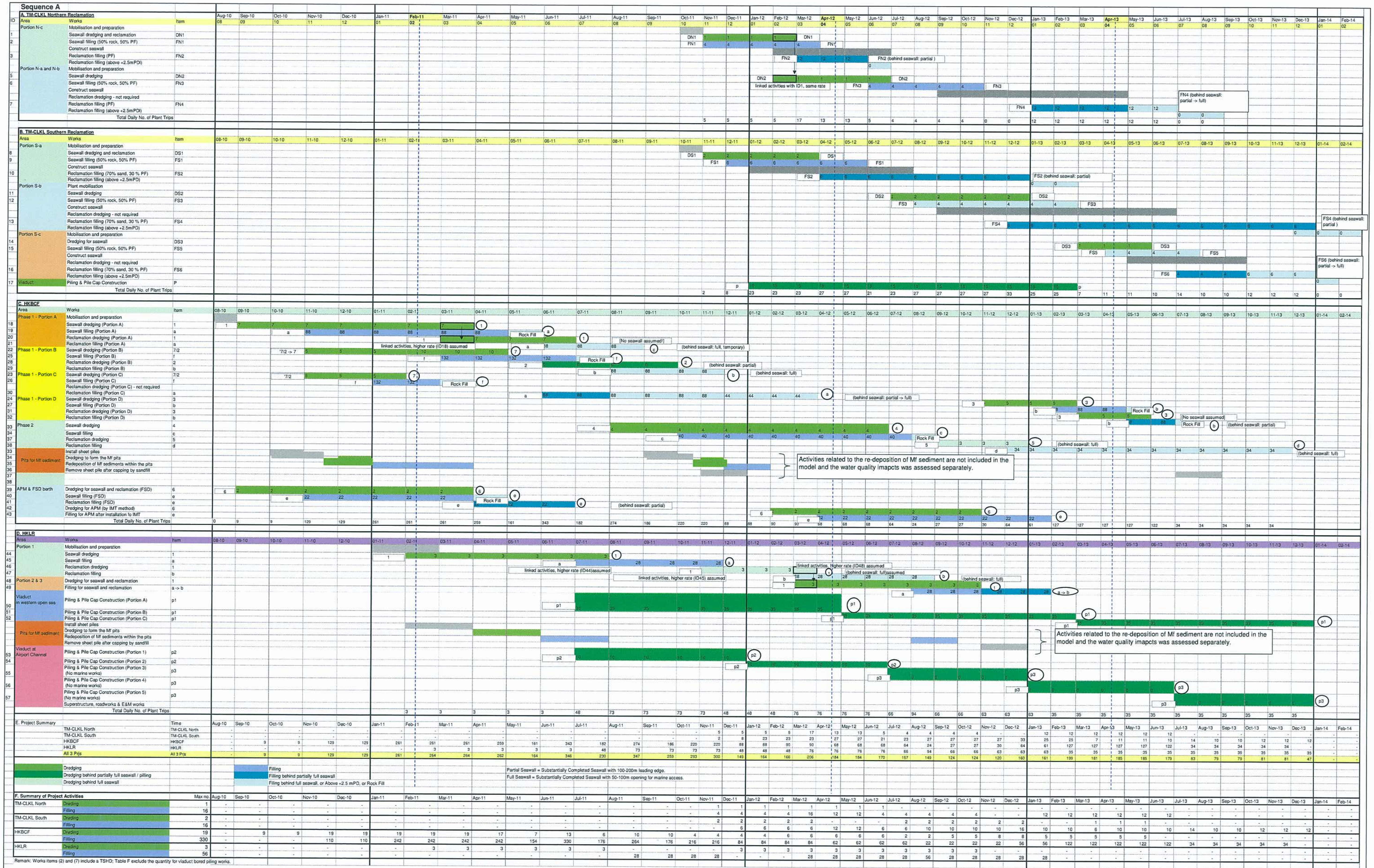
Project	Activity	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12
TM-CLKL North	Dreding	7,200	7,200	7,200	7,200	7,200	7,200	-	-	-	-	-	-
	Filling	4,000	4,000	16,000	12,000	12,000	4,000	4,000	4,000	4,000	4,000	-	-
TM-CLKL South	Dreding	14,400	14,400	14,400	-	-	-	14,400	14,400	14,400	14,400	14,400	14,400
	Filling	6,000	6,000	6,000	12,000	12,000	6,000	6,000	10,000	10,000	10,000	10,000	16,000
HKBCF	Dreding	28,800	43,200	43,200	43,200	43,200	43,200	14,400	14,400	36,000	36,000	57,600	57,600
	Filling	84,000	84,000	84,000	62,000	62,000	62,000	62,000	22,000	22,000	22,000	22,000	56,000
HKLR	Dreding	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	21,600	-	-
	Filling	-	-	28,000	28,000	28,000	28,000	28,000	56,000	28,000	28,000	28,000	28,000

Project	Activity	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14
TM-CLKL North	Dreding	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Filling	12,000	12,000	12,000	12,000	12,000	12,000	-	-	-	-	-	-	-	-
TM-CLKL South	Dreding	-	-	7,200	7,200	7,200	-	-	-	-	-	-	-	-	-
	Filling	10,000	10,000	6,000	10,000	10,000	10,000	14,000	10,000	10,000	12,000	12,000	12,000	-	-
HKBCF	Dreding	36,000	36,000	36,000	36,000	36,000	-	-	-	-	-	-	-	-	-
	Filling	56,000	122,000	122,000	122,000	122,000	122,000	34,000	34,000	34,000	34,000	34,000	-	-	-
HKLR	Dreding	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Filling	28,000	-	-	-	-	-	-	-	-	-	-	-	-	-

Remark: Works items (2) and (7) include a TSHD; Table F exclude the quantity for viaduct bored piling works.

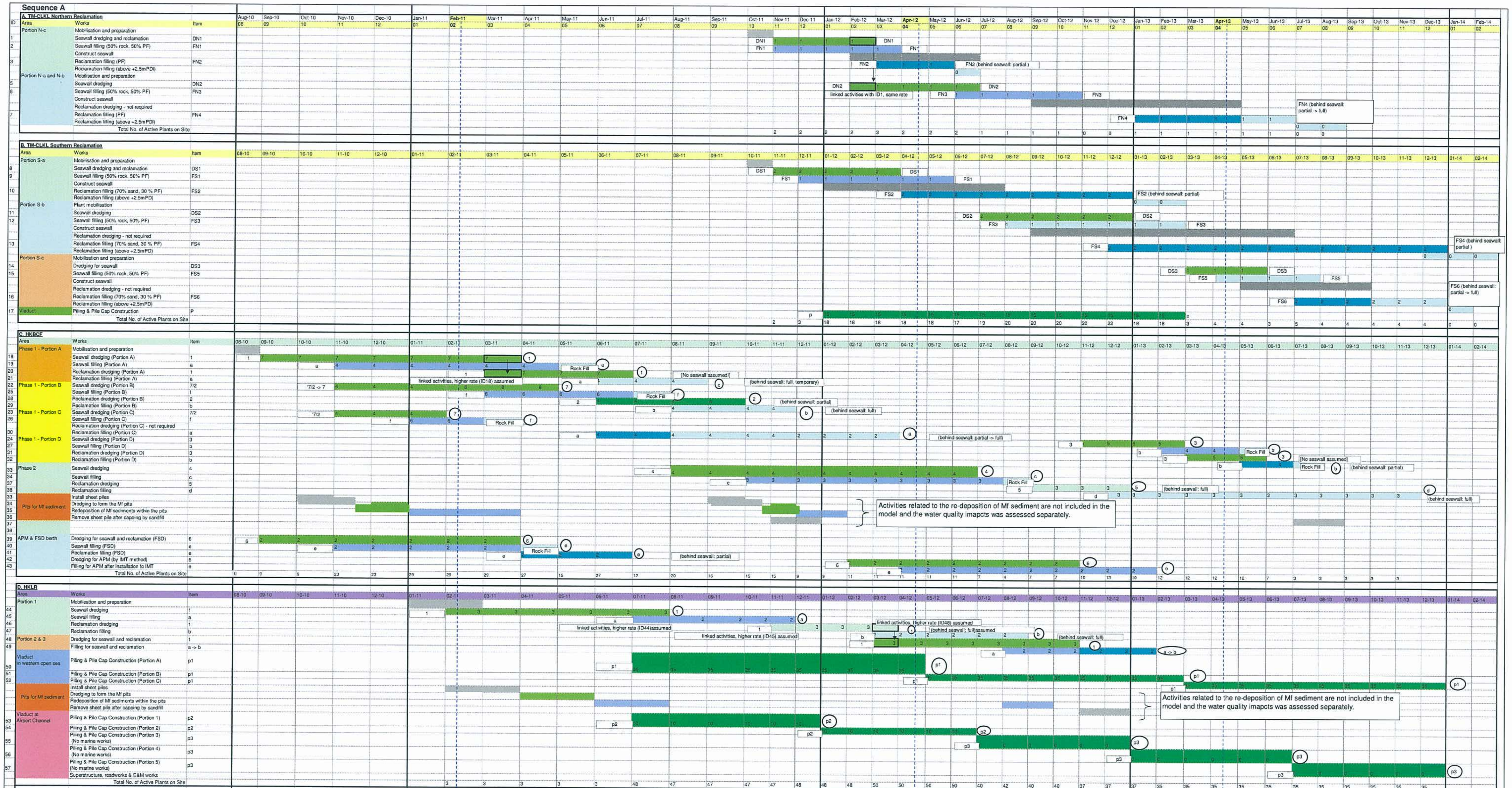
Overall Programme for TM-CLKL + HKBCF + HKLR - Maximum Daily Production Rate (bulked volume, m3/day) (Sequence A)

Figure 7b



Overall Programme for TM-CLKL + HKBCF + HKLR - Daily No. of Plant Trips (Sequence A)

Figure 7c



E. Project Summary	Time	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14
TM-CLKL North	TM-CLKL North	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2	2	3	2	2	2	1	1	1	1	-	-	1	1	1	1	1	1	-	-	-	-	-	-	-	-
TM-CLKL South	TM-CLKL South	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	3	18	18	18	18	18	17	19	20	20	20	20	22	18	18	3	4	4	3	5	4	4	4	4	4	-	-
HKBCF	HKBCF	-	9	9	23	23	29	29	29	27	15	27	12	20	16	15	15	9	9	11	11	11	11	11	7	4	7	7	10	13	10	12	12	12	12	7	3	3	3	3	3	-	-	-
HKLR	HKLR	-	-	-	-	-	-	3	3	3	3	3	48	47	47	47	47	48	48	48	50	50	50	50	40	42	40	40	37	37	37	35	35	35	35	35	35	35	35	35	35	35	-	-
All 3 Prjs	All 3 Prjs	-	9	9	23	23	29	32	32	30	18	30	60	67	63	62	66	62	77	79	82	81	81	80	67	67	68	68	67	72	66	66	51	52	52	46	43	42	42	42	42	39	-	-

Dredging
Dredging behind partially full seawall / piling
Dredging behind full seawall

Filling
Filling behind partially full seawall
Filling behind full seawall, or Above +2.5 mPD, or Rock Fill

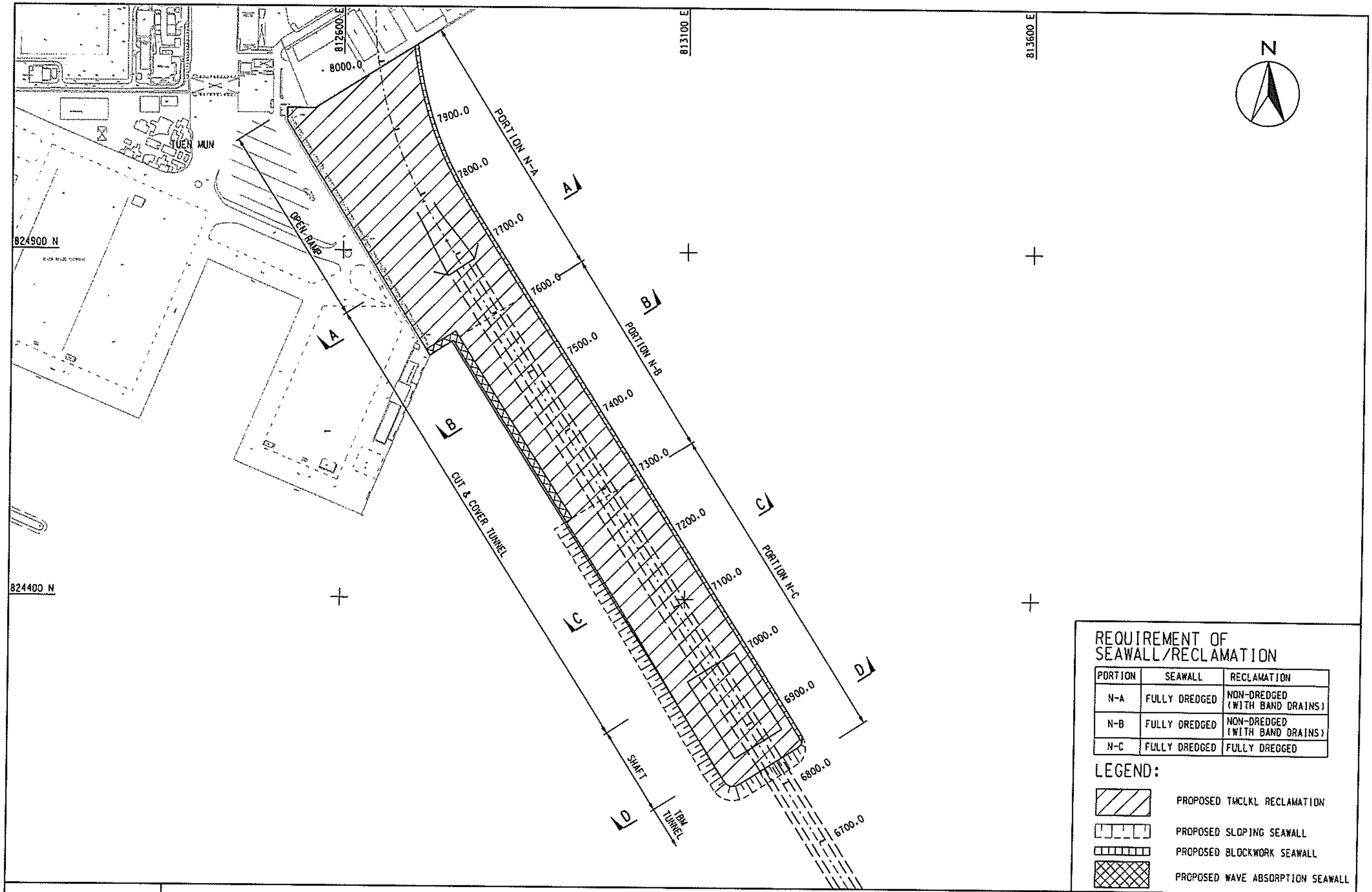
Partial Seawall = Substantially Completed Seawall with 100-200m leading edge.
Full Seawall = Substantially Completed Seawall with 50-100m opening for marine access.

F. Summary of Project Activities		Max no.	Aug-10	Sep-10	Oct-10	Nov-10	Dec-10	Jan-11	Feb-11	Mar-11	Apr-11	May-11	Jun-11	Jul-11	Aug-11	Sep-11	Oct-11	Nov-11	Dec-11	Jan-12	Feb-12	Mar-12	Apr-12	May-12	Jun-12	Jul-12	Aug-12	Sep-12	Oct-12	Nov-12	Dec-12	Jan-13	Feb-13	Mar-13	Apr-13	May-13	Jun-13	Jul-13	Aug-13	Sep-13	Oct-13	Nov-13	Dec-13	Jan-14	Feb-14
TM-CLKL North	Dreding	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	1	1	1	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Filling	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	2	1	1	1	1	1	1	1	-	-	1	1	1	1	1	1	-	-	-	-	-	-	-	-
TM-CLKL South	Dreding	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2	2	2	-	-	-	2	2	2	2	2	2	-	-	1	1	1	-	-	-	-	-	-	-	-	-
	Filling	5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1	1	1	1	3	3	2	2	3	3	3	3	5	3	3	2	3	3	3	5	4	4	4	4	4	-	-
HKBCF	Dreding	17	-	9	9	17	17	17	17	17	15	7	11	4	8	8	4	4	4	4	6	6	6	6	6	2	2	5	5	8	8	5	5	5	5	5	-	-	-	-	-	-	-	-	-
	Filling	16	-	-	-	6	6	12	12	12	12	8	16	8	12	8	11	11	5	5	5	5	5	5	5	5	2	2	2	2	5	5	7	7	7	7	7	3	3	3	3	3	-	-	-
HKLR	Dreding	3	-	-	-	-	-	-	3	3	3	3	3	3	-	-	-	-	3	3	3	3	3	3	3	3	3	3	3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	Filling	4	-	-	-	-	-	-	-	-	-	-	-	-	2	2	2	2	-	-	-	2	2	2	2	2	4	2	2	2	2	2	-	-	-	-	-	-	-	-	-	-	-	-	-

Remark: Works items (2) and (7) include a TSHD; Table F exclude the quantity for viaduct bored piling works.

Overall Programme for TM-CLKL + HKBCF + HKLR - No. of Active Dredging/Filling Plants on Site (Sequence A)

Figure 7d



REQUIREMENT OF SEAWALL/RECLAMATION

PORTION	SEAWALL	RECLAMATION
N-A	FULLY DREDGED	NON-DREDGED (WITH BAND DRAINS)
N-B	FULLY DREDGED	NON-DREDGED (WITH BAND DRAINS)
N-C	FULLY DREDGED	FULLY DREDGED

LEGEND:

- PROPOSED TMCLKL RECLAMATION
- PROPOSED SLOPING SEAWALL
- PROPOSED BLOCKWORK SEAWALL
- PROPOSED WAVE ABSORPTION SEAWALL

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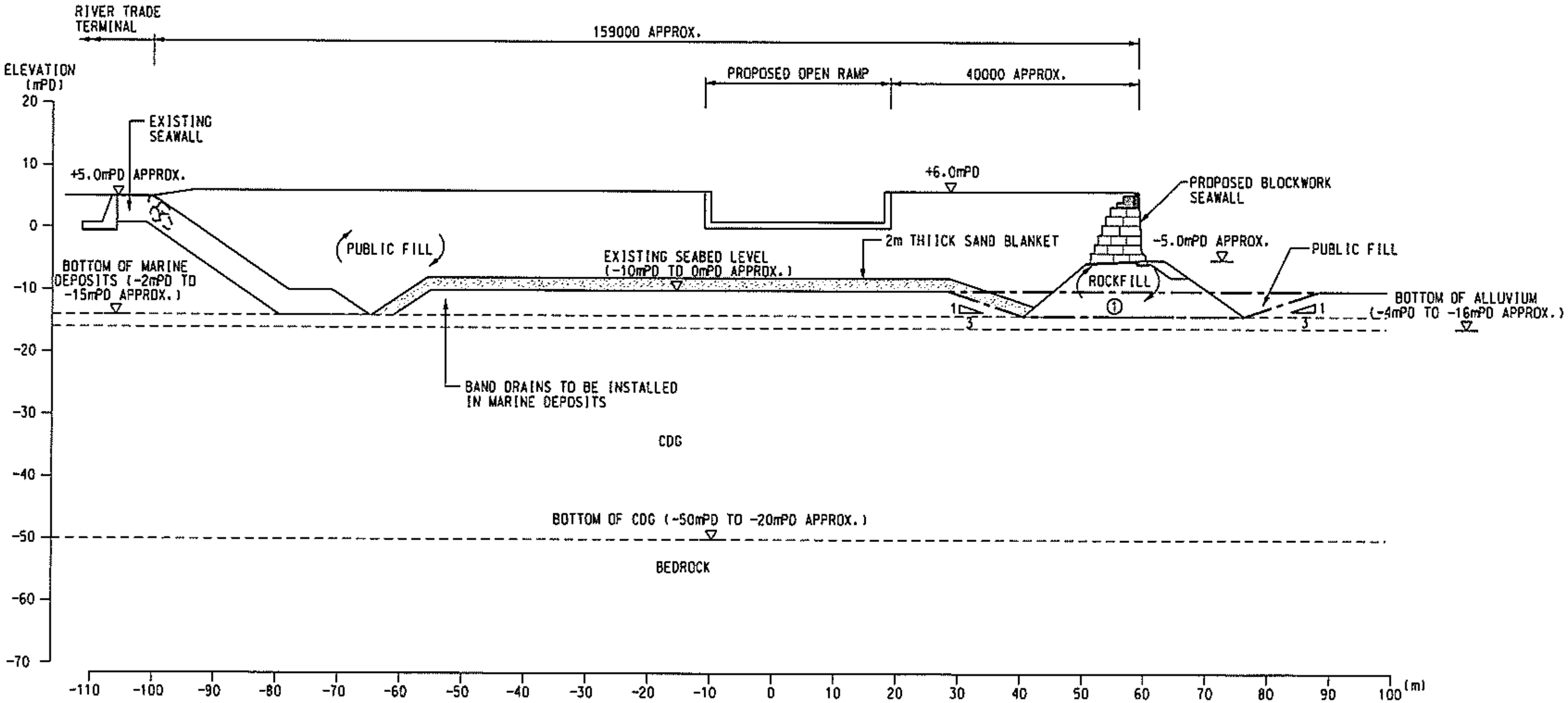
TUEN MUN - CHEK LAP KOK LINK - INVESTIGATION

EXTENT OF DREDGED AREA AND TYPICAL SEAWALL SECTIONS IN NORTHERN LANDFALL OF TM - CLKL

SHEET 1 OF 3

SCALE	A3 1:5000	DATE	MAR.2009
CHECK	--	DRAWN	LCG
JOB No.	60044963	DRAWING No.	FIGURE 8
REV	A		

p.\PROJECTS\60044963\DRAWING\FIGURE\DRAWINGS FOR EIA REPORT\Ch6\FIGURE 8-1.dgn



LEGEND:

EXTENT OF MARINE DEPOSITS TO BE DREDGED

① DREDGING DURING CONSTRUCTION OF SEAWALL

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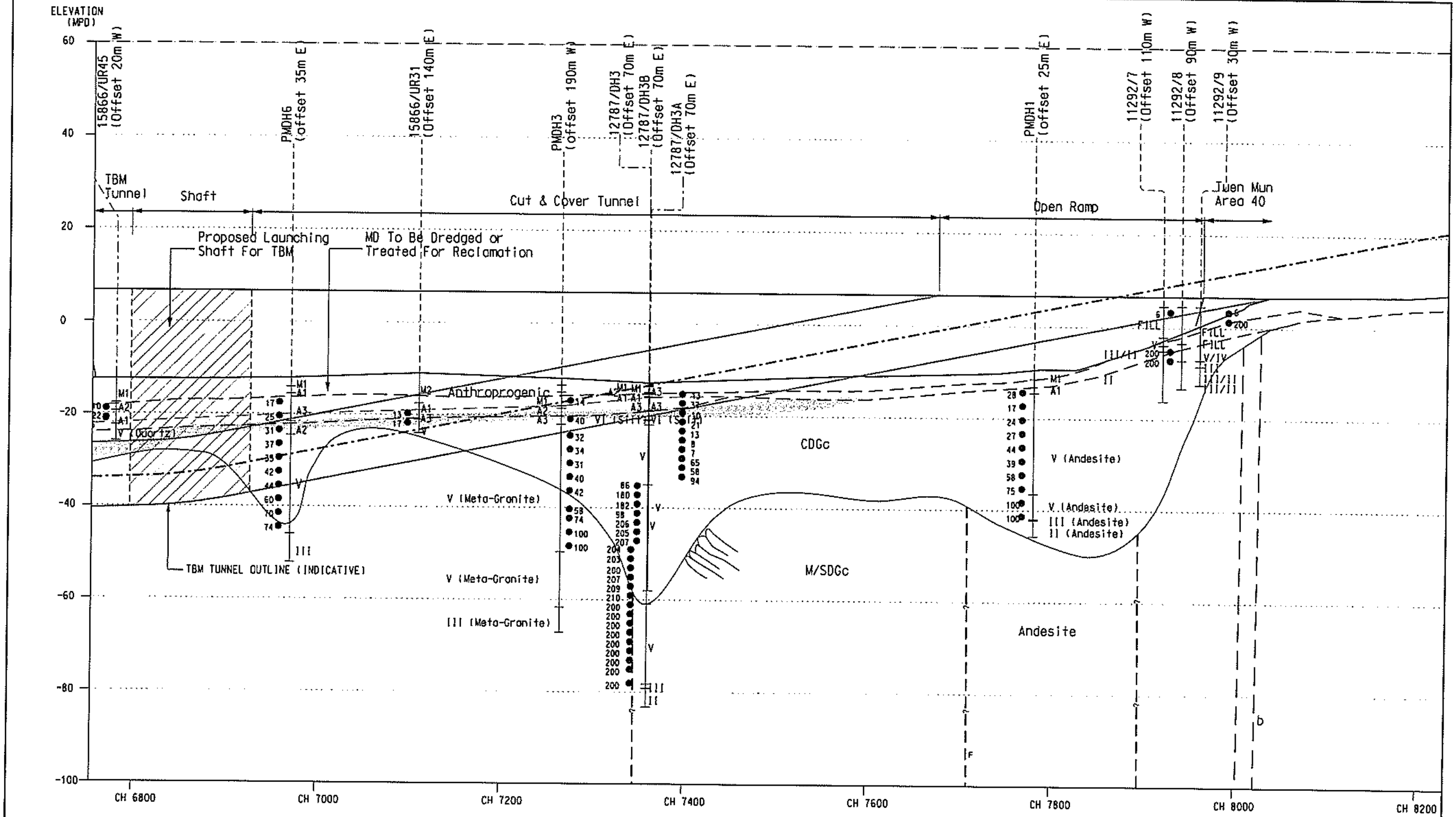
TUEN MUN - CHEK LAP KOK LINK - INVESTIGATION

EXTENT OF DREDGED AREA AND TYPICAL SEAWALL SECTIONS IN NORTHERN LANDFALL OF TM - CLKL

SHEET 2 OF 3

SCALE	A3 1:800	DATE	MAR. 2009
CHECK	---	DRAWN	LCG
JOB No.	60044963	DRAWING No.	FIGURE 8 REV A

p.\PROJECTS\60044963\DRAWING\FIGURE\DRAWINGS FOR EIA REPORT\Ch6\FIGURE 8-2.dgn



NOTE:

ROCKHEAD LEVEL & MATERIAL PROFILES ARE REFERRED FROM ADJACENT DRILLHOLES & GEOPHYSICAL SURVEY RESULTS

—?—F—?— INFERRED FAULT FROM GEOPHYSICAL DATA/BOREHOLE INFORMATION

—— INFERRED ROCKHEAD ALONG ORIGINAL ALIGNMENT

SCALE VOR. 1 : 800 @ A3
HOR. 1 : 4000 @ A3

LEGEND:

- ALLUVIAL SAND
- M - MARINE DEPOSIT
- A - ALLUVIAL DEPOSIT
- 1 CLAY
- 2 SILT
- 3 SAND
- V - COMPLETELY DECOMPOSED ROCKS
- IV - HIGHLY DECOMPOSED ROCKS
- III - MODERATELY DECOMPOSED ROCKS
- II - SLIGHTLY DECOMPOSED ROCKS
- ●20 - SPT N VALUE

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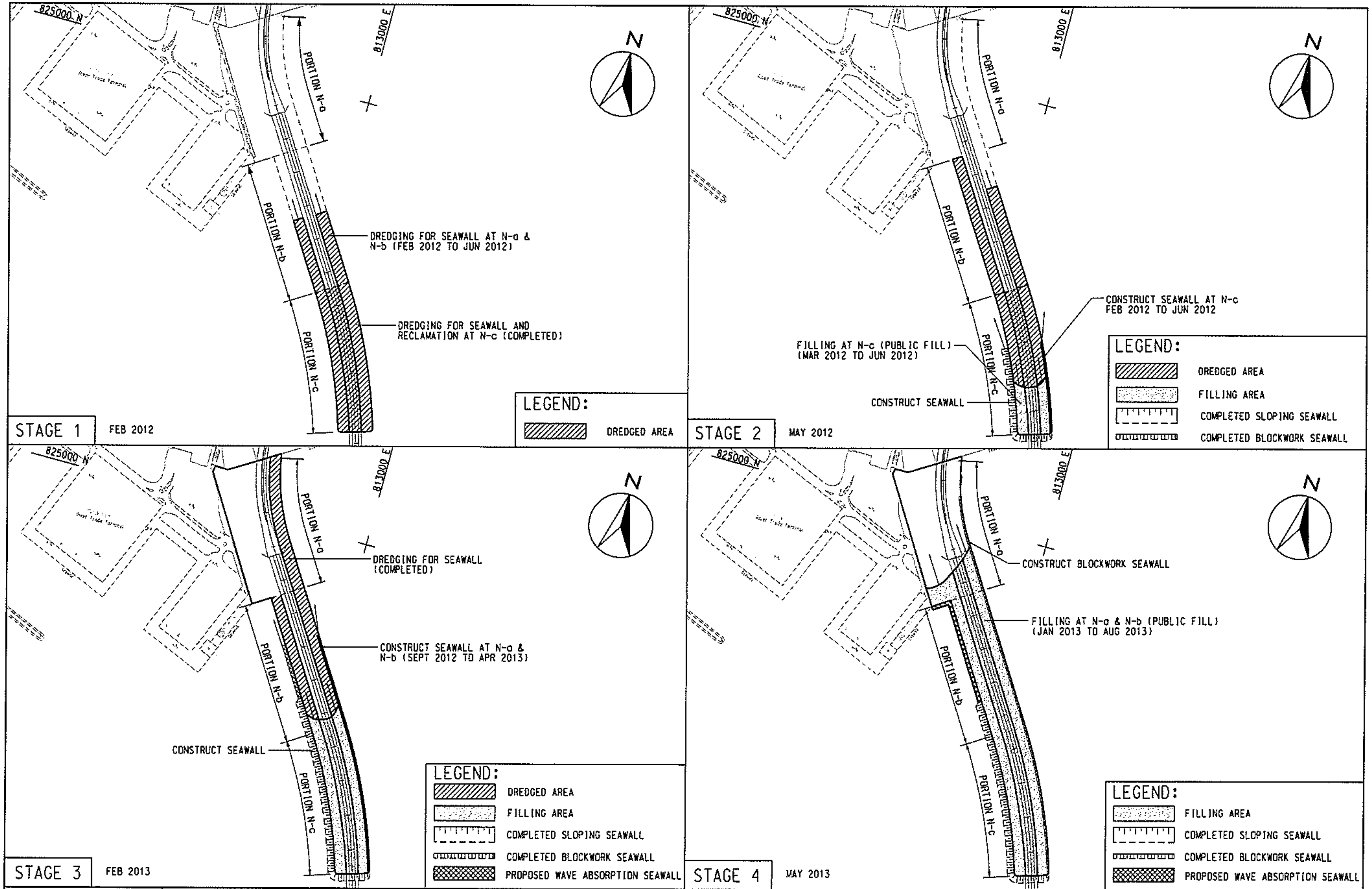
TUEN MUN - CHEK LAP KOK LINK - INVESTIGATION

EXTENT OF DREDGED AREA AND TYPICAL SEAWALL SECTIONS IN NORTHERN LANDFALL OF TM - CLKL

SHEET 3 OF 3

SCALE	AS SHOWN	DATE	MAR.2009
CHECK	--	DRAWN	LCG
JOB No.	60044963	DRAWING No.	FIGURE 8
		REV	A

p:\PROJECTS\60044963\DRAWING\FIGURE\DRAWINGS FOR EIA REPORT\Ch6\FIGURE 8-3.dgn



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TUEN MUN - CHEK LAP KOK LINK - INVESTIGATION

ANTICIPATED CONSTRUCTION SEQUENCE OF TM-CLKL

(SHEET 1 OF 2)

SCALE	A3 1:5000	DATE	MAR.2009	
CHECK	--	DRAWN	LCG	
JOB No.	60044963	DRAWING No.	FIGURE 9	REV --

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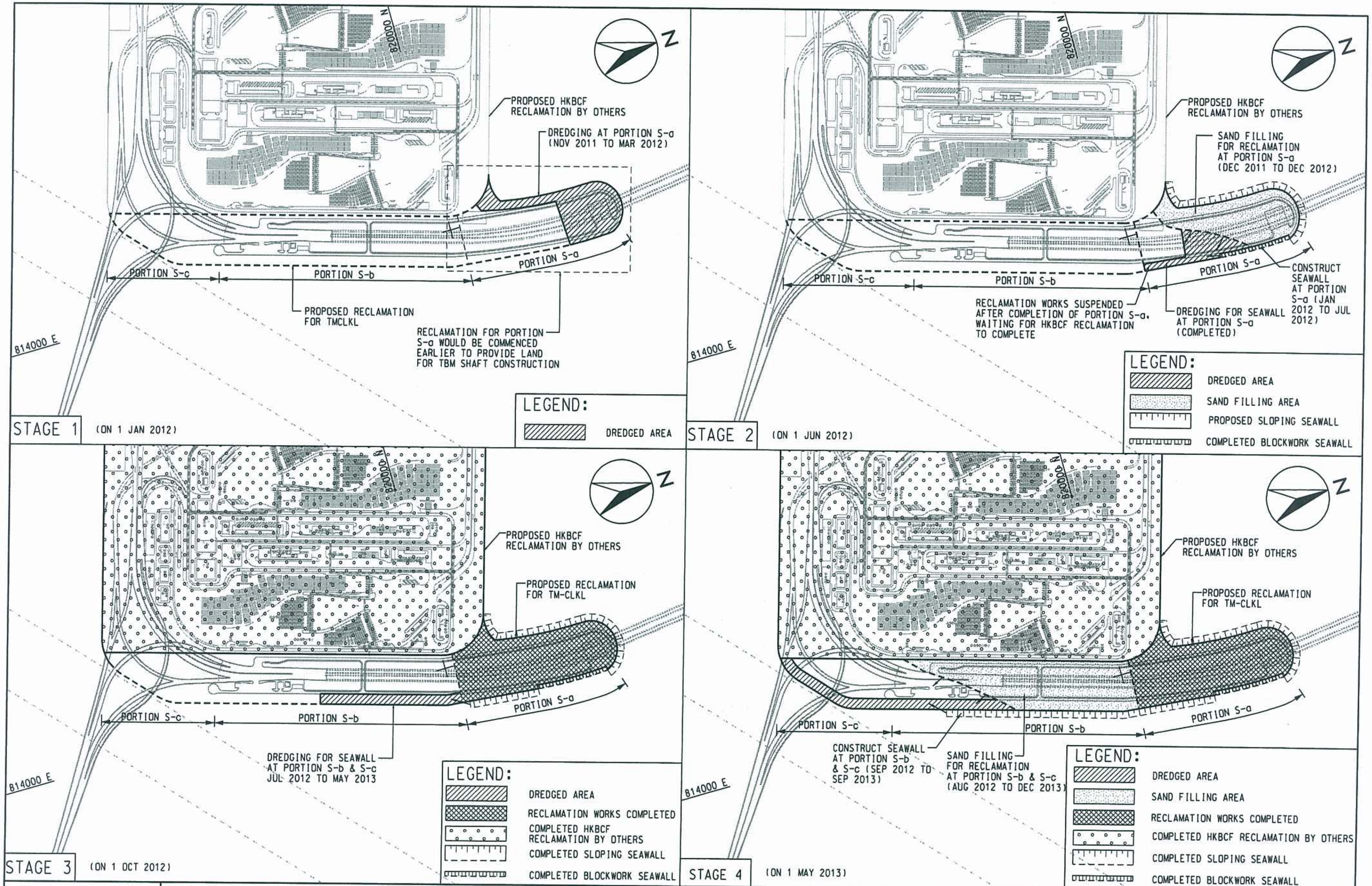

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TUEN MUN - CHEK LAP KOK LINK - INVESTIGATION

ANTICIPATED CONSTRUCTION SEQUENCE OF TM-CLKL

(SHEET 2 OF 2)

SCALE	A3 1:10000	DATE	MAY 2009
CHECK	--	DRAWN	CL
JOB No.	60044963	DRAWING No.	FIGURE 9
		REV	--

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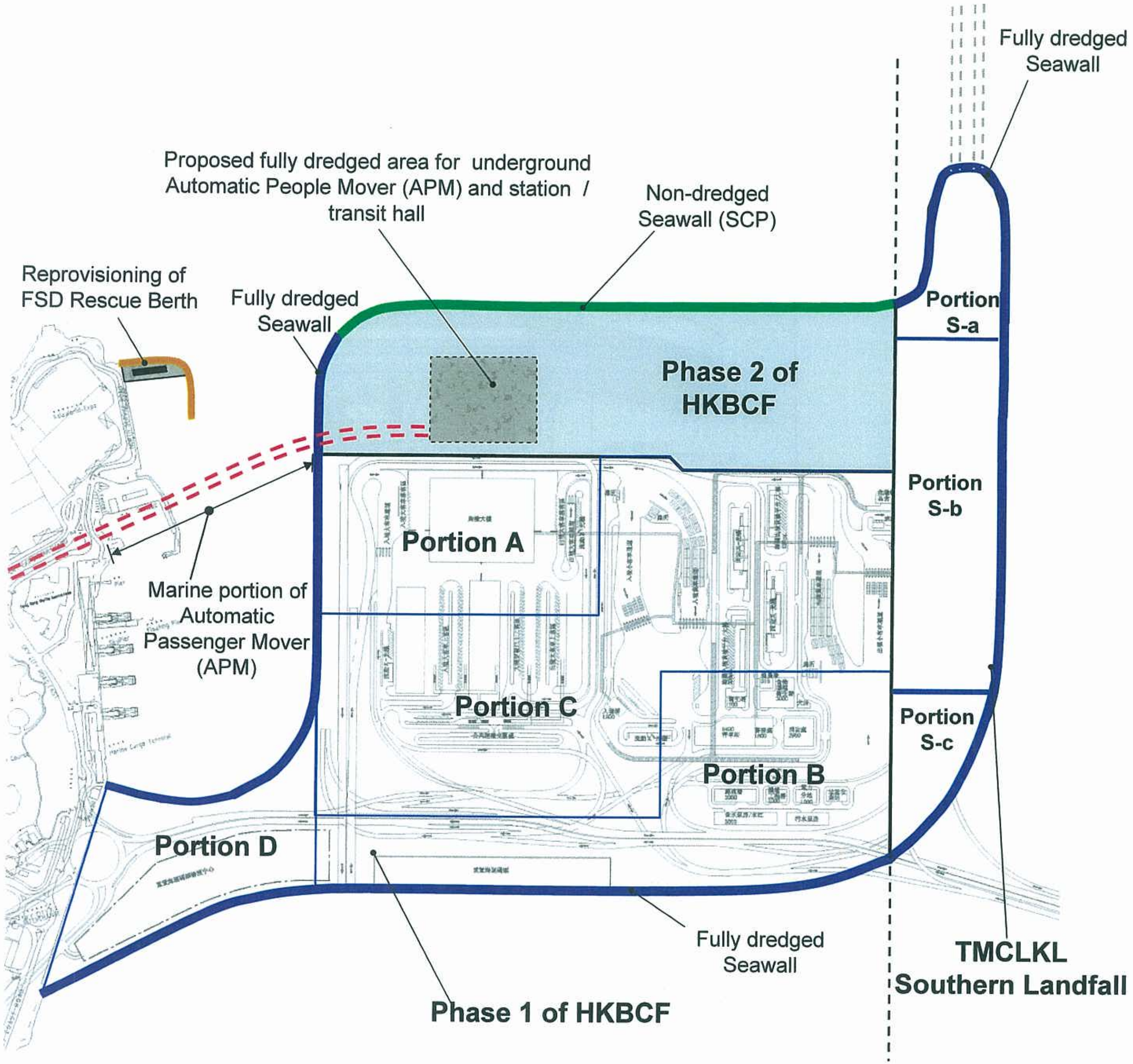

Phase 1 of HKBCF

Seawall – Fully Dredged

Reclamation:
Portion A – Dredged
Portion B – Dredged
Portion C – Non dredged (with Band Drains)
Portion D – Dredged

Phase 2 of HKBCF

Seawall – Fully Dredged / SCP (refer the extent shown in the sketch)

Reclamation – Non-dredged (with Band Drains) except the underground APM station and ARL station where the removal of marine sediment for underground construction is required

TM-CLKL Southern Landfall

Seawall – Fully Dredged

Reclamation:
Portion S-a – Non dredged (with Band Drains)
Portion S-b – Non dredged (with Band Drains)
Portion S-c – Non dredged (with Band Drains)

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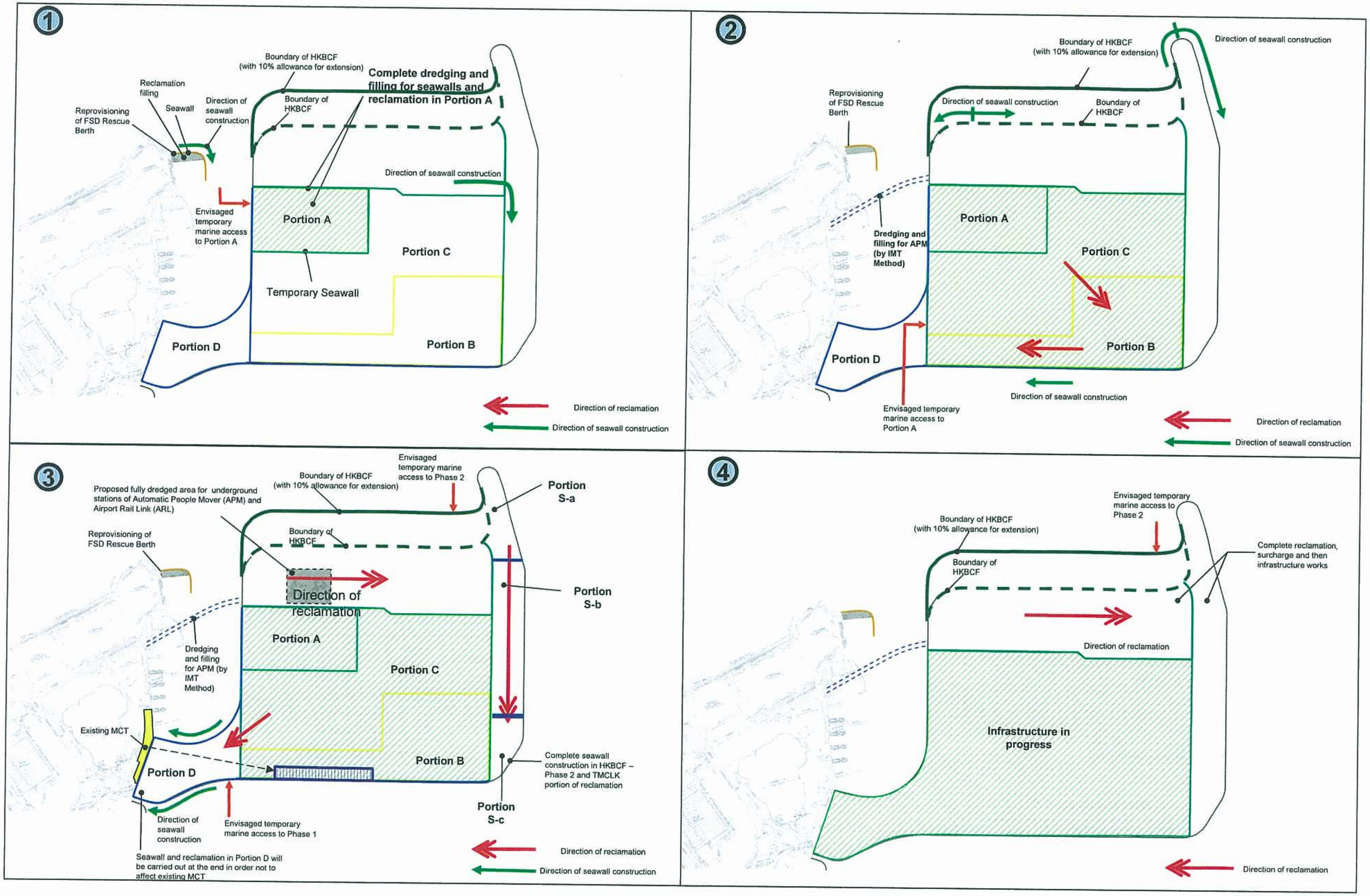
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Extent of Dredged and Non-dredged Areas in HKBCF and Southern Landfall of TM-CLKL

SCALE	NTS	DATE	MAY. 2009
CHECK		DRAWN	
JOB No.	60044963	DRAWING No.	10	REV	

FILE:



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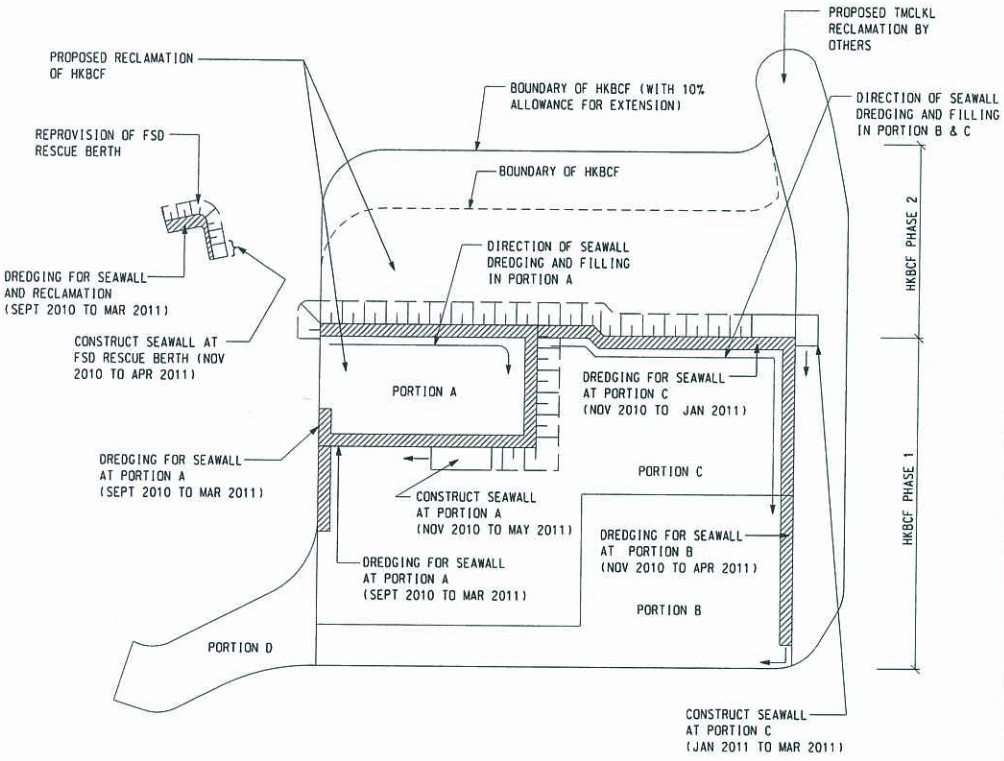
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

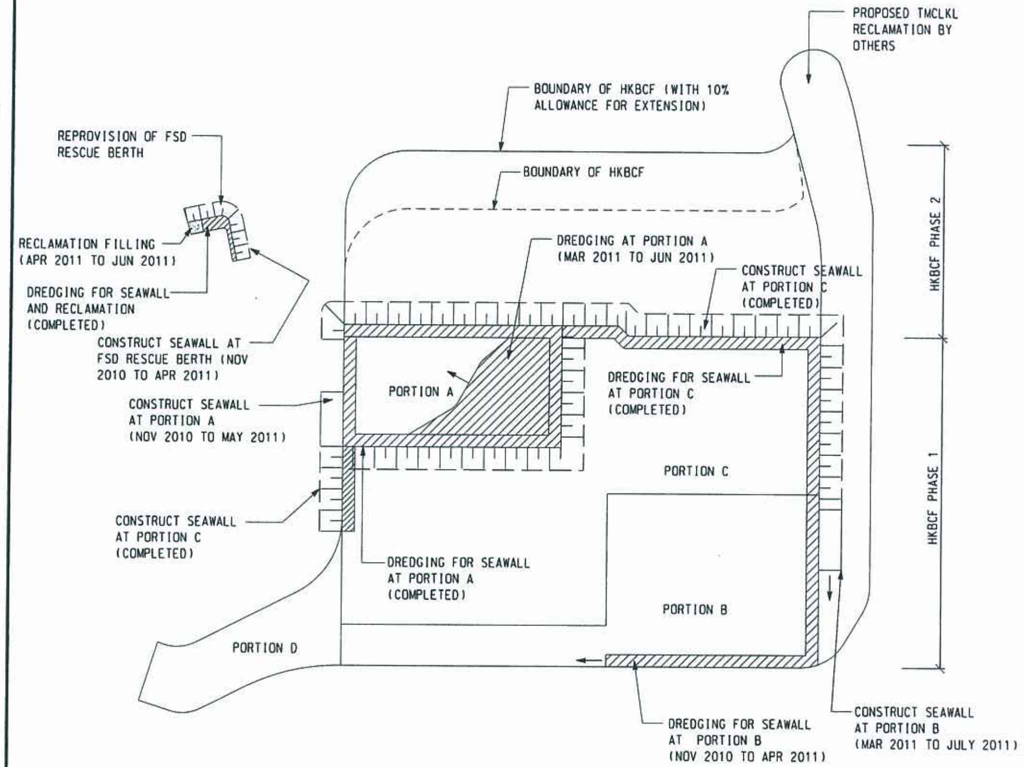
Schematic Construction Sequence of HKBCF

SCALE	NTS	DATE	MAY. 2009
CHECK		DRAWN	
JOB No.	60044963	DRAWING No.	11
		REV	

FILE:



STAGE 1 (ON FEB 2011)



STAGE 2 (ON APRIL 2011)

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HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong - Zhuhai - Macao Bridge
Hong Kong Project Management Office

ARUP Ove Arup & Partners Hong Kong Limited

Job Title
Agreement No. CE 14/2008 (CE)
Hong Kong-Zhuhai-Macao Bridge Hong Kong Boundary Crossing Facilities – Investigation

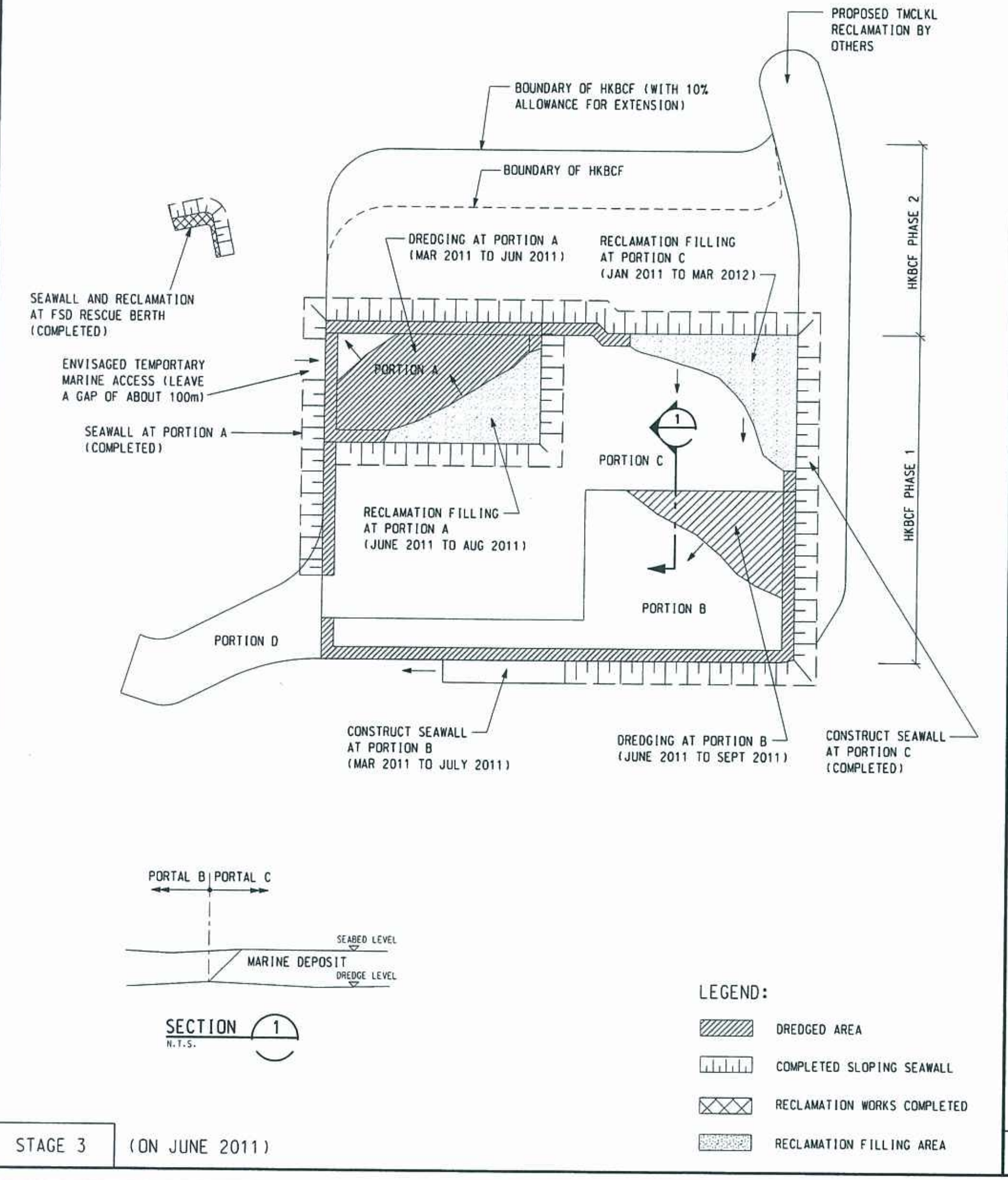
Drawing Title
ANTICIPATED CONSTRUCTION SEQUENCE OF HKBCF

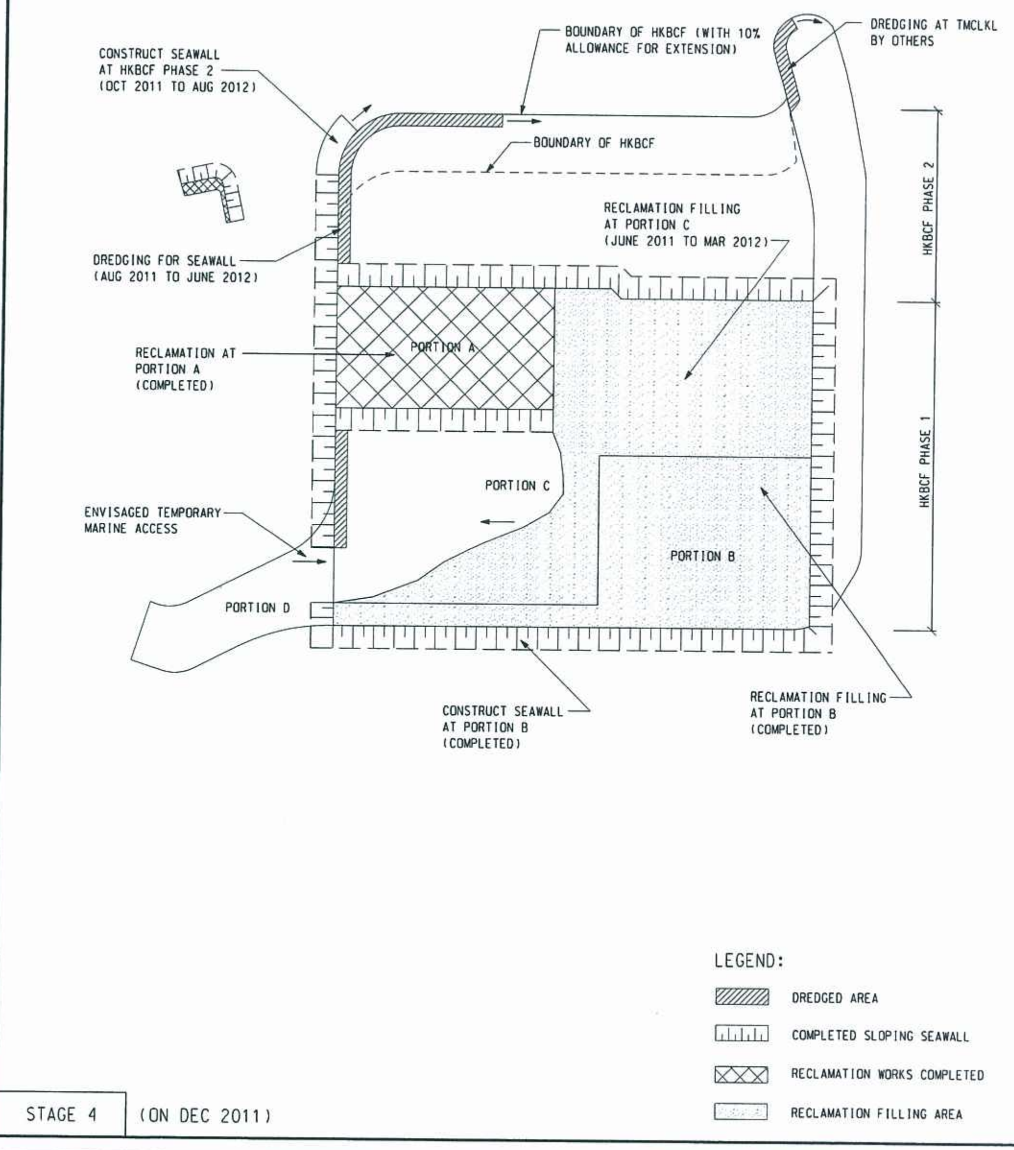
Sheet 1 of 4

Rev.	Description	Date
A	FIRST ISSUE	02/09

Drawn: CN	Date: 02/09	Drawing No.	Figure 12
Checked: SK	Approved: AK		
Scale: 1:12500 on A3		Status: PRELIMINARY	Rev. A

5308-SK-41-301.dgn 30/3/2009 15:19:16





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港珠澳大橋香港工程管理處
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Hong Kong Project Management Office

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Job Title
Agreement No. CE 14/2008 (CE)
Hong Kong-Zhuhai-Macao Bridge Hong Kong Boundary Crossing Facilities – Investigation

Drawing Title
ANTICIPATED CONSTRUCTION SEQUENCE OF HKBCF

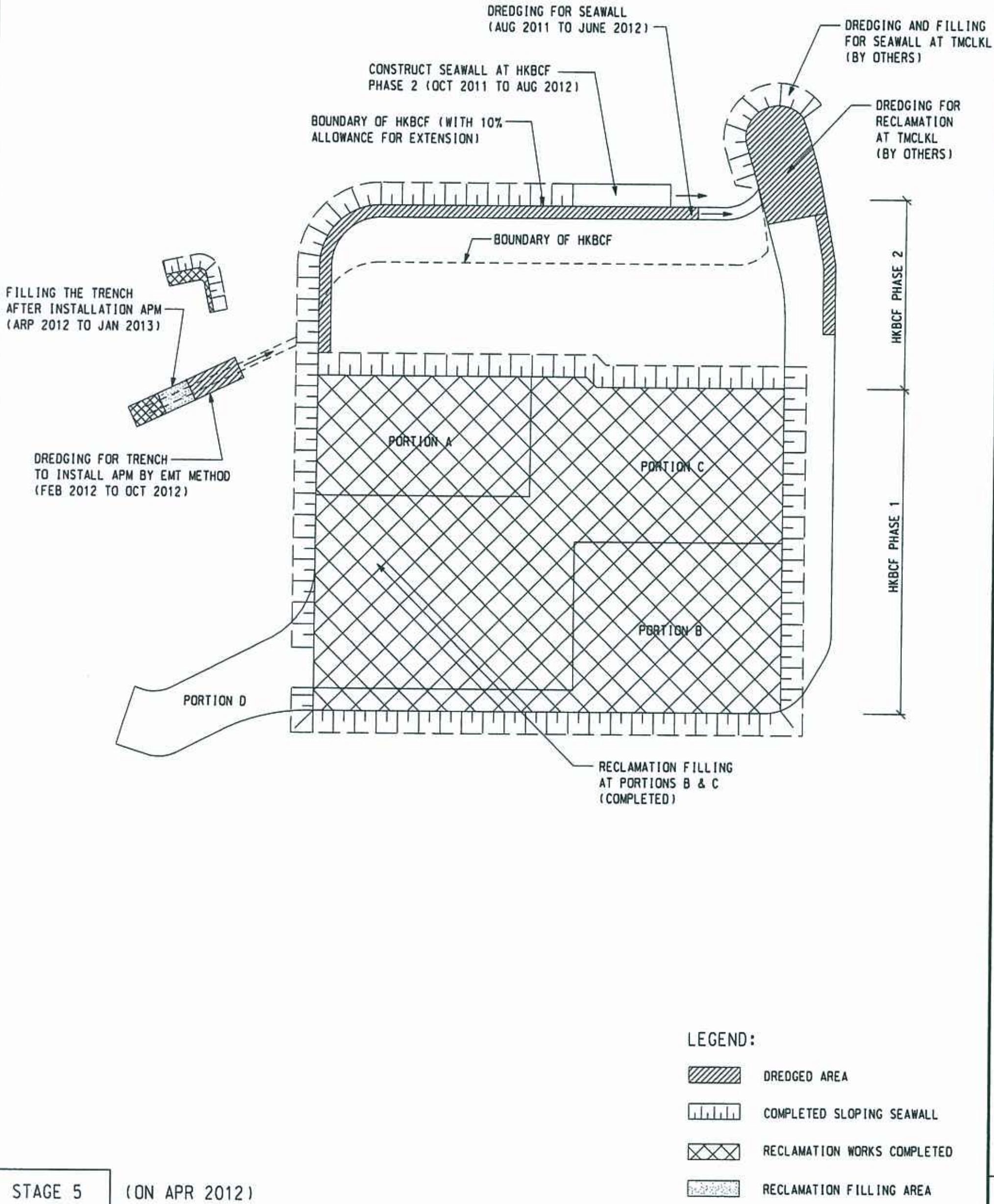
Sheet 2 of 4

Rev.	Description	Date
A	FIRST ISSUE	02/09

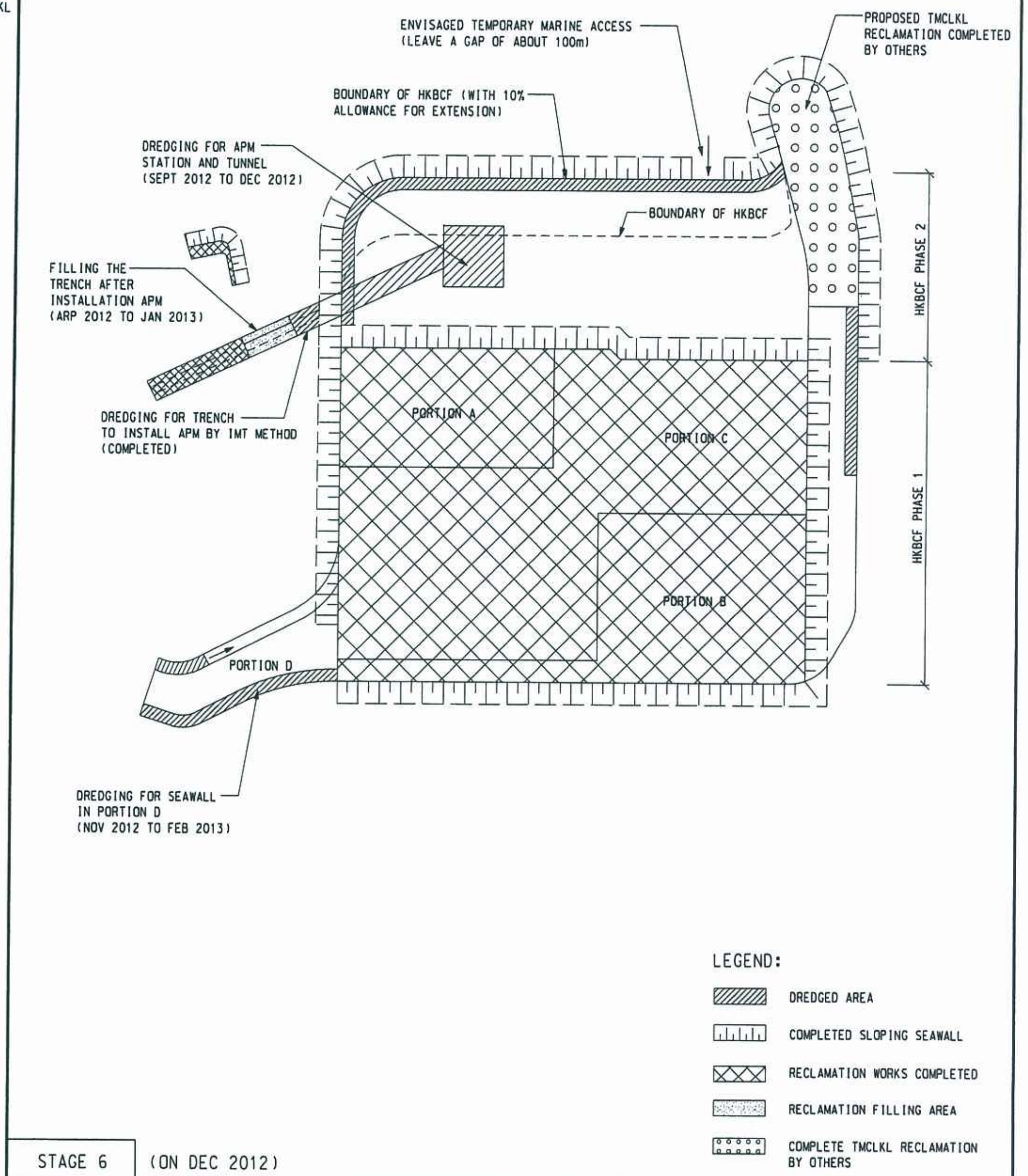
Drawn CN | Date 02/09
Checked SK | Approved AK
Scale 1:12500 on A3

Drawing No. Figure 12
Status PRELIMINARY | Rev. A

5308-SK-41-302.dgn 30/3/2009 15:19:18



STAGE 5 (ON APR 2012)



STAGE 6 (ON DEC 2012)

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HIGHWAYS DEPARTMENT
港珠澳大橋香港工程管理處
Hong Kong - Zhuhai - Macao Bridge
Hong Kong Project Management Office

ARUP Ove Arup & Partners Hong Kong Limited

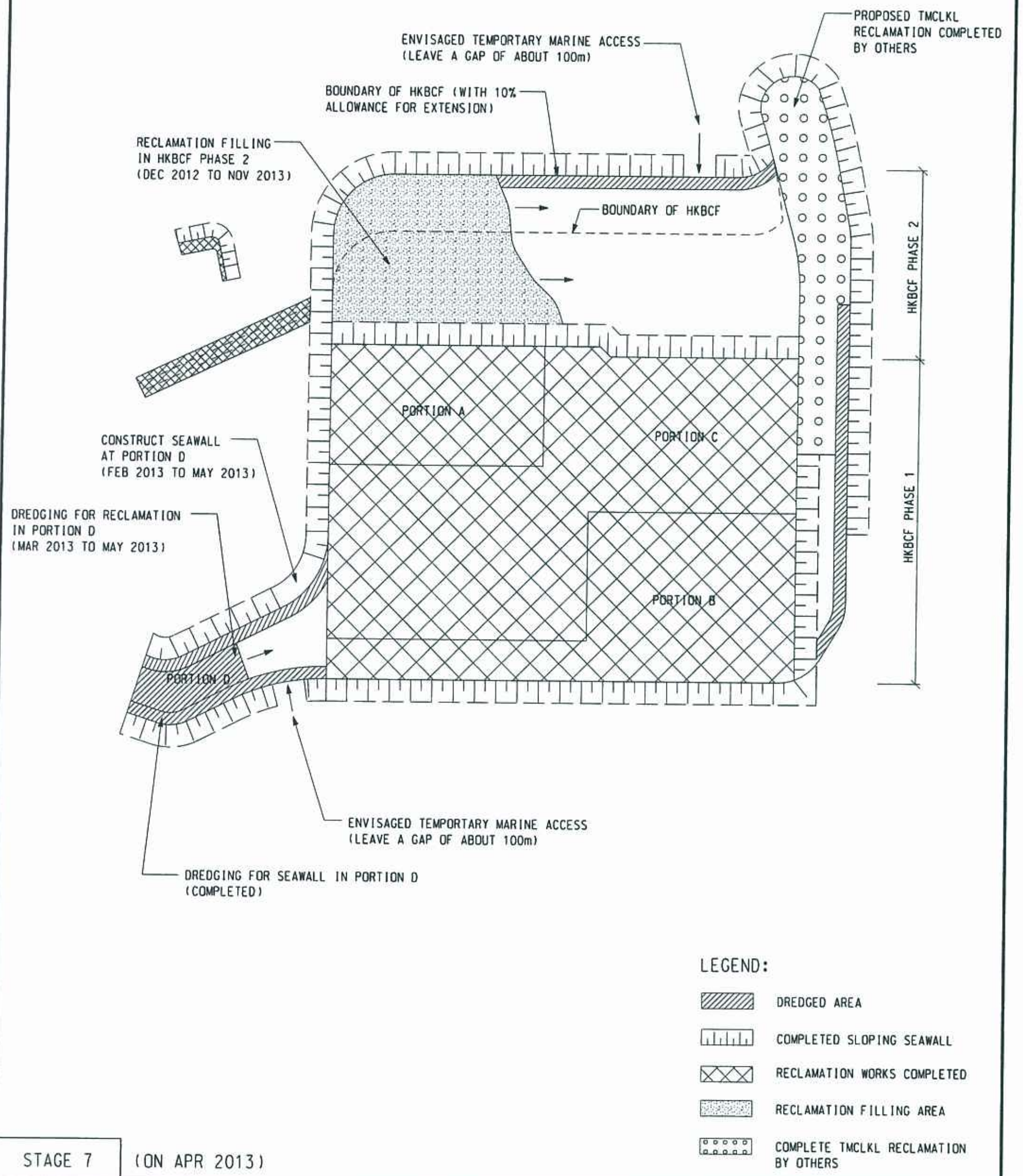
Job Title
Agreement No. CE 14/2008 (CE)
Hong Kong-Zhuhai-Macao Bridge Hong Kong
Boundary Crossing Facilities – Investigation

Drawing Title
ANTICIPATED CONSTRUCTION
SEQUENCE OF HKBCF

Sheet 3 of 4

Rev.	Description	Date
A	FIRST ISSUE	02/09

Drawn	Date	Checked	Approved	Scale	Drawing No.	Status	Rev.
CN	02/09	SK	AK	1:12500 on A3	Figure 12	PRELIMINARY	A



STAGE 7 (ON APR 2013)

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Job Title: Agreement No. CE 14/2008 (CE) Hong Kong-Zhuhai-Macao Bridge Hong Kong Boundary Crossing Facilities – Investigation

Drawing Title: ANTICIPATED CONSTRUCTION SEQUENCE OF HKBCF

Sheet 4 of 4

Rev.	Description	Date
A	FIRST ISSUE	02/09

Drawn: CN | Date: 02/09 | Checked: SK | Approved: AK | Scale: 1:12500 on A3

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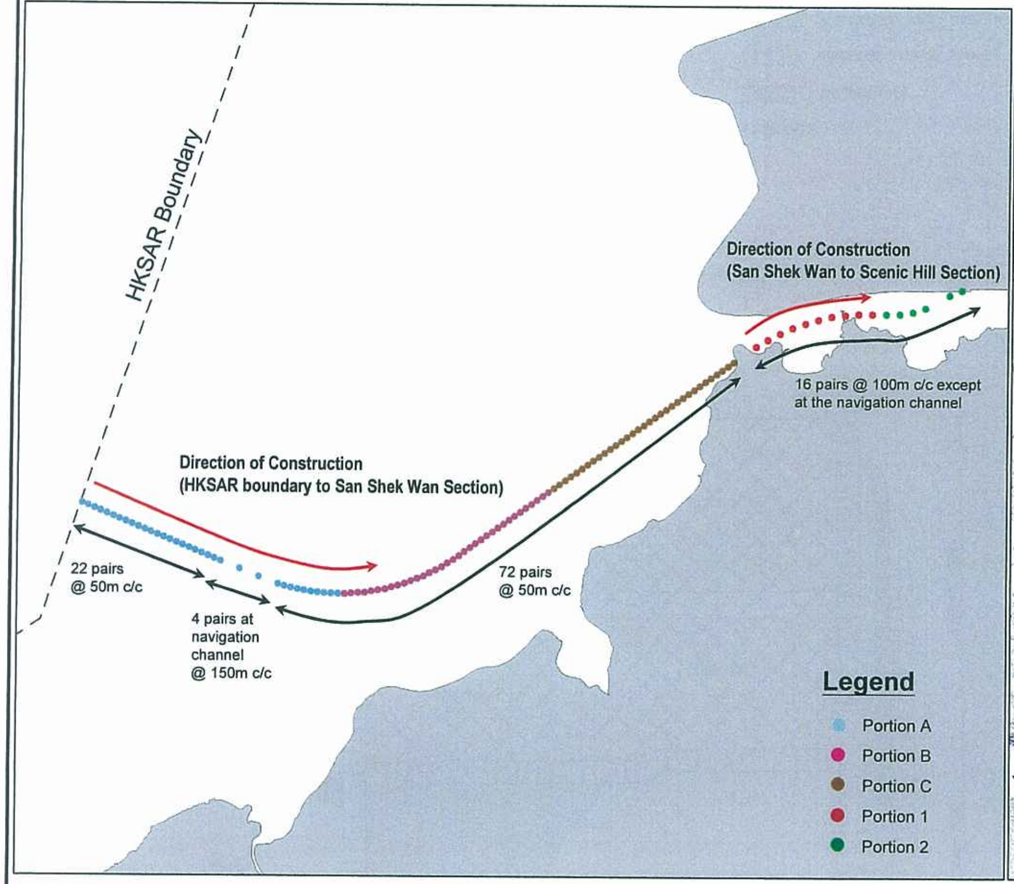

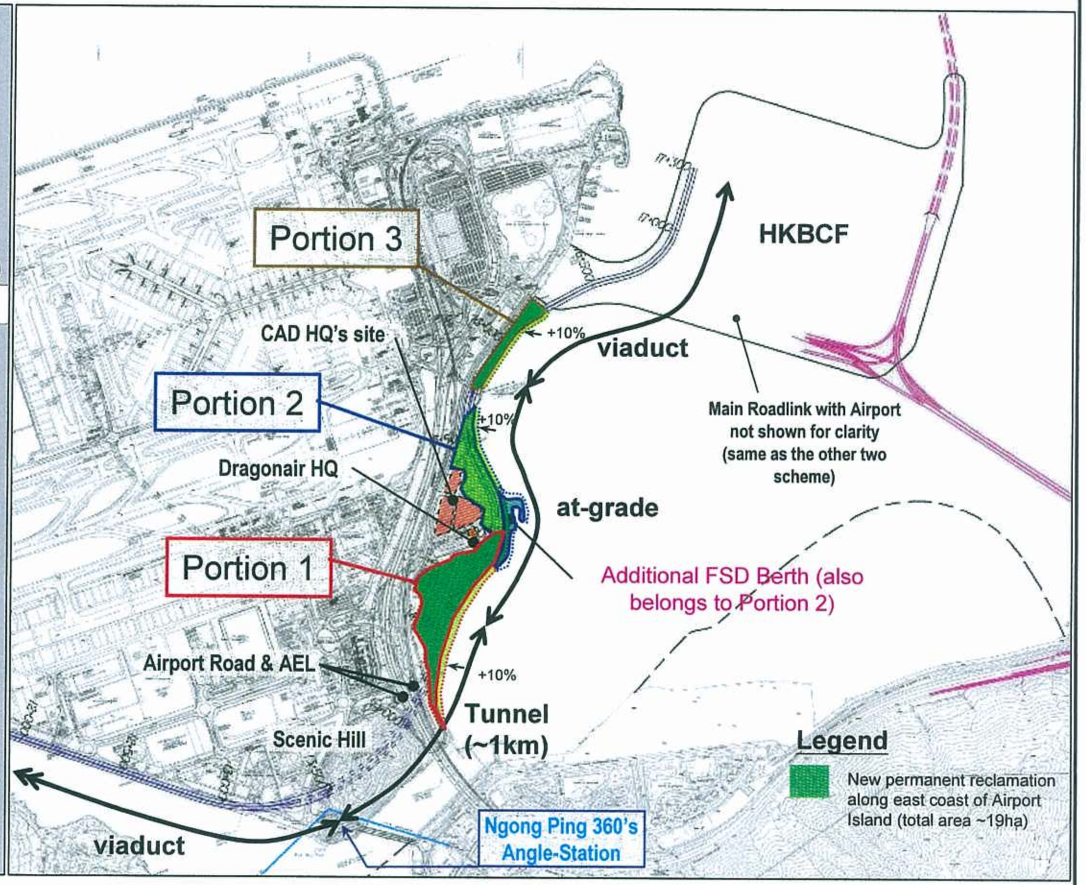

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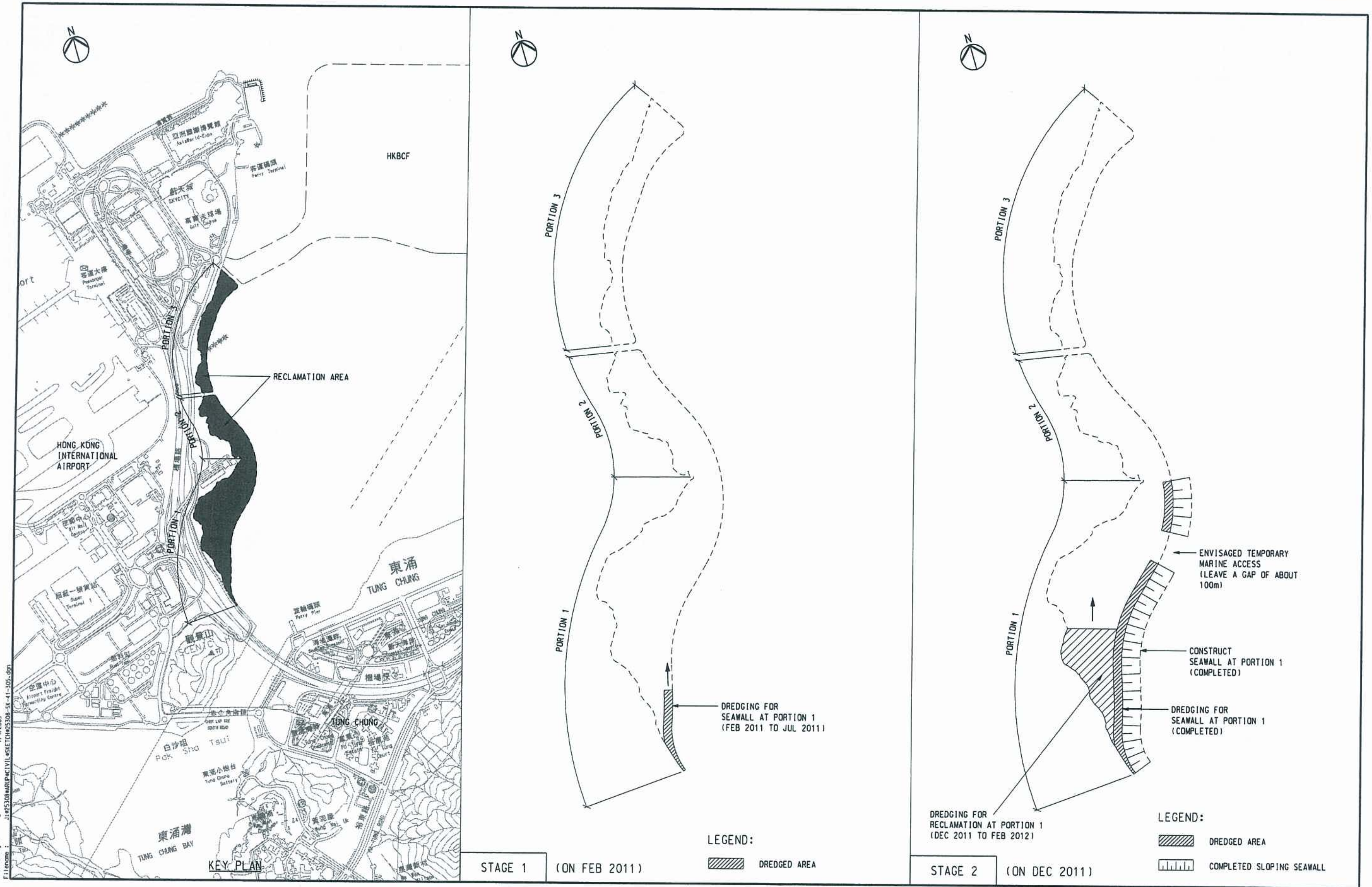
AGREEMENT No. CE 52/2007 (HY)
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

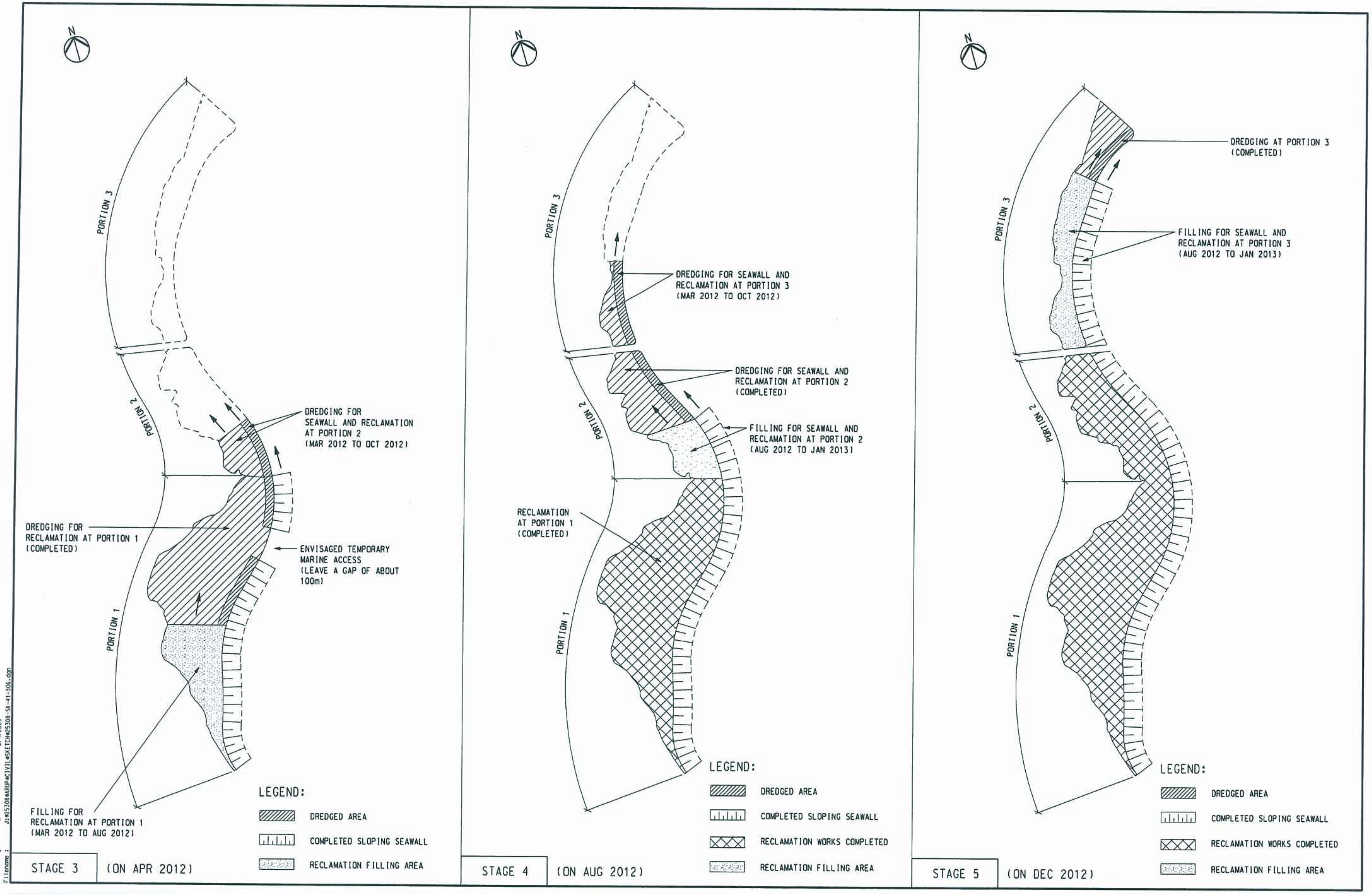
Layout of Tunnel cum At-Grade Scheme of HKLR and Viaduct Alignment

SCALE	NTS	DATE	FEB. 2009	
CHECK		DRAWN		
JOB No.	60044963	DRAWING No.	13	REV

FILE:



路政署 HIGHWAYS DEPARTMENT 港珠澳大橋香港工程管理處 Hong Kong - Zhuhai - Macao Bridge Hong Kong Project Management Office	ARUP Ove Arup & Partners Hong Kong Limited	Job Title: Agreement No. CE 14/2008 (CE) Hong Kong-Zhuhai-Macao Bridge Hong Kong Boundary Crossing Facilities – Investigation	Drawing Title: ANTICIPATED CONSTRUCTION SEQUENCE OF HKLR — Sheet 1 of 2	Rev. A — FIRST ISSUE — 02/09 (Rev. / Description / Date)	Drawn AL; Date 02/09; Checked SK; Approved AK; Scale 1:10000 on A3; Drawing No. Figure 14; Status PRELIMINARY; Rev. A



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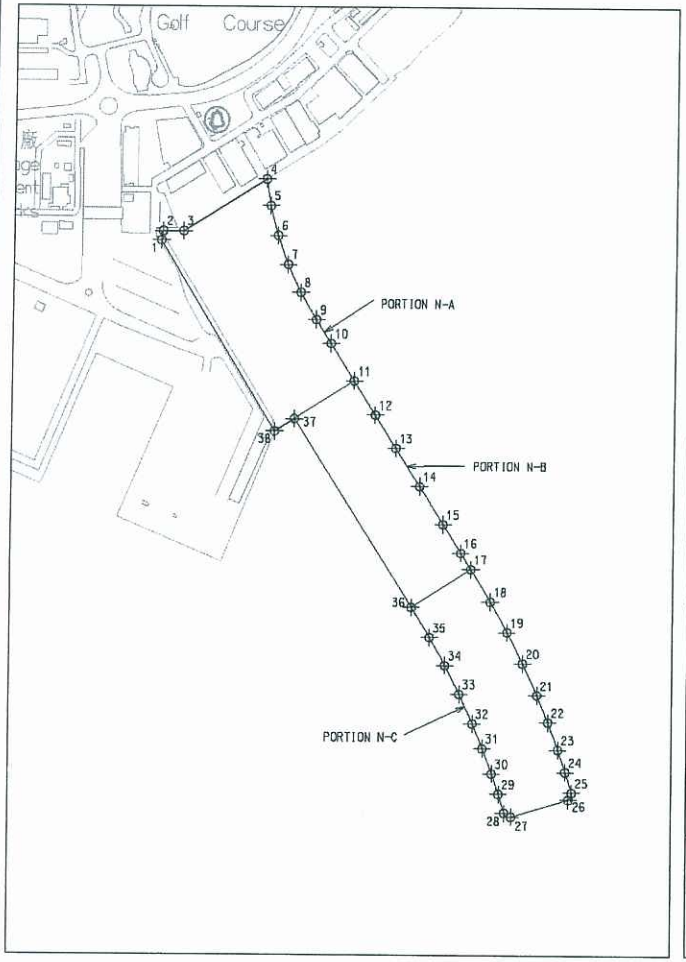
路政署 HIGHWAYS DEPARTMENT 港珠澳大橋香港工程管理處 Hong Kong - Zhuhai - Macao Bridge Hong Kong Project Management Office	ARUP Ove Arup & Partners Hong Kong Limited	Job Title: Agreement No. CE 14/2008 (CE) Hong Kong-Zhuhai-Macao Bridge Hong Kong Boundary Crossing Facilities – Investigation	Drawing Title: ANTICIPATED CONSTRUCTION SEQUENCE OF HKLR — Sheet 2 of 2	Drawing No. Figure 14

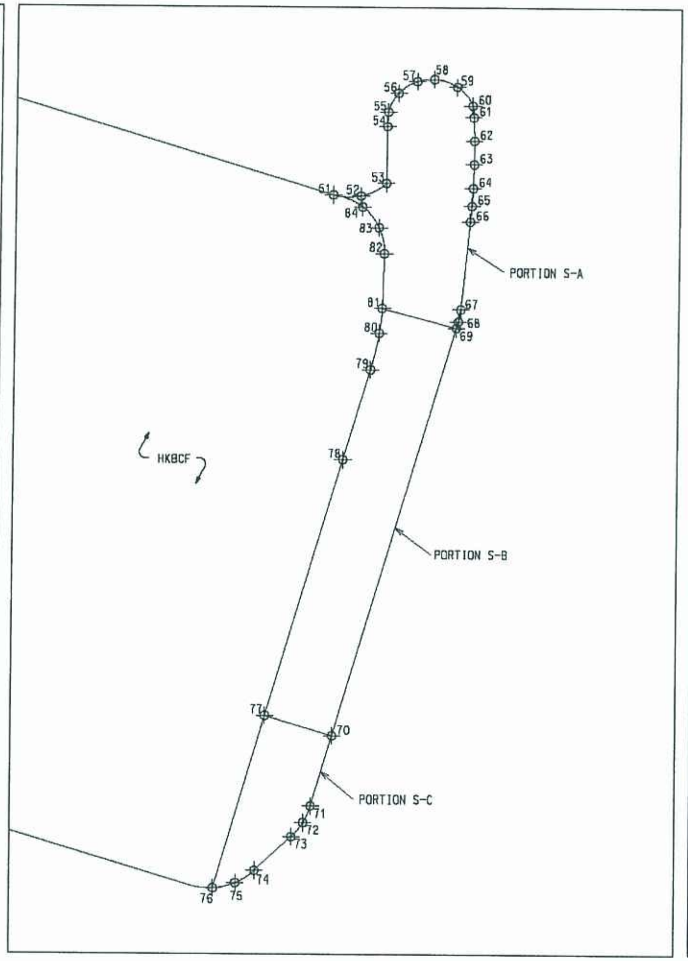
Rev.	Description	Date
A	FIRST ISSUE	02/09

Drawn: AL	Date: 02/09	Checked: SK	Approved: AK
Scale: 1:10000 on A3	Status: PRELIMINARY	Rev. A	

Northern Landfall (works not yet commence)



Southern Landfall (works not yet commence)



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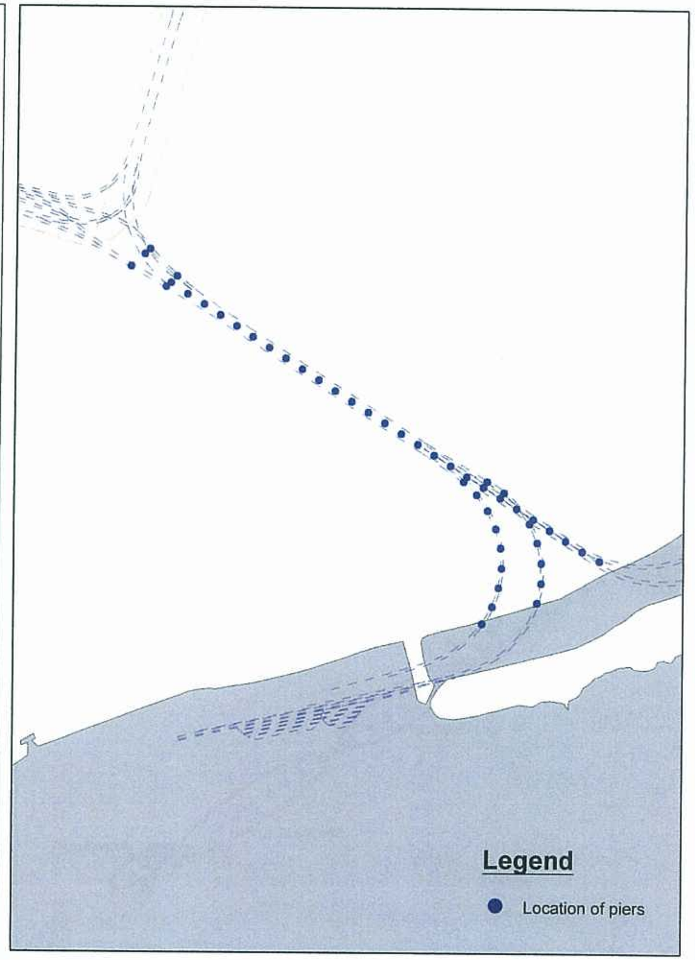

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AGREEMENT No. CE 52/2007 (HY)
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Anticipated Progress of Marine Works for TM-CLKL at Year 2011

SCALE	NTS	DATE	FEB. 2009	
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JOB No.	60044963	DRAWING No.	15	REV

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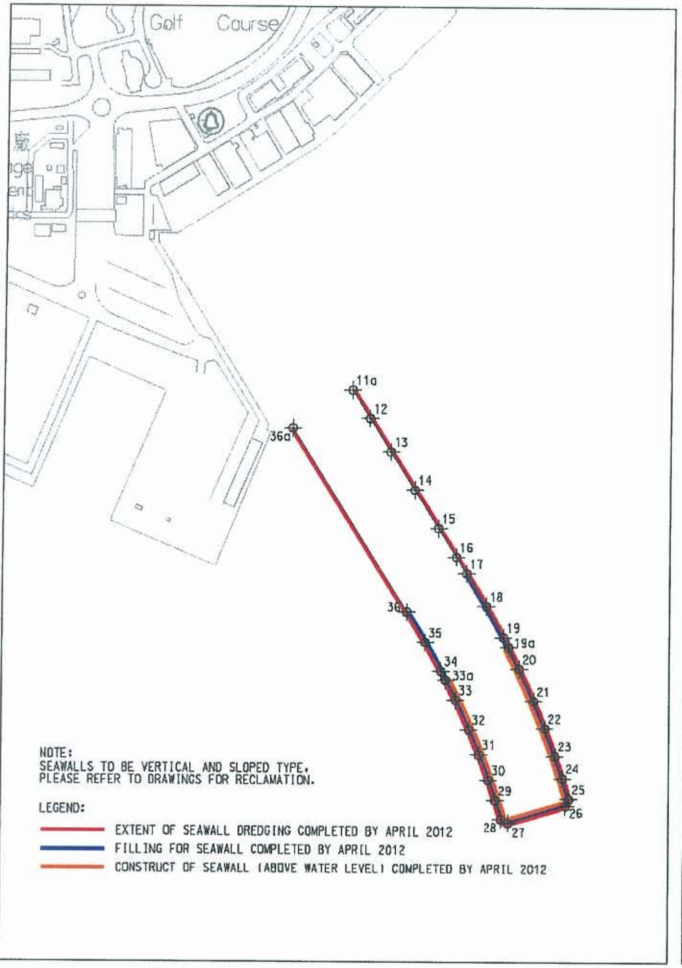
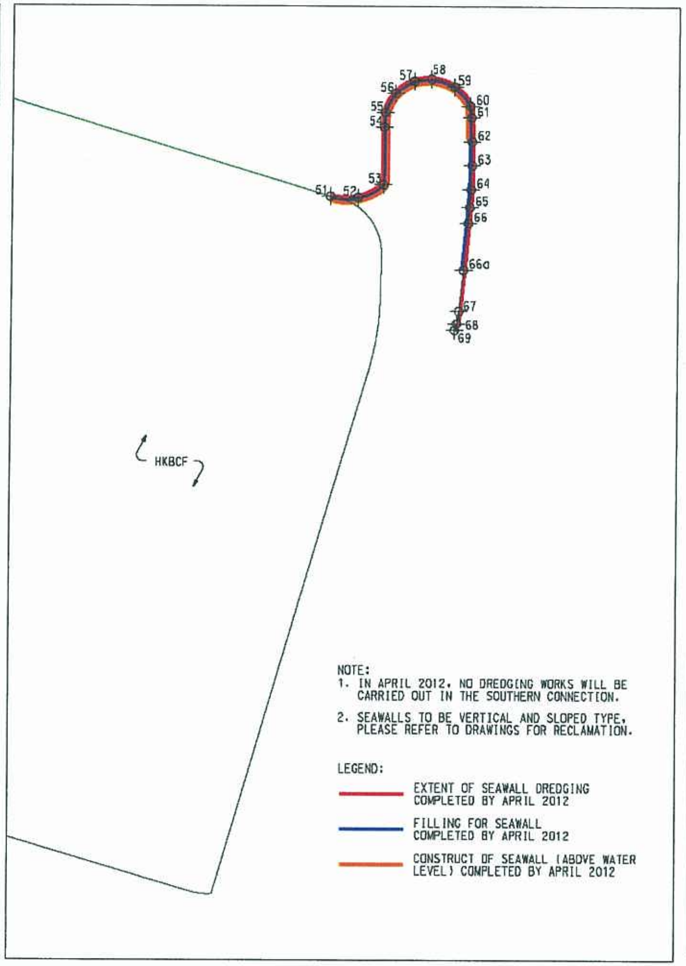
Northern Landfall



Southern Landfall



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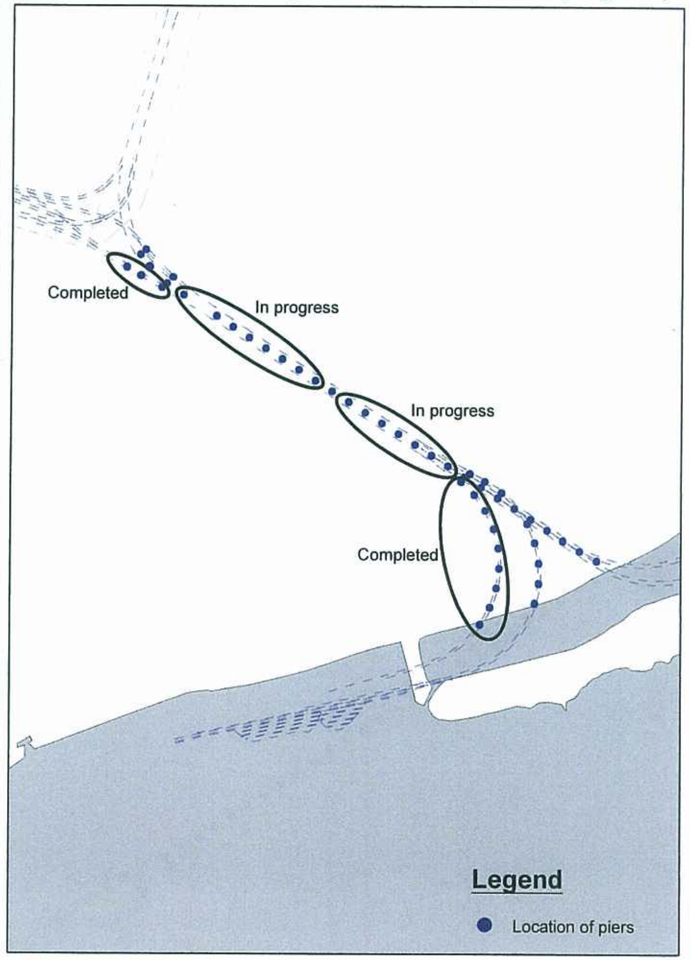

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AGREEMENT No. CE 52/2007 (HY)
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Anticipated Progress of Marine Works for TM-CLKL at Year 2012

SCALE	NTS	DATE	FEB. 2009
CHECK		DRAWN	
JOB No.	60044963	DRAWING No.	16
		REV	

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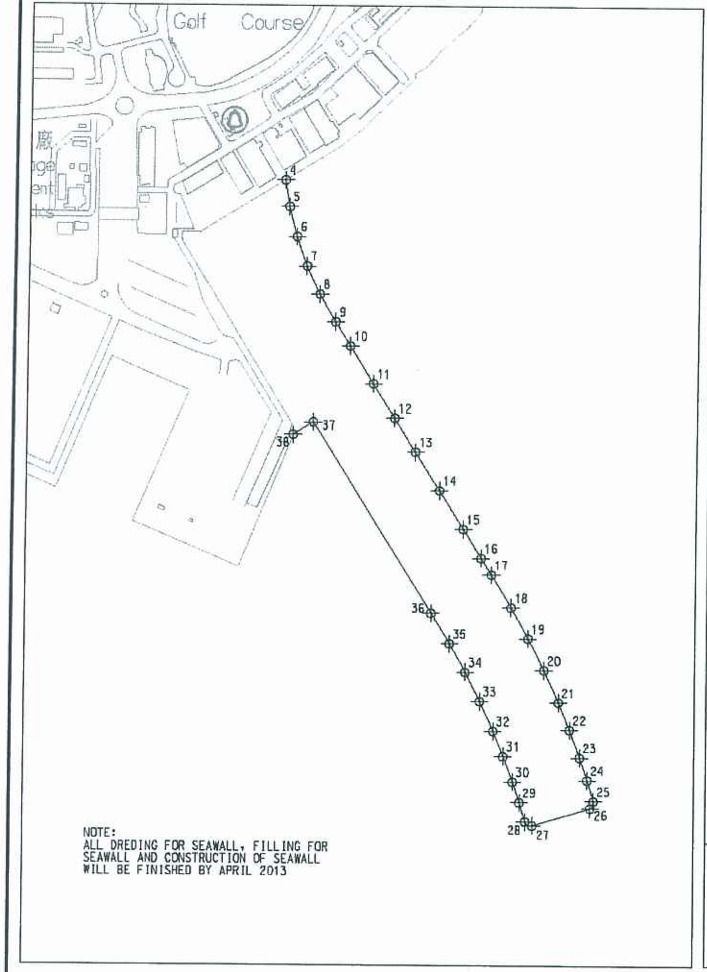
Northern Landfall



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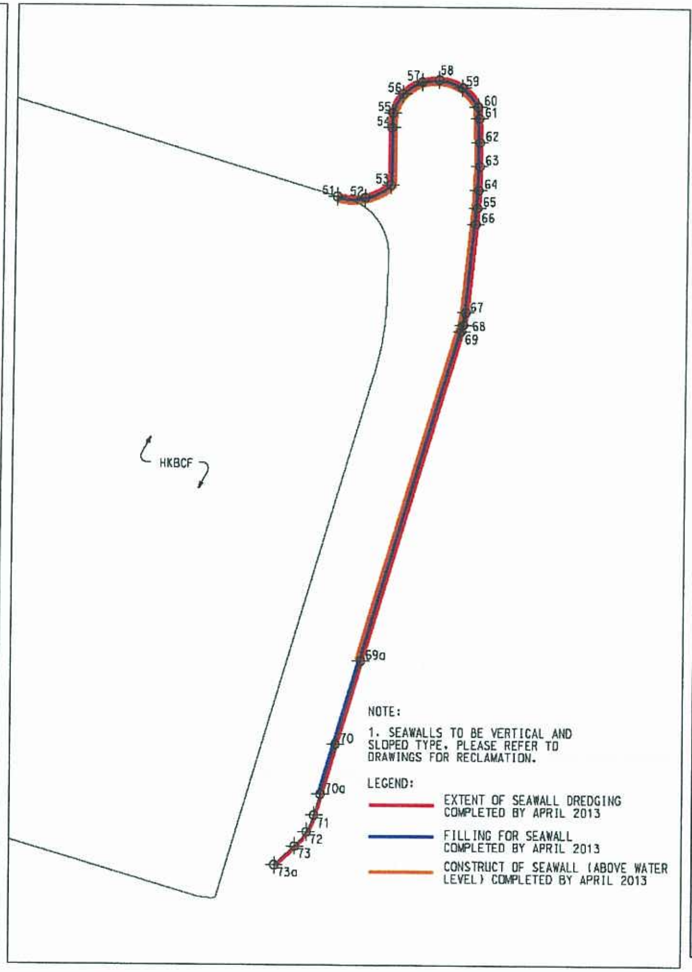

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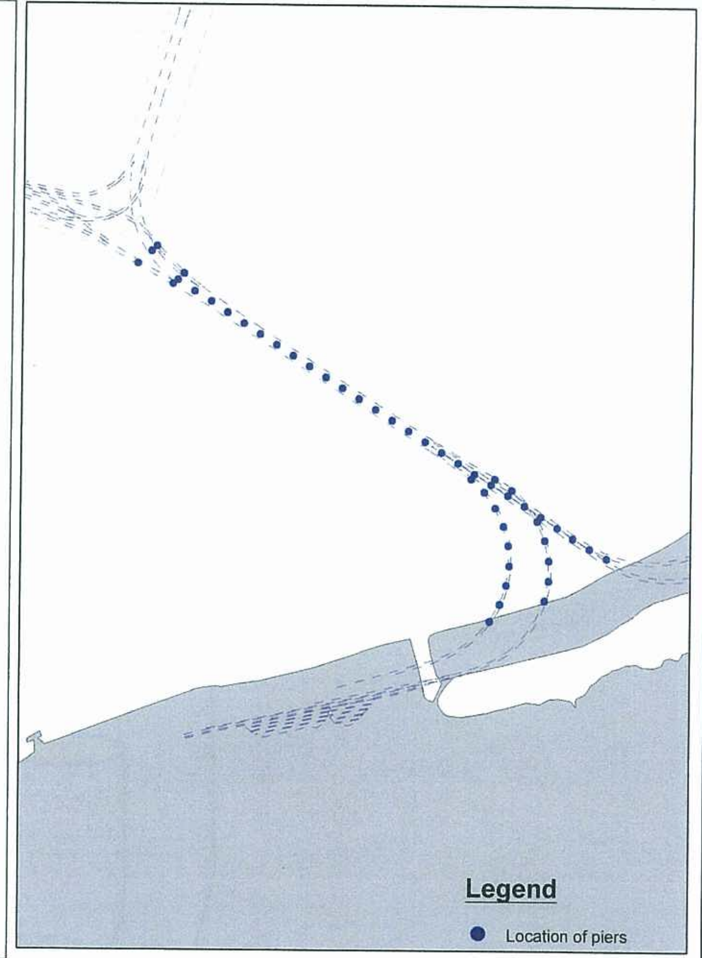

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AGREEMENT No. CE 52/2007 (HY)
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Anticipated Progress of Marine Works for TM-CLKL at Year 2013

SCALE	NTS	DATE	FEB. 2009
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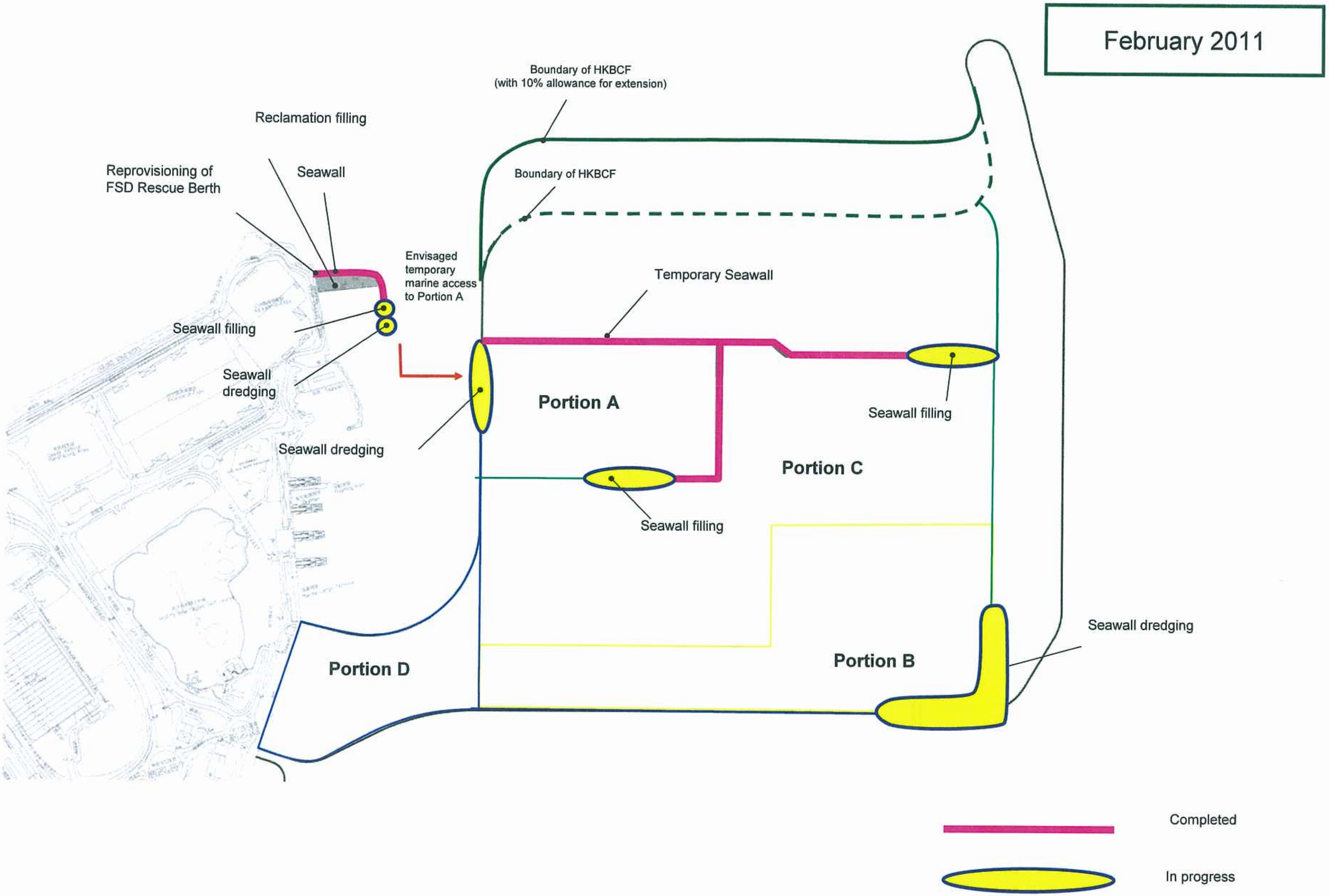

MAUNSELL AECOM Maunsell Consultants Asia Ltd	AGREEMENT No. CE 52/2007 (HY) TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION **Anticipated Progress of Marine Works for HKBCF at Year 2011**	SCALE	NTS	DATE	MAY. 2009
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		JOB No.	60044963	DRAWING No.	18 REV

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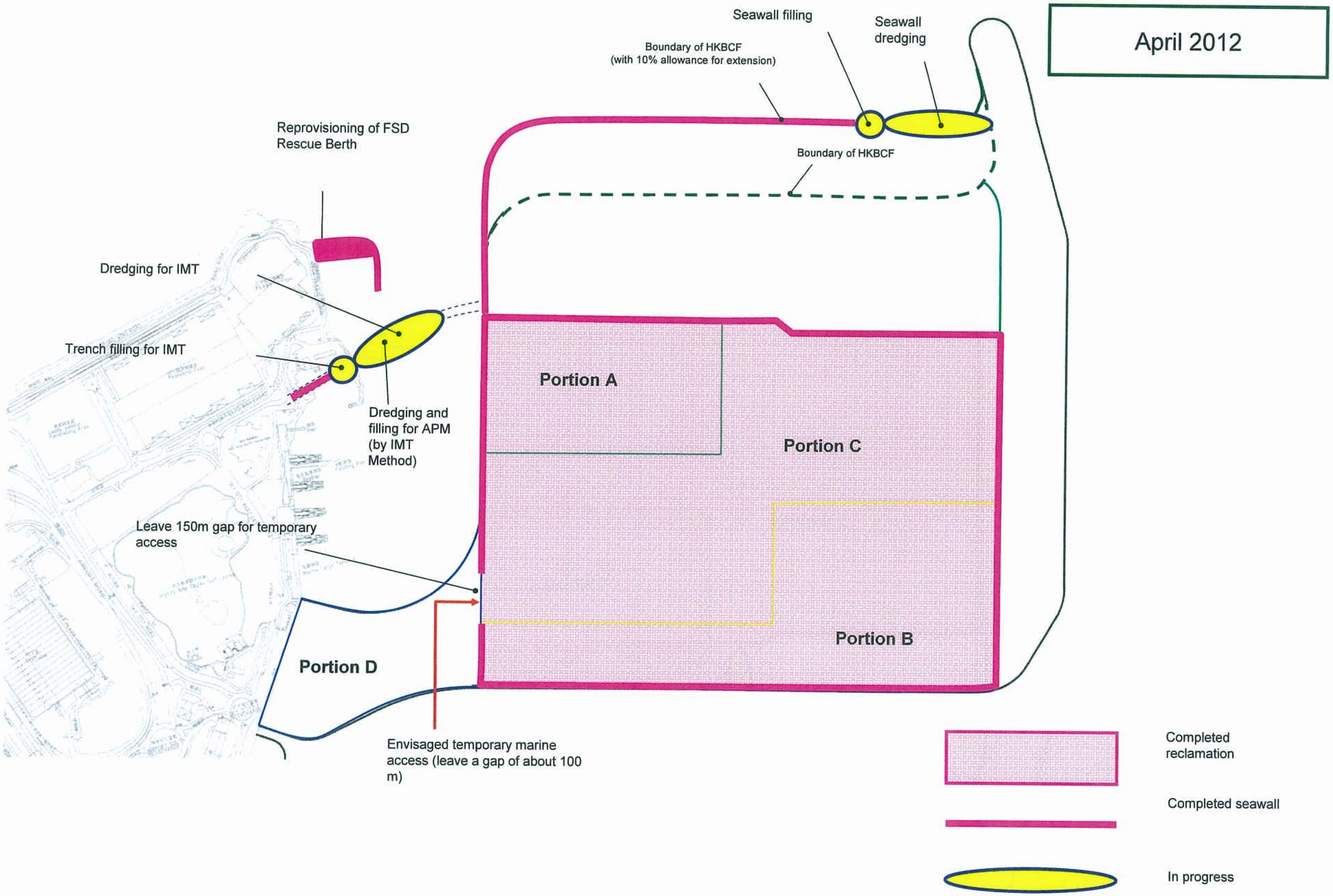

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AGREEMENT No. CE 52/2007 (HY)
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Anticipated Progress of Marine Works for HKBCF at Year 2012

SCALE	NTS	DATE	MAY. 2009
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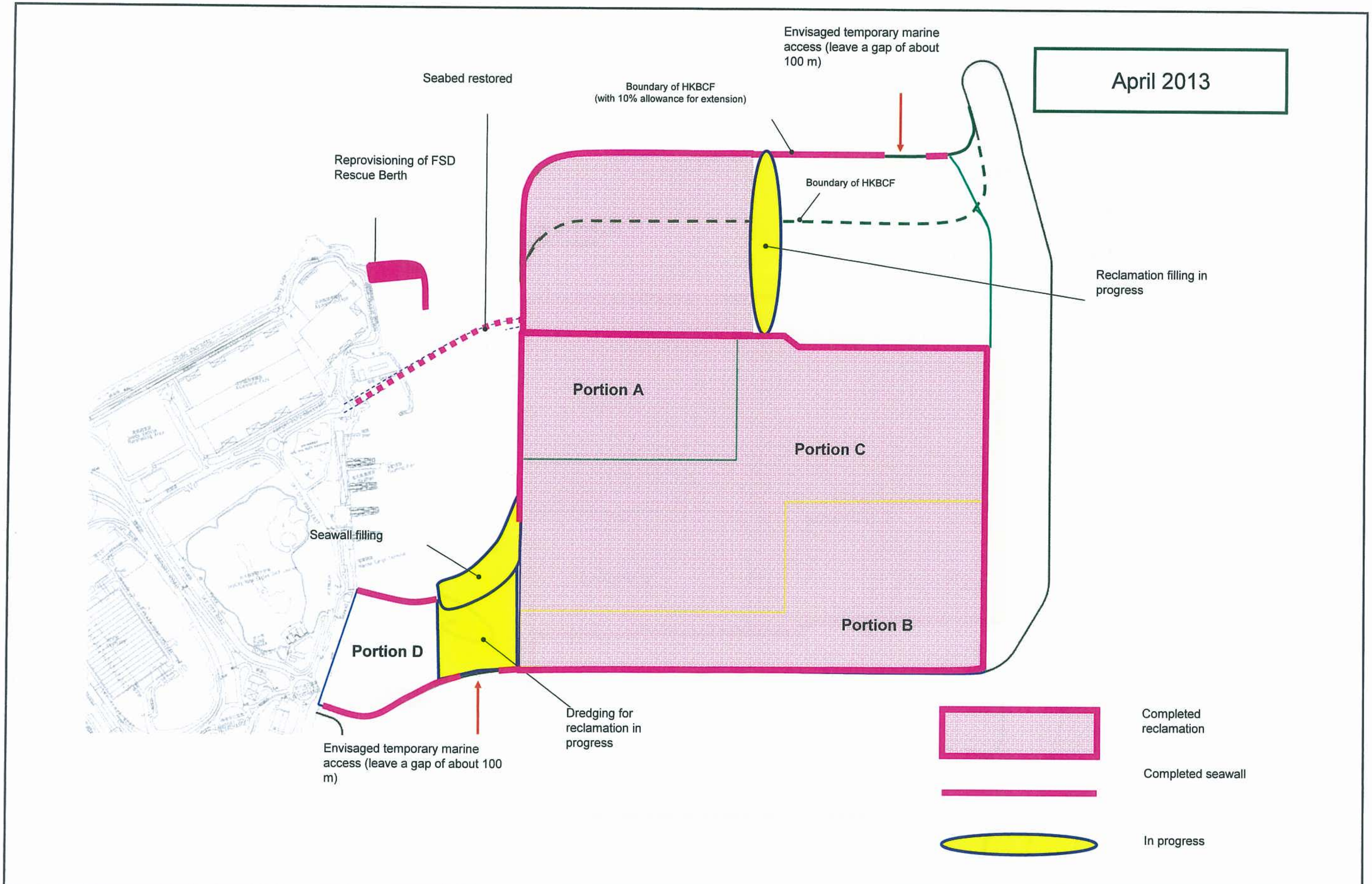

MAUNSELL | AECOM Maunsell Consultants Asia Ltd	AGREEMENT No. CE 52/2007 (HY) TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION **Anticipated Progress of Marine Works for HKBCF at Year 2013**	SCALE	NTS	DATE	MAY. 2009
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		JOB No.	60044963	DRAWING No.	20
				REV	

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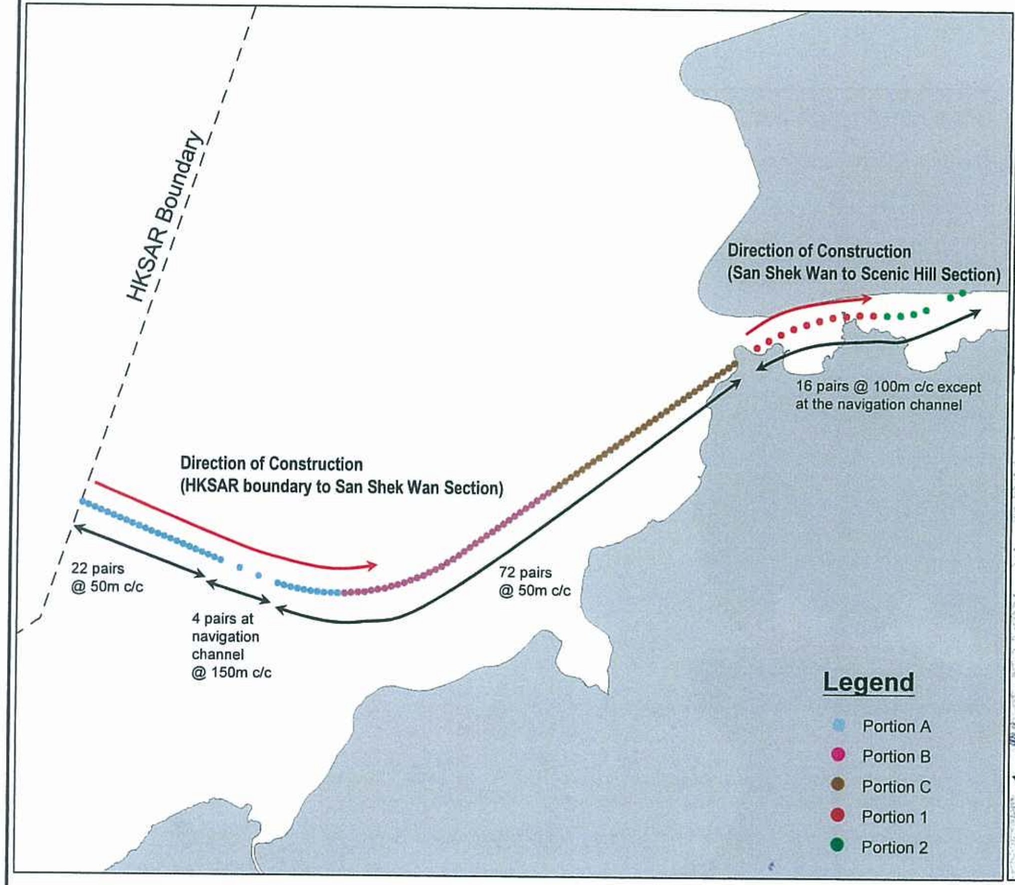
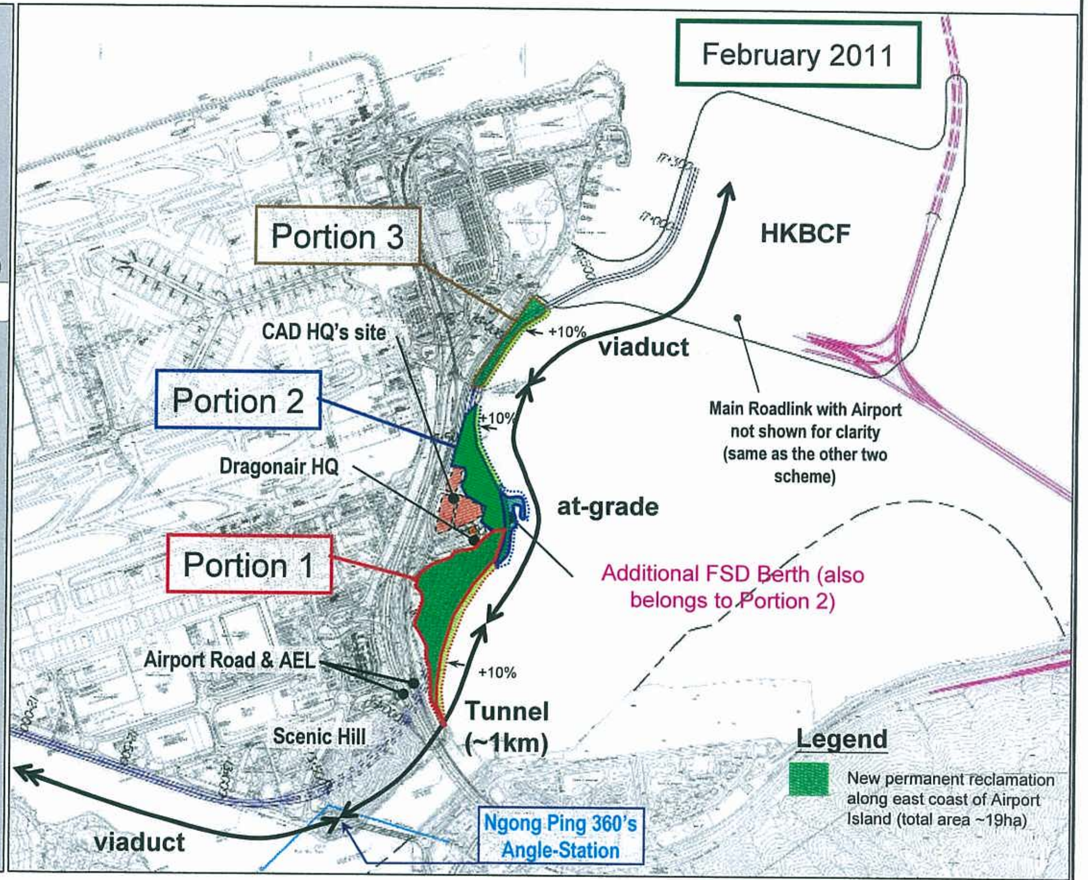
Construction of piles not yet commence



Dredging / reclamation not yet commence



MAUNSELL AECOM Maunsell Consultants Asia Ltd	AGREEMENT No. CE 52/2007 (HY) TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION **Anticipated Progress of Marine Works for HKLR at Year 2011**	SCALE	NTS	DATE	FEB. 2009
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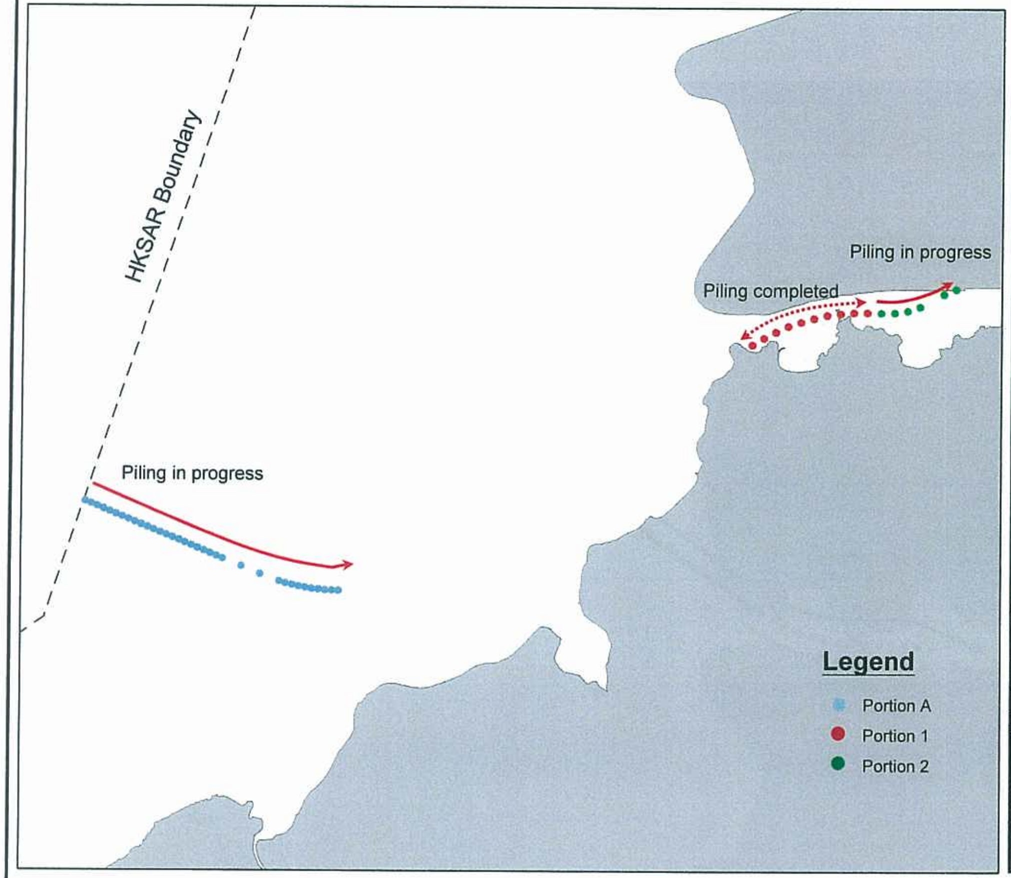

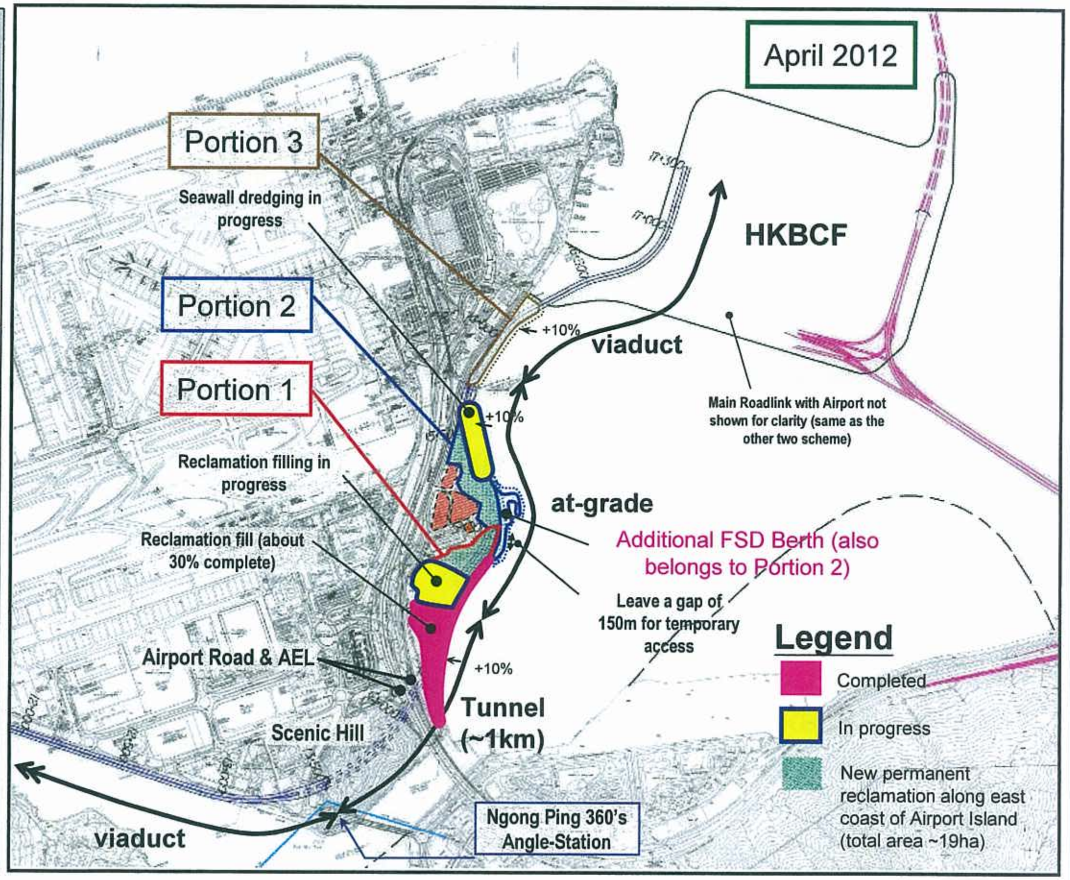

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AGREEMENT No. CE 52/2007 (HY)
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Anticipated Progress of Marine Works for HKLR at Year 2012

SCALE	NTS	DATE	FEB. 2009
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JOB No.	60044963	DRAWING No.	22
		REV	

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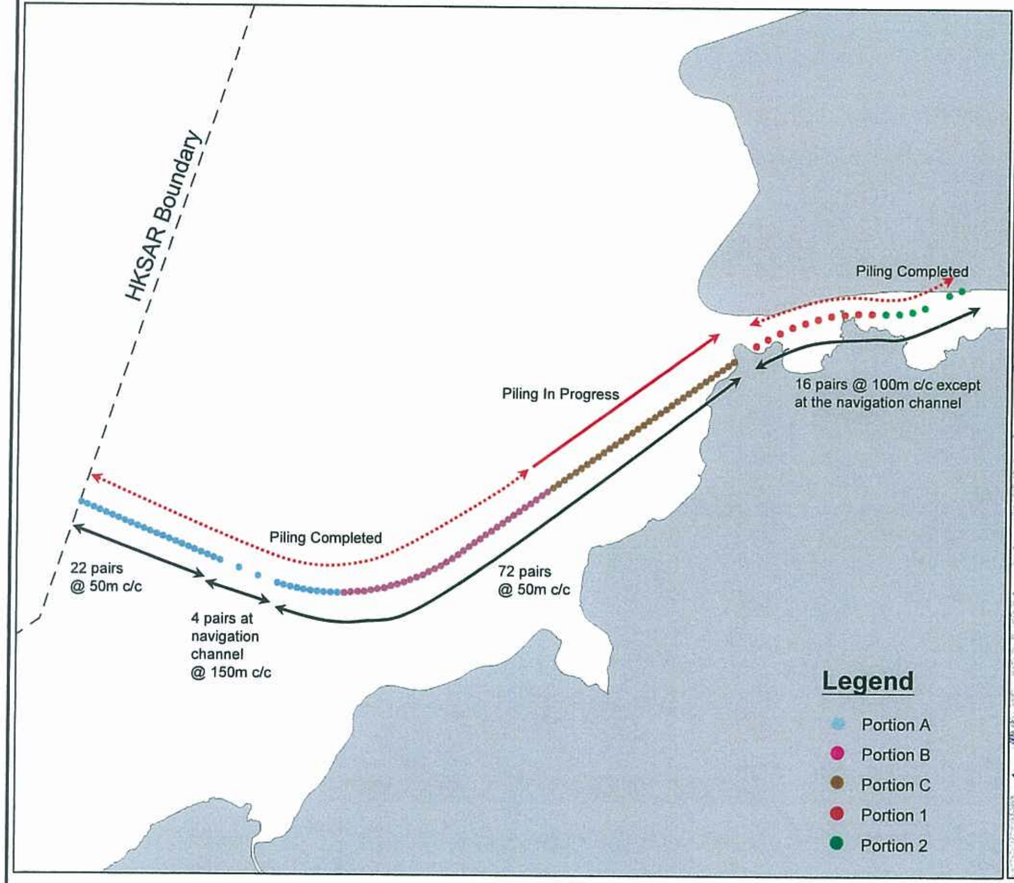
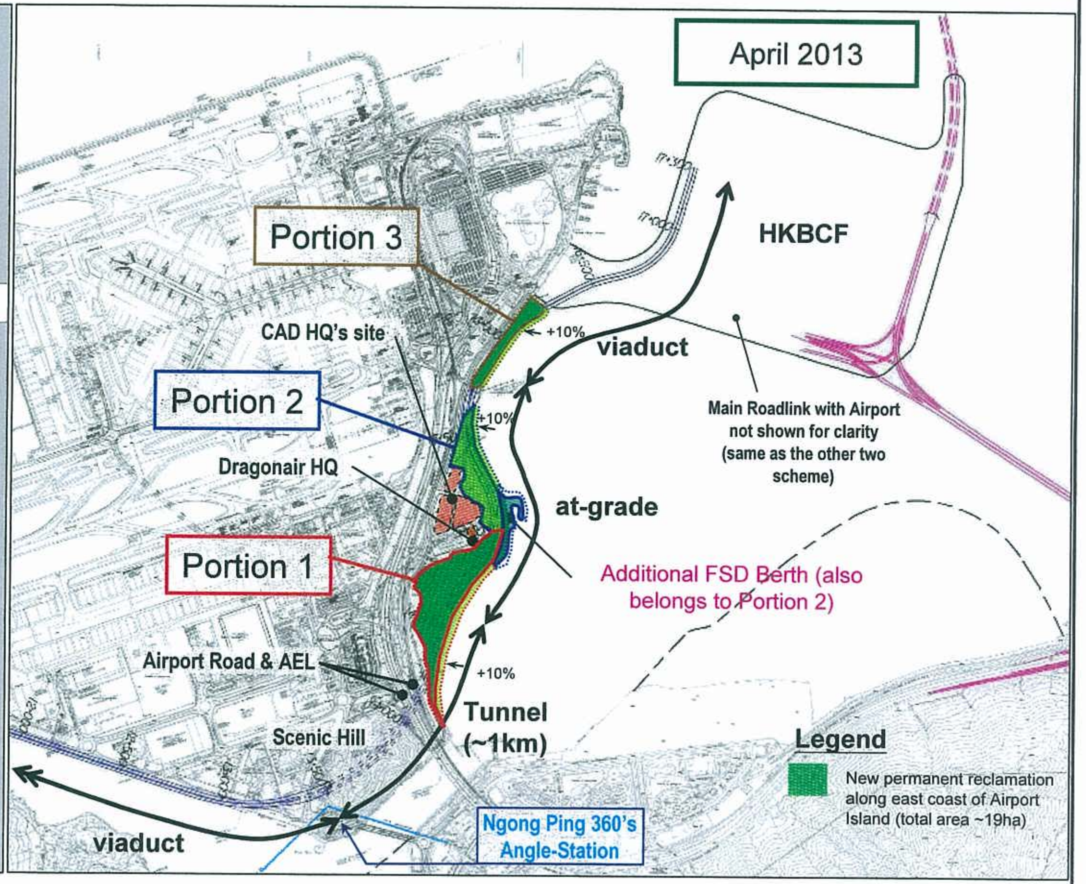
Dredging / reclamation completed





MAUNSELL | AECOM Maunsell Consultants Asia Ltd	AGREEMENT No. CE 52/2007 (HY) TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION **Anticipated Progress of Marine Works for HKLR at Year 2013**	SCALE	NTS	DATE	FEB. 2009	
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AGREEMENT No. CE 52/2007 (HY)
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Envisaged Programme of Reclamation and Sediment Loss Rates for TM-CLKL +HKBCF + HKLR

SCALE	NTS	DATE	MAY. 2009
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JOB No.	60044963	DRAWING No.	24
		REV	

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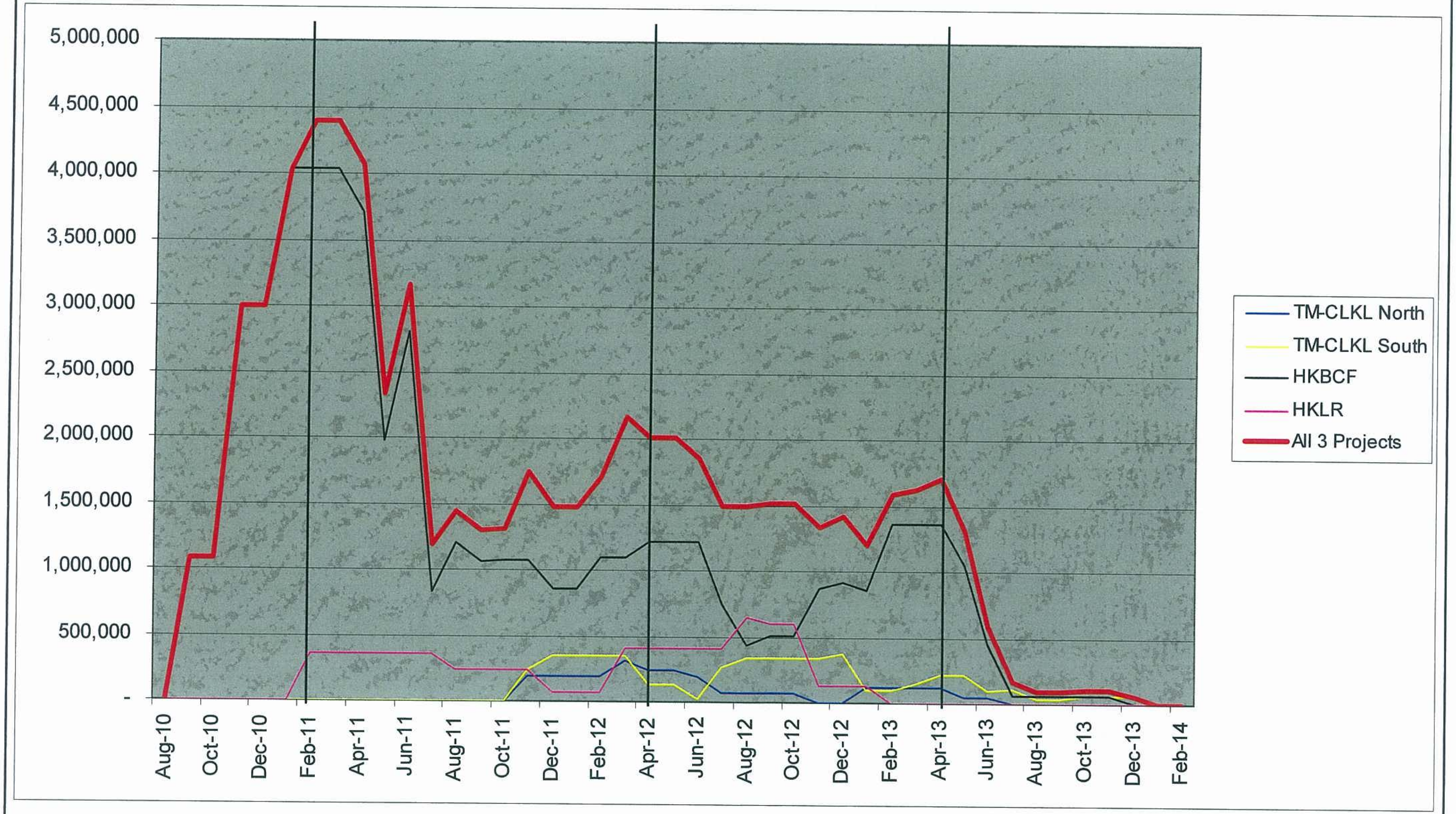
Loss Rate (kg/day)



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AGREEMENT No. CE 52/2007 (HY)
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Total and Individual Unmitigated Sediment Loss Rates for the TM-CLKL+HKBCF+HKLR

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JOB No.	60044963	DRAWING No.	25
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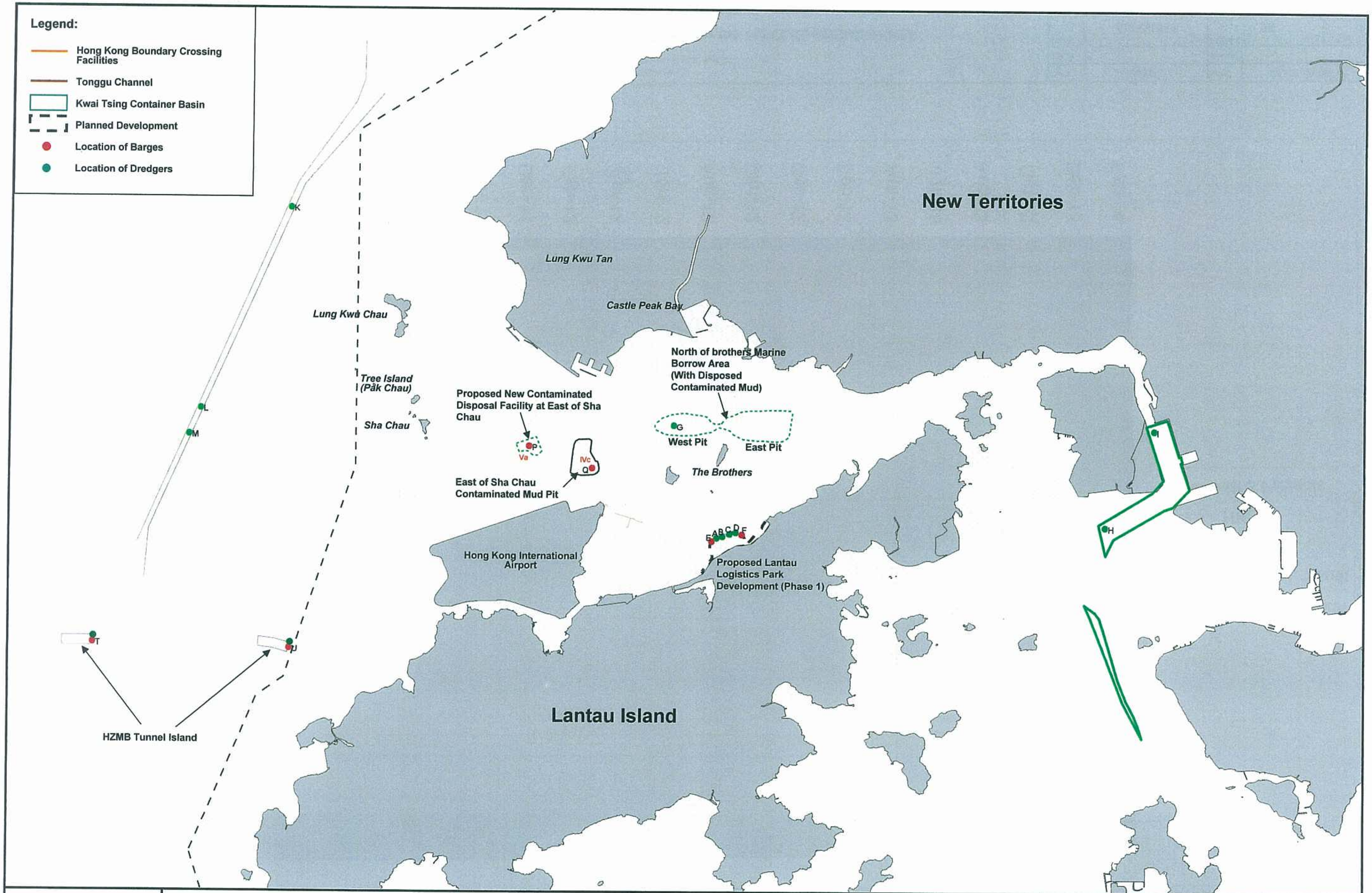

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AGREEMENT No. CE 52/2007 (HY)
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Assumed Coastline at 2011 with Indicative Location of Marine Plants For Concurrent Projects

SCALE	NTS	DATE	MAY. 2009
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JOB No.	60044963	DRAWING No.	26
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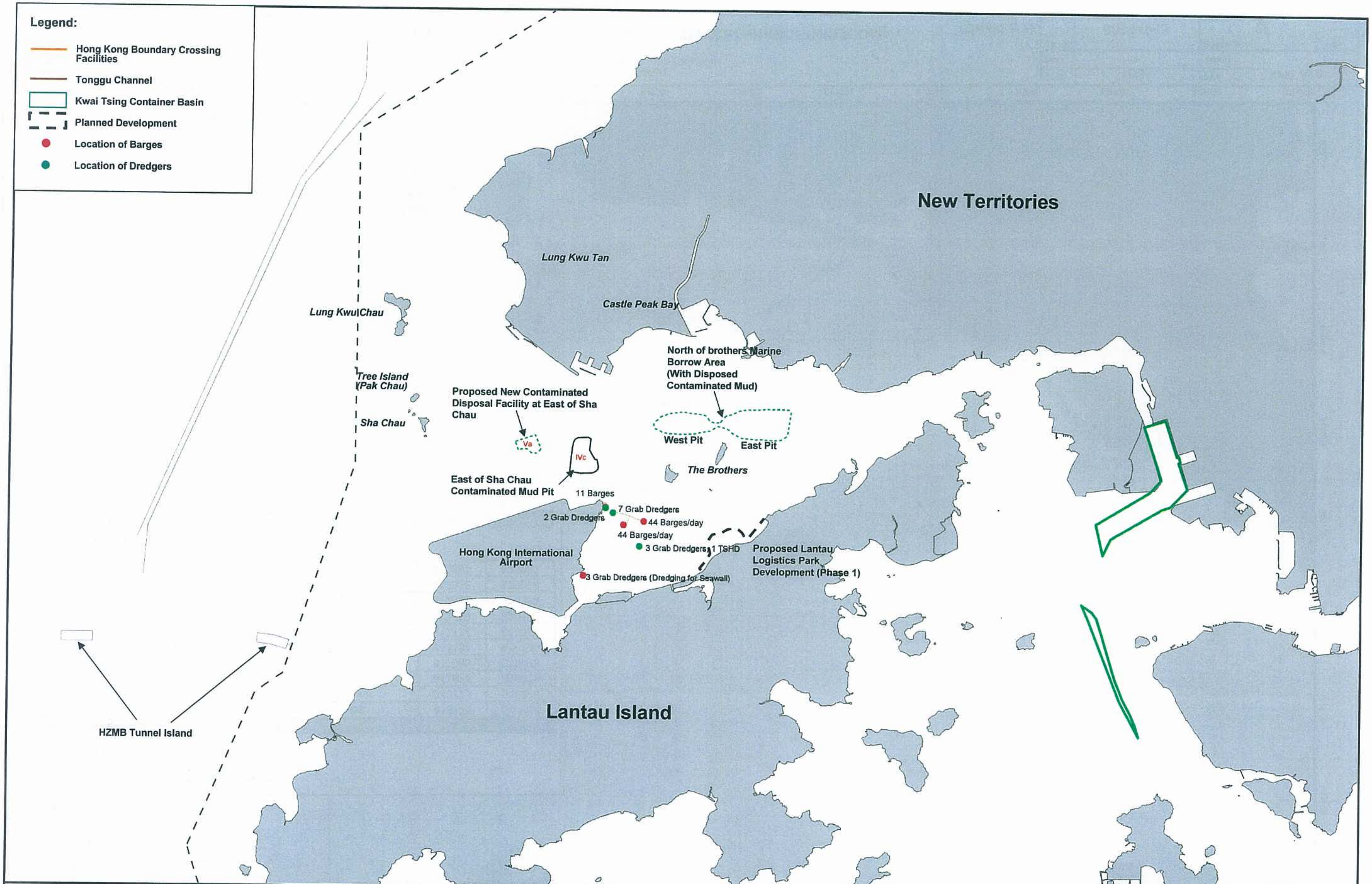

MAUNSELL AECOM	AGREEMENT No. CE 52/2007 (HY) TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION **Assumed Coastline at 2011 with Marine Plants for TM-CLKL+HKBCF+HKLR Only** (Sheet 1 of 2)	SCALE: NTS	DATE: FEB. 2009
Maunsell Consultants Asia Ltd		CHECK	DRAWN
		JOB No. 60044963	DRAWING No. 27 REV

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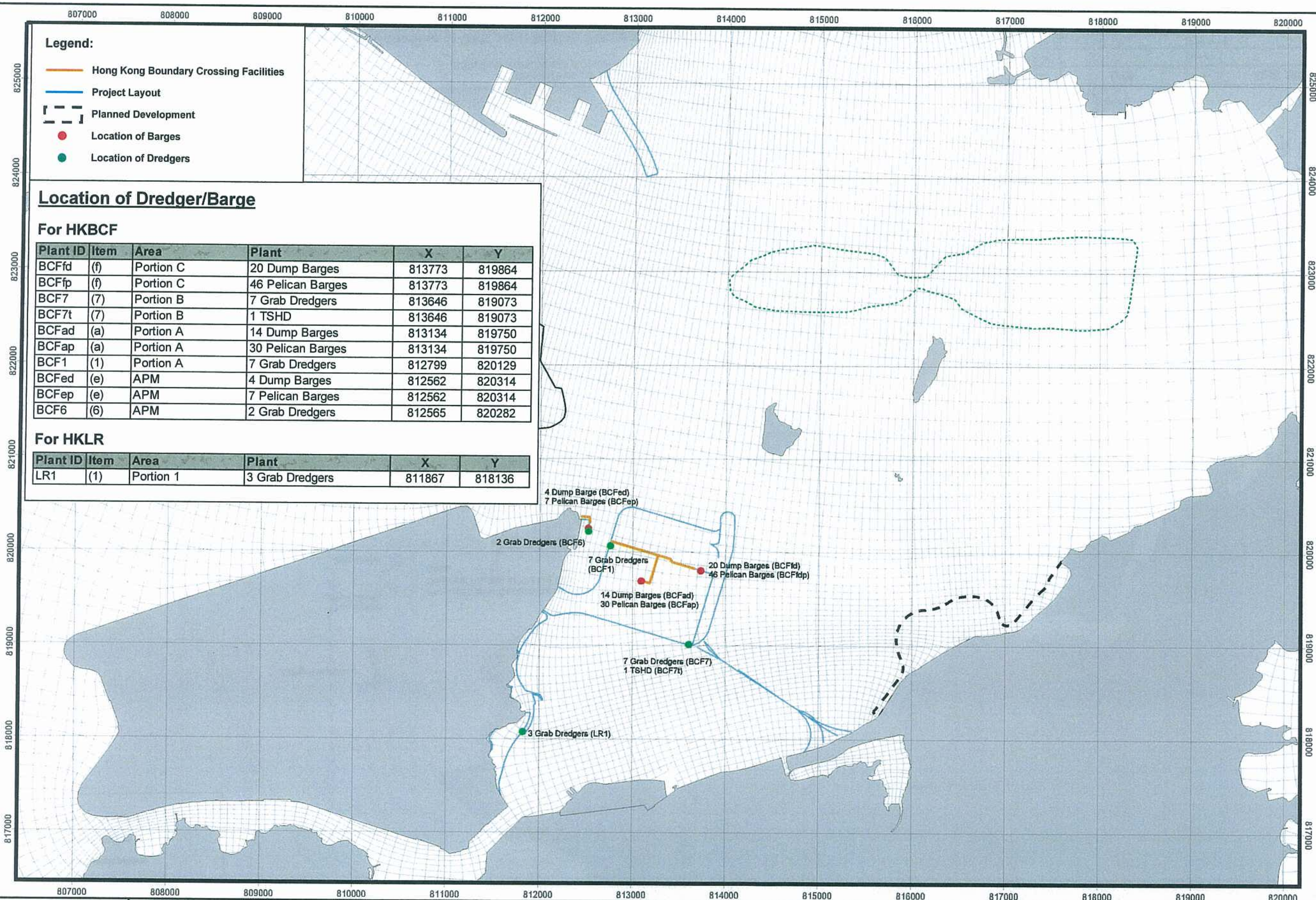

Location of Dredger/Barge

For HKBCF

Plant ID	Item	Area	Plant	X	Y
BCFfd	(f)	Portion C	20 Dump Barges	813773	819864
BCFfp	(f)	Portion C	46 Pelican Barges	813773	819864
BCF7	(7)	Portion B	7 Grab Dredgers	813646	819073
BCF7t	(7)	Portion B	1 TSHD	813646	819073
BCFad	(a)	Portion A	14 Dump Barges	813134	819750
BCFap	(a)	Portion A	30 Pelican Barges	813134	819750
BCF1	(1)	Portion A	7 Grab Dredgers	812799	820129
BCFed	(e)	APM	4 Dump Barges	812562	820314
BCFep	(e)	APM	7 Pelican Barges	812562	820314
BCF6	(6)	APM	2 Grab Dredgers	812565	820282

For HKLR

Plant ID	Item	Area	Plant	X	Y
LR1	(1)	Portion 1	3 Grab Dredgers	811867	818136

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TUEN MUN - CHEK LAP KOK LINK - INVESTIGATION

Assumed Coastline at 2011 with Marine Plants for TM-CLKL+HKBCF+HKLR Only (Sheet 2 of 2)

SCALE	NTS	DATE	APR. 2009
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JOB No.	60044963	DRAWING No.	27
REV	--		

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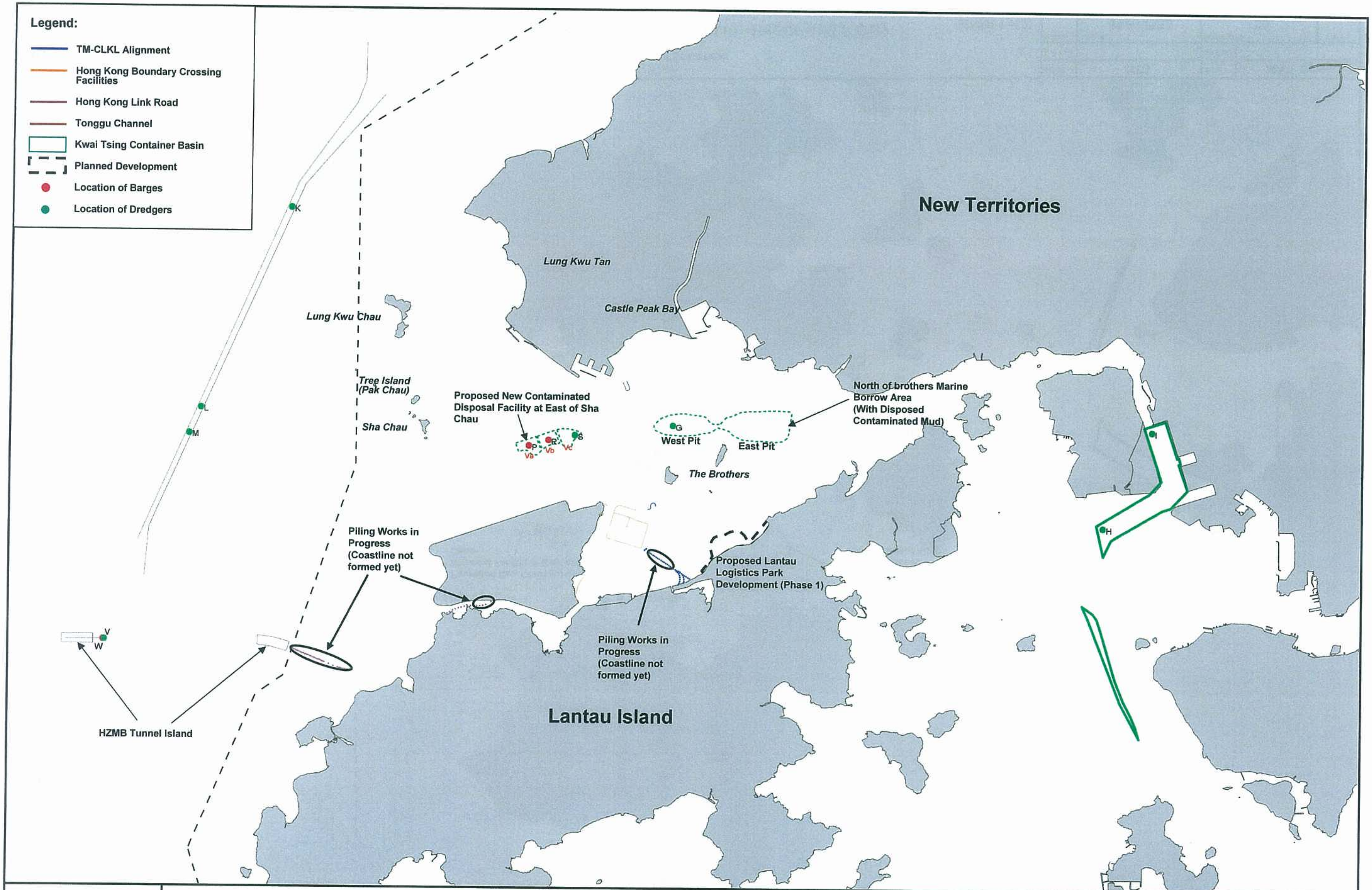

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AGREEMENT No. CE 52/2007 (HY)
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Assumed Coastline at 2012 with Indicative Location of Marine Plants for Concurrent Projects

SCALE	NTS	DATE	MAY. 2009
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JOB No.	60044963	DRAWING No.	28
		REV	

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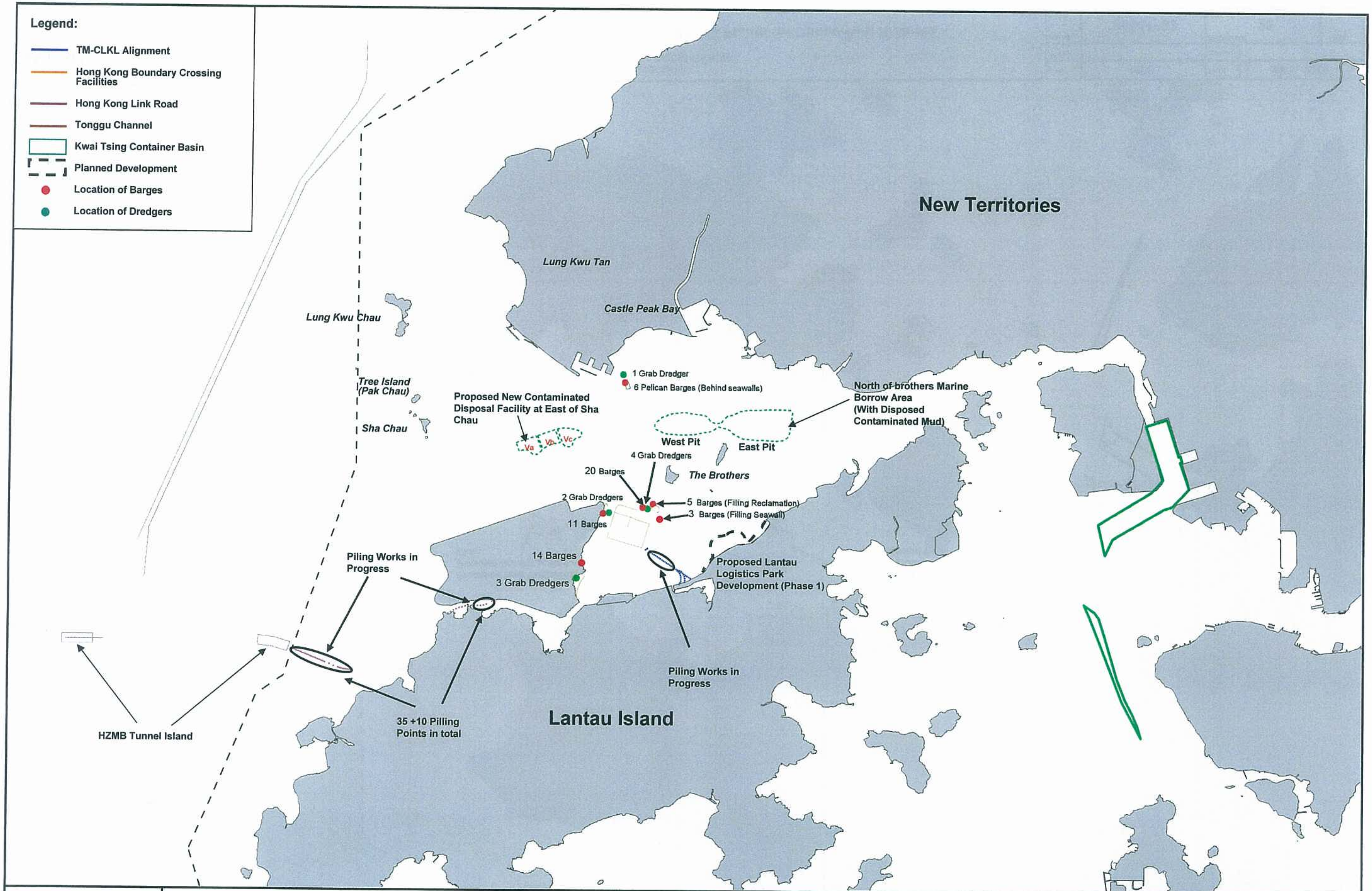

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TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Assumed Coastline at 2012 with Marine Plants for TM-CLKL+HKBCF+HKLR Only (Sheet 1 of 2)

SCALE	NTS	DATE	MAY. 2009	
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JOB No.	60044963	DRAWING No.	29	REV

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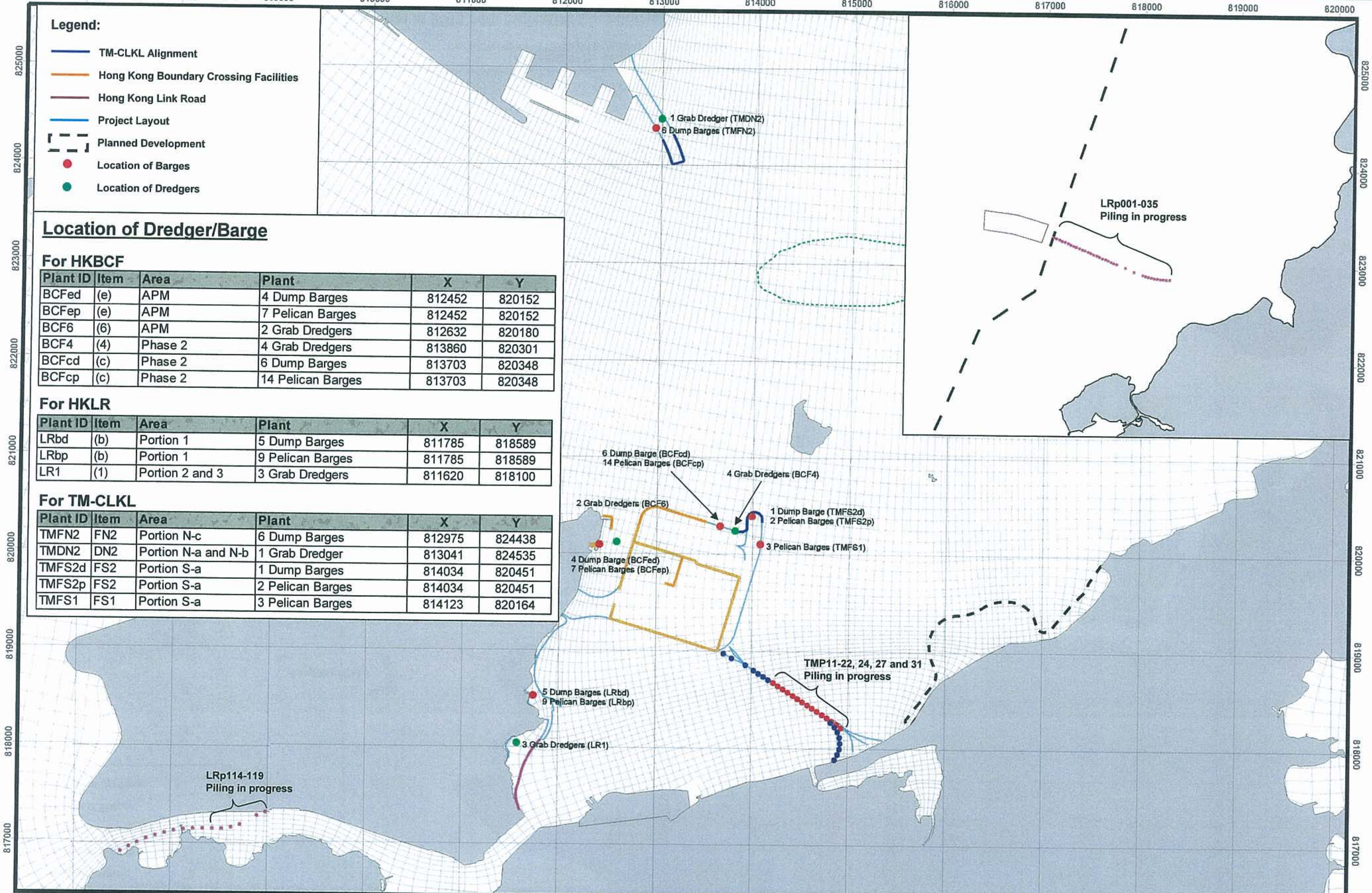

Location of Dredger/Barge

For HKBCF

Plant ID	Item	Area	Plant	X	Y
BCFed	(e)	APM	4 Dump Barges	812452	820152
BCFep	(e)	APM	7 Pelican Barges	812452	820152
BCF6	(6)	APM	2 Grab Dredgers	812632	820180
BCF4	(4)	Phase 2	4 Grab Dredgers	813860	820301
BCFcd	(c)	Phase 2	6 Dump Barges	813703	820348
BCFcp	(c)	Phase 2	14 Pelican Barges	813703	820348

For HKLR

Plant ID	Item	Area	Plant	X	Y
LRbd	(b)	Portion 1	5 Dump Barges	811785	818589
LRbp	(b)	Portion 1	9 Pelican Barges	811785	818589
LR1	(1)	Portion 2 and 3	3 Grab Dredgers	811620	818100

For TM-CLKL

Plant ID	Item	Area	Plant	X	Y
TMFN2	FN2	Portion N-c	6 Dump Barges	812975	824438
TMDN2	DN2	Portion N-a and N-b	1 Grab Dredger	813041	824535
TMFS2d	FS2	Portion S-a	1 Dump Barges	814034	820451
TMFS2p	FS2	Portion S-a	2 Pelican Barges	814034	820451
TMFS1	FS1	Portion S-a	3 Pelican Barges	814123	820164

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AGREEMENT NO. CE 52 / 2007 (HY)
TUEN MUN - CHEK LAP KOK LINK - INVESTIGATION

Assumed Coastline at 2012 with Marine Plants for TM-CLKL+HKBCF+HKLR Only

(Sheet 2 of 2)

SCALE	NTS	DATE	MAY. 2009
CHECK	--	DRAWN	--
JOB No.	60044963	DRAWING No.	29
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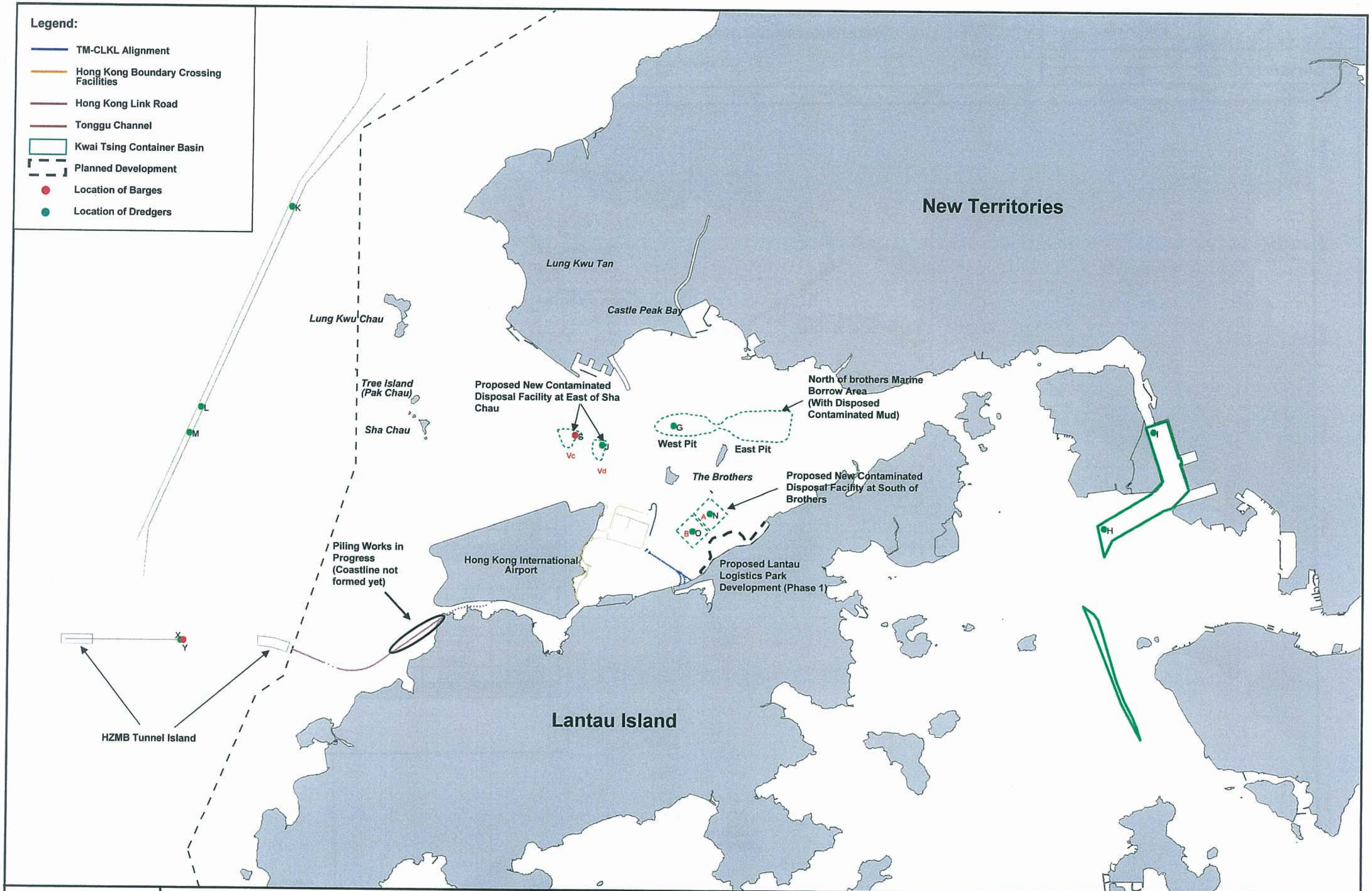

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AGREEMENT No. CE 52/2007 (HY)
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Assumed Coastline at 2013 with Indicative Location of Marine Plants For Concurrent Projects

SCALE	NTS	DATE	FEB. 2009
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JOB No.	60044963	DRAWING No.	30
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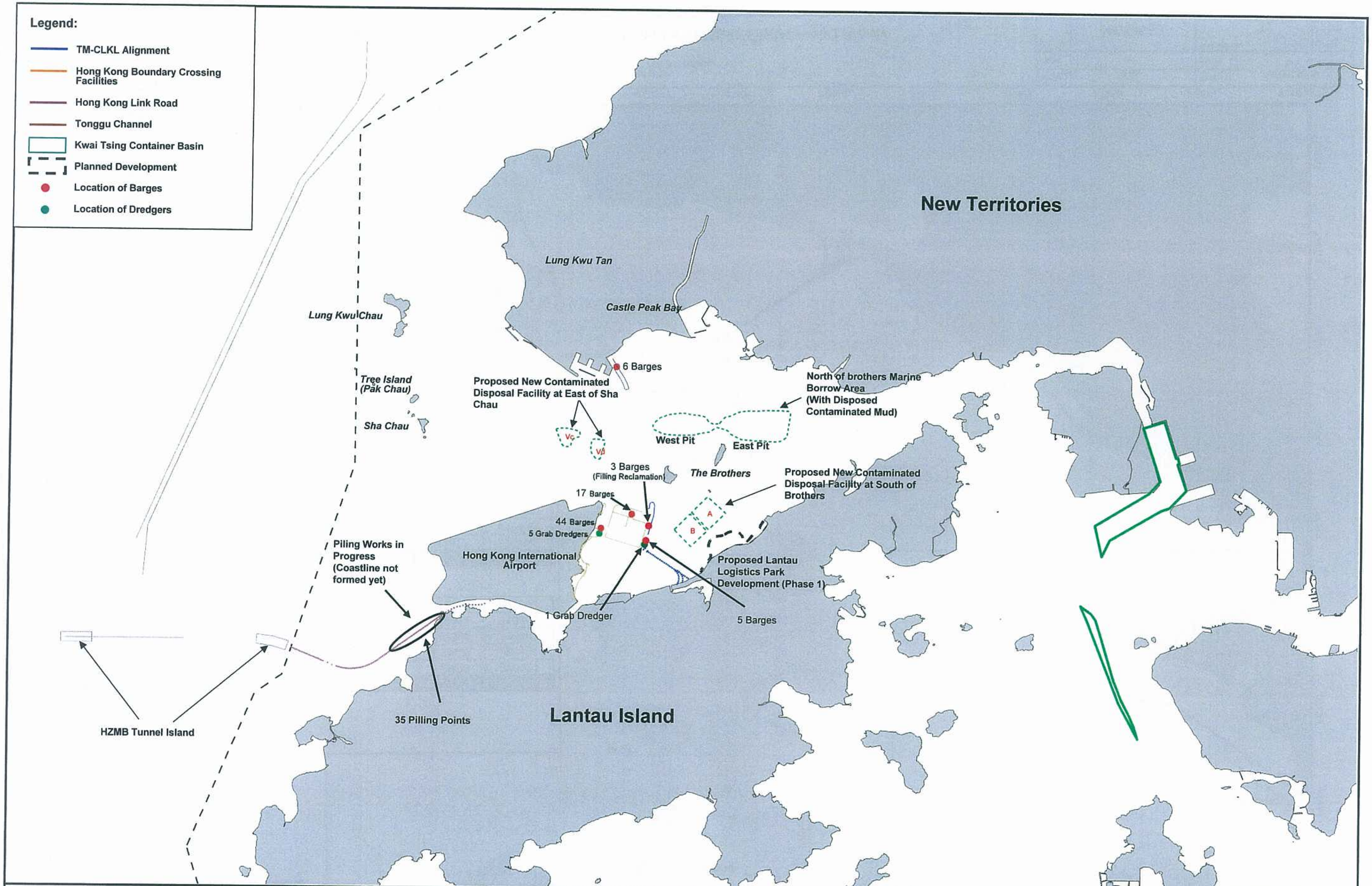

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AGREEMENT No. CE 52/2007 (HY)
TUEN MUN – CHECK LAP KOK LINK - INVESTIGATION

Assumed Coastline at 2013 with Marine Plants for TMCLKL+HKBCF+HKLR only

SHEET 1 OF 2

SCALE	NTS	DATE	FEB. 2009
CHECK		DRAWN	
JOB No.	60044963	DRAWING No.	31
		REV	

FILE:

Legend:

- TM-CLKL Alignment
- Hong Kong Boundary Crossing Facilities
- Hong Kong Link Road
- Project Layout
- Planned Development
- Location of Barges
- Location of Dredgers

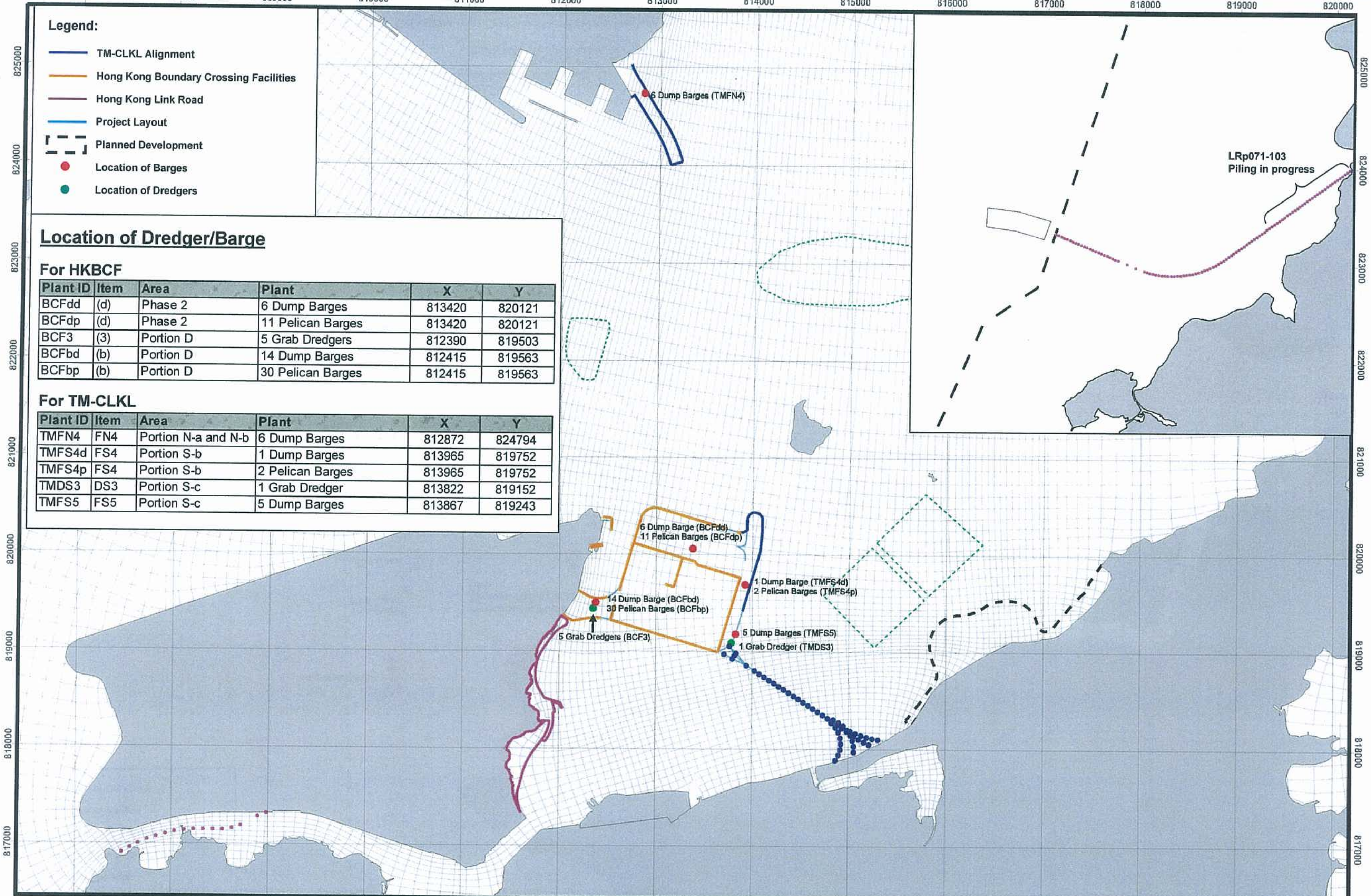
Location of Dredger/Barge

For HKBCF

Plant ID	Item	Area	Plant	X	Y
BCFdd	(d)	Phase 2	6 Dump Barges	813420	820121
BCFdp	(d)	Phase 2	11 Pelican Barges	813420	820121
BCF3	(3)	Portion D	5 Grab Dredgers	812390	819503
BCFbd	(b)	Portion D	14 Dump Barges	812415	819563
BCFbp	(b)	Portion D	30 Pelican Barges	812415	819563

For TM-CLKL

Plant ID	Item	Area	Plant	X	Y
TMFN4	FN4	Portion N-a and N-b	6 Dump Barges	812872	824794
TMFS4d	FS4	Portion S-b	1 Dump Barges	813965	819752
TMFS4p	FS4	Portion S-b	2 Pelican Barges	813965	819752
TMDS3	DS3	Portion S-c	1 Grab Dredger	813822	819152
TMFS5	FS5	Portion S-c	5 Dump Barges	813867	819243



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AGREEMENT NO. CE 52 / 2007 (HY)
TUEN MUN - CHEK LAP KOK LINK - INVESTIGATION

Assumed Coastline at 2013 with Marine Plants for TMCLKL+HKBCF+HKLR only

SHEET 1 OF 2

SCALE	NTS	DATE	MAY. 2009
CHECK	--	DRAWN	--
JOB No.	60044963	DRAWING No.	31
REV	--		

Plotting By: $DATE$
PLOT SCALE: $SCALE$HORTS
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Scenario No.	Year	Description	Purpose	Model Output	Concurrent Projects Included
Simulations of Tidal Flows (Wet and Dry Season Simulations)					
V1	Verification (2010)	Simulation of the Baseline (2010) Scenario using the original model grid before any grid refinement	To verify that the grid refinement has not changed the simulation of the large scale tidal flows	The model results (tidal levels, water velocities and salinity at selected locations and discharges across selected sections) will be compared with the Baseline Simulation (No. 1 below) to verify that the grid refinement has not modified large scale tidal flows	see No 1. below
V2	Verification (2010)	Repeat the Baseline (2010) Scenario using the refined model grid for successive 15 days simulaiton period.	To verify that the spin up and simulation periods are sufficient and results stabilised	The model results (tidal levels, water velocities and salinity at selected locations and discharges across selected sections) will be compared with the Baseline Simulation (No. 1 below) to verify that the model has stabilised	see No 1. below
1	2010	Baseline Scenario using the refined model grid	Baseline Scenario before construction of the TM-CLKL+HKBCF+HKLR	The model results will be compared with the Verification simulations	Tonggu Channel changed bathymetry, CMPs 2010, Cooling water discharges from Black Point, Castle Peak and Lamma Power Stations
2	Feb 2011	Simulation of the coastline and exrtent of seawall construction in February 2011	To provide the tidal flows for the simulation of the initial worst case dredging and filling scenario	The model results will be compared with the Verification simulation and will provide tidal flow fields for the sediment plume simulations for the TM-CLKL+HKBCF+HKLR plus all concurrent projects expected to begin construction or be underway in 2011	Tonggu Channel changed bathymetry, CMPs 2011, Kwai Tsing Basin changed bathymetry, Cooling water discharges from Black Point, Castle Peak and Lamma Power Stations, part seawall for Portion A of HKBCF, HZMB artificial islands
3	Apr 2012	Intermediate construction phase on bulk completion of the HKBCF Phase I in April 2012	Tidal flow fields required for assessment of the construciton impact of the intermediate phase of TM-CLKL+HKBCF+HKLR and all concurrent works in 2012.	Model results will provide tidal flow fields for the sediment plume simulations for the TM-CLKL+HKBCF+HKLR plus all concurrent projects expected to be under construction in this year at the time the Phase I works are finishing	Tonggu Channel changed bathymetry, CMPs at interim year, Kwai Tsing Basin changed bathymetry at 2012, Cooling water discharges from Black Point, Castle Peak and Lamma Power Stations, portion A, B and C and part phase II seawall for HKBCF, part TM-CLKL southern viaduct piers, seawall for southern nib and northern nib of northern and southern TM-CLKL reclamations respectively, Portion 1 and part of piers for HKLR, HZMB artifical islands, seawall for LLP 72ha.
4	Apr 2013	Simulation of the substantially completed TM-CLKL+ HKBCF+HKLR and concurrent works in April 2013 when works are nearing completion but potential sediment losses are still significant	Tidal flow fields required for assessment of the construciton impact of the nearly completed TM-CLKL+HKBCF+HKLR and all concurrent works in 2013.	Model results will provide tidal flow fields for the sediment plume simulations for the TM-CLKL+HKBCF+HKLR plus all concurrent projects expected to be under construction in this year at the time the Phase II works are finishing	Tonggu Channel changed bathymetry, CMPs at 2013, complete Kwai Tsing Basin changed bathymetry, Cooling water discharges from Black Point, Castle Peak and Lamma Power Stations, complete Phase I HKBCF, part complete Phase II reclamation and Portion D for HKBCF, complete northern reclamation for TM-CLKL, complete southern viaduct for TM-CLKL, complete reclamation for HKLR, part complete piers for HKLR, HZMB artificial islands, complete LLP 72ha
5	end 2026	Simulation of the completed TM-CLKL+HKBCF+HKLR and concurrent works including Road P1 in 2026	Tidal flow fields required for the assessment of the impact the completed TM-CLKL+HKBCF+HKLR compared to other concurrent works in completed 2026 has on tidal flows	Model results will provide the tidal flow fields required for the simulation of water quality on completion of the TM-CLKL+HKBCF+HKLR and all concurrent works in 2026	Tonggu Channel changed bathymetry, CMPs at 2016, complete Kwai Tsing Basin changed bathymetry, Cooling water discharges from Black Point, Castle Peak and Lamma Power Stations, complete HKBCF, complete TM-CLKL, complete HKLR, complete HZMB, LLP 72ha, LLP 40ha, Tung Chung East and West developments, Road P1 eastern section
6	end 2026	Simulation of the completed concurrent works including Road P1but <u>without</u> the TM-CLKL+HKBCF+HKLR	Tidal flow fields required for the assessment of the impact the completed concurrent works in 2026 has on tidal flows without the TM-CLKL+HKBCF+HKLR.	Model results will provide the tidal flow fields required for the simulation of water quality on completion of all concurrent works in 2026 without the TM-CLKL+HKBCF+HKLR	Tonggu Channel changed bathymetry, CMPs at 2016, complete Kwai Tsing Basin changed bathymetry, Cooling water discharges from Black Point, Castle Peak and Lamma Power Stations, complete HZMB, LLP 72ha, LLP 40ha, Tung Chung East and West developments, Road P1 eastern section
Simulations of Sediment Plumes (Wet and Dry Season Simulations) - Construction Impacts					**Notes**
P1	2011	Simulation of the start of construction of the TM-CLKL+HKBCF+HKLR together with all concurrent projects underway or beginning in 2011	To assess cumulative impacts on suspended solids concentrations arising from losses of fine sediment to suspension during the construction of the TM-CLKL+ HKBCF+HKLR and all other concurrent works in 2011	The model results (in terms of elevations in suspended solids concentrations and deposition rates) will be assessed with respect to the Water Quality Objectives and other water quality standards set for, for example, seawater intakes, marine life and deposition rates on coral sites. If the sediment to be dredged is contaminated, the model results will be interpreted in terms of the maximum contaminant concentrations in the water column and at the sensitive receivers.	These simulations will use the tidal flow model results from the Flow simulation No. 2 above and including sediment losses from concurrent projects listed above.
P2	2012	Simulation of the interim stages of construction of the TM-CLKL+HKBCF+HKLR Phase I together with all concurrent projects underway in 2012	To assess cumulative impacts on suspended solids concentrations arising from losses of fine sediment to suspension during the interim stages of construction of the TM-CLKL+ HKBCF+HKLR Phase I and all other concurrent works in 2012	same as P1	These simulations will use the tidal flow model results from the Flow simulation No. 3 above and including sediment losses from concurrent projects listed above.
P3	2013	Simulation of the interim stages of construction of the TM-CLKL+HKBCF+HKLR Phase II together with all concurrent projects underway in 2013	To assess cumulative impacts on suspended solids concentrations arising from losses of fine sediment to suspension during the interim stages of construction of the TM-CLKL+ HKBCF+HKLR Phase II and all other concurrent works in 2013	Same as P1	These simulations will use the tidal flow model results from the Flow simulation No. 4 above and including sediment losses from concurrent projects listed above.
P4	2011	Simulation of the start of construction of the TM-CLKL+HKBCF+HKLR in 2011	To assess impacts on suspended solids concentrations arising from losses of fine sediment to suspension during the construction of the TM-CLKL+ HKBCF+HKLR in 2011	Same as P1	Similar to Simulation P1, but the sediment losses from concurrent projects excluded.
P5	2012	Simulation of the interim stages of construction of the TM-CLKL+HKBCF+HKLR Phase I	To assess impacts on suspended solids concentrations arising from losses of fine sediment to suspension during the interim stages of construction of the TM-CLKL+ HKBCF+HKLR Phase I in 2012	same as P1	Similar to Simulation P2, but the sediment losses from concurrent projects excluded.
P6	2013	Simulation of the interim stages of construction of the TM-CLKL+HKBCF+HKLR Phase II	To assess impacts on suspended solids concentrations arising from losses of fine sediment to suspension during the interim stages of construction of the TM-CLKL+ HKBCF+HKLR Phase II in 2013	Same as P1	Similar to Simulation P3, but the sediment losses from concurrent projects excluded.
P7	2011	Simulation of the start of construction of the TM-CLKL+HKBCF+HKLR in 2011	Similar to P4, but with specific mitigation measures applied to lower the sediment losses.	Same as P1	Similar to Simulation P4, but the sediment losses from the project mitigated.
P8	2012	Simulation of the interim stages of construction of the TM-CLKL+HKBCF+HKLR Phase I	Similar to P5, but with specific mitigation measures applied to lower the sediment losses.	same as P1	Similar to Simulation P5, but the sediment losses from the project mitigated.
P9	2013	Simulation of the interim stages of construction of the TM-CLKL+HKBCF+HKLR Phase II	Similar to P6, but with specific mitigation measures applied to lower the sediment losses.	Same as P1	Similar to Simulation P6, but the sediment losses from the project mitigated.
Simulations of Marine Water Quality (Annual Simulations) - Operational Impacts					
WQ1	2026	Simulation of the completed TM-CLKL+HKBCF+ HKLR and all other concurrent projects in 2026	This simulation is required to determine future water quality patterns following completion of the TM-CLKL+ HKBCF+ HKLR and all expected concurrent works	The results from this simulation will be compared with the relevant Water Quality Objectives and other water quality standards which might apply. The results will also be compared with those from WQ2 below in order to assess the potential impacts from the completed TM-CLKL+HKBCF+HKLR on marine water quality.	
WQ2	2026	Simulation of the completed concurrent projects in 2026 but <u>without</u> the TM-CLKL+HKBCF+HKLR	This simulation is required to determine future water quality patterns assuming the TM-CLKL+HKBCF+ HKLR is not constructed	The results from this simulation will be compared with the relevant Water Quality Objectives and other water quality standards which might apply. The results will also be compared with those from WQ1 above in order to assess the potential impacts from the completed TM-CLKL+HKBCF+HKLR on marine water quality.	

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Summary of Proposed Simulations for Water Quality Modelling for the HKBCF, HKLR and TM-CLKL

SCALE	NTS	DATE	MAY. 2009		
CHECK		DRAWN			
JOB No.	60044963	DRAWING No.	32	REV	

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Item	Project	Construction Works Start	Construction Works End	Results of Liaison	Dredging/Filling Plant	Filling Plant	Working Day	Dredging Rate	Filling Rate	Dredging Losses[1]	Mitigated Dredging Losses[2]	Filling Losses[3]	Dredging/Filling Frequency	Filling Frequency	Dredging Locations	Filling Locations	Remarks
1	Lantau Logistics Park (LLP) - 72ha.	2010	2012	CEDD/HKIS (CR)/2/1/92 letter 26.9.08 to Arup gave the following information: Seawall dredging and filling would begin simultaneously from both the eastern and western ends of the seawall. At each end, 2 grabs and one barge would be used and dredging and filling would proceed concurrently. For each of the eastern and western seawalls, the following parameters would apply:	2 Closed Grabs (on each of east and west seawalls)	12 Barges of 800m³ (on each of east and west seawalls)	24 hours	204m³/hr for each of 4 grab dredgers (2 on each seawall)	9,600m³/day (12 barges of 800m³ on each seawall)	0.96kg/s/grab dredger	0.19kg/s/grab dredger	3,200kg/event (assuming barges of 800m³ capacity	Continuous (24-hours/day)	2-hourly for 12 filling events on each seawall	A, B, C, D	E, F	The dredging and filling locations have been selected to coincide with the final stages of construction when all 4 grab dredgers (2 on each half seawall) are closest together. It will be assumed that the grabs on each seawall are 300m apart and that filling proceeds 300m behind the closest grab.
2	Tonggu Channel	(completed)		This project has already been completed. Annual maintenance dredging is required in each of 3 Zones. Zone 1 is only dredged on a flood tide while Zone II is only dredged on an ebb tide. Zone III has no restriction on dredging times.	Zone I & II : 1 TSHD (4,375m³) III : 1 TSHD (6,250m³)		24 hours			Zone I : 14.6kg/s II : 14.6kg/s III : 12.1kg/s (1st 55 minutes) : 26.0kg/s (final 5 minutes)			Zone I : once per day II : twice per day III : twice per day	Zone I : 1x35 minute dredging period on flood tide II : 2x35 minute dredging periods on ebb tide separated by 205 minutes III : 2 60 minute dredging periods separated by 282 minutes during day time	Zone I : K II : L III : M		
3	Marine Borrow Pits - North of the Brothers	(re-opened by 2009)		CEDD's letter to the TMCLKL Consultant (Maunsell) dated 8.9.08 gave updated information on these facilities. The facility could be backfilled using Category L material at a maximum rate of 100,000m3/day or using Category M material at a maximum rate of 26,700m3/day. Assuming it is used for Category L material at 100,000m3/day is assumed to be the worst case with respect to sediment losses)		12 TSHD (6,000m³) and 5 barges (800m³) per day	24-hours		100,000m³/day			Losses per disposal event assuming the dry density of barge material is 750kg/m³ and the dry density of TSHD material is 556kg/m³ TSHD (5%): 222,400kg Barge (3%) : 18,000kg		TSHD :every 2hrs (beginning at 00:00 until 22:00) Barge: every 4 hrs (beginning at 05:00 until 21:00)		G	Include for Water Quality Impact Assessment, both operation (flow) and construction phases, based on: (a) CEDD's letter dated 8.9.08; (b) EIA report prepared under Consultancy CE 12/2002 which was already approved under the EIAO and is available from EPD's web-page.
4	Contaminated Mud-Pits - East of Sha Chau (IV)	mid 2010		CEDD's letter to the TMCLKL Consultant (Maunsell) dated 8.9.08 gave updated information on these facilities.		TSHD (4,500m³ dredging 3050m³ in-situ material per cycle) 23.375 barges of 800m³ capacity	24-hours		26,700m³/day (13,500m³/day from 3 TSHD, 13,200m³/day from 16.5 barges)			Losses per disposal event assuming the dry density of barge material is 750kg/m3 and the dry density of TSHD material is 556kg/m³ Barge (3%) : 18,000kg TSHD (5%) : 125,100kg		TSHD every 8 hours Barge every minutes 87		Q	Include for Water Quality Impact Assessment, both operation (flow)and construction phases, based on: (a) CEDD's letter dated 8.9.08; (b) EIA report prepared under Consultancy CE 12/2002 which was already approved under the EIAO and is available from EPD's web-page.
5	Contaminated Mud-Pits - Proposed East of Sha Chau (V)	(commence construction in 2009)		CEDD's letter to the TMCLKL Consultant (Maunsell) dated 8.9.08 gave updated information on these facilities.	2 Grab Dredgers	TSHD (4,500m³ dredging 3050m³ in-situ material per cycle) 23.375 barges of 800m³ capacity	24-hours	506m³/hour	26,700m³/day (13,500m³/day from 3 TSHD, 13,200m³/day from 16.5 barges)	2.8kg/s		Losses per disposal event assuming the dry density of barge material is 750kg/m3 and the dry density of TSHD material is 556kg/m³ Barge (3%) : 18,000kg TSHD (5%) : 125,100kg	Continuous	TSHD every 8 hours Barge every minutes 87	S J	S P R	Include for Water Quality Impact Assessment, both operation and construction phases, based on: (a) CEDD's letter dated 8.9.08; (b) EIA report prepared under Consultancy CE 12/2002 which was already approved under the EIAO and is available from EPD's web-page.
6	Contaminated Mud-Pits - South of Brothers	(commencement not later than 2011)		CEDD's letter to the TMCLKL Consultant (Maunsell) dated 8.9.08 gave updated information on these facilities.	2 Grab Dredgers	TSHD (4,500m³ dredging 3050m³ in-situ material per cycle) 23.375 barges of 800m³ capacity	24-hours		26,700m³/day (13,500m³/day from 3 TSHD, 13,200m³/day from 16.5 barges)	2.8kg/s		Losses per disposal event assuming the dry density of barge material is 750kg/m3 and the dry density of TSHD material is 556kg/m³ Barge (3%) : 18,000kg TSHD (5%) : 125,100kg	Continuous	TSHD every 8 hours Barge every minutes 87	O N		Include for Water Quality Impact Assessment, both operation (flow) and construction phases, based on: (a) CEDD's letter dated 8.9.08; (b) EIA report prepared under Consultancy CE 12/2002 which was already approved under the EIAO and is available from EPD's web-page.
7	Kwai Tsing Container Basin & Approach Channel	2010	2013	Enquiry has been made to CEDD (the proponent of this project) for relevant information.		1 TSHD (4,500m³)	8 hours	8,000m³/day		20.9 kg/s on each dredging period each lasting for 17 minutes			11.63 hours (2.62 cycles per day)		H, I		For the water quality assessment, the dredging activities of the basin will be included construction phase assessment and the dredged bathymetry will be included in the operational phase assessment. Excluded for all other aspects.
8	HZMB	2010	2014	Commencement : February 2011 Intermediate : April 2012 Final : April 2013	3 TSHD + 1 Grab Dredger 3 TSHD + 1 Grab Dredger 3 TSHD + 1 Grab Dredger	8 barges per island 8 barges 8 barges	Grab: 24 hr TSHD: 8 hr Barge: 24hr	47,400m³/day	6,400m³/day	TSHD: 28.2kg/s (10 ms)+31kg/s (60 ms) Grab: 1.44 kg/s/grab		3,200kg/event	TSHD: 2 cycles each at 4 hrs Grab: Continuous	3-hours (for 8 events)	T, U V X	T, U W Y	To be constructed concurrently with TMCLKL
9	TMCLKL	2011	2014	Commencement : February 2011 Intermediate : April 2012 Final : April 2013	See Tables 24 - 26 for details.												
10	HKBCF	2010	2013	Commencement : February 2011 Intermediate : April 2012 Final : April 2013													
11	HZMB HKLR	2011	2013	Commencement : February 2011 Intermediate : April 2012 Final : April 2013													

Notes:
1 Losses of sediment to suspension from grab dredging assumed to be 17kg/m³ dredged without mitigation
2 Cage type silt curtains will be used around the closed dedgers which is assumed to reduce losses by 80% (Reference 9)
3 Losses of fine material to suspension from filling are based on 5% of fill assumed to be fine (<63um) with 5% of fines being lost to suspension

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Summary of Modelling Activities for Concurrent Projects

SCALE	NTS	DATE	MAY. 2009
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