

## **APPENDIX II**

### **DREDGING RESEARCH LTD**

**SUSPENDED SEDIMENT DATA COLLECTION  
DRAFT REPORT ON THE FIRST TERRITORIAL SUSPENDED SEDIMENT SURVEY  
(AUGUST 1993)**

**Introduction**

**Discussion and Summary of Conclusions**

**Contoured Plans of Depth-averaged Solids Concentration**

DREDGING RESEARCH LIMITED



**STUDY AND MEASUREMENT OF  
DREDGED MATERIALS  
FILL MANAGEMENT STUDY**



**SUSPENDED SEDIMENT DATA COLLECTION  
DRAFT REPORT ON THE FIRST TERRITORIAL  
SUSPENDED SEDIMENT SURVEY (AUGUST 1993)**

FEBRUARY 1994

GEOTECHNICAL ENGINEERING OFFICE  
CIVIL ENGINEERING DEPARTMENT  
HONG KONG



AGREEMENT CE 2/93  
STUDY AND MEASUREMENT OF DREDGED MATERIALS

DRAFT REPORT ON FIRST TERRITORIAL SUSPENDED SEDIMENT SURVEY

1. INTRODUCTION

- 1.1 The work described in this report was carried out as a part of The Study and Measurement of Dredged Materials under Agreement CE 2/93. The Study comprises two main elements:
- A. The development of the Acoustic Doppler Current Profiler (ADCP) as a tool for the measurement of suspended solids in the water column;
  - B. Field measurements of suspended sediment intended to establish the effects of the extensive dredging and dredging material disposal operations which are now in progress.
- 1.2 Element A is essentially a research project during which field experiments and desk studies are being undertaken in order to establish a sound theoretical and practical basis for the use of ADCPs for measuring suspended solids. This part of the Study, whilst at an advanced stage, is still in progress. Much of the knowledge and experience gained since the commencement of the Study has yet to be fully reported and, even now, data interpretation procedures are still being refined.
- 1.3 There are two types of field measurement involved in second part of the Study:
- 1. Territorial Suspended Sediment Surveys: Very large surveys covering the greater part of the territorial waters which are intended to gather data at a coarse scale concerning the overall suspended sediment regime in Hong Kong .
  - 2. Focused Surveys: detailed surveys during which specific areas are investigated.
- 1.4 At the time of preparation of this report, focused surveys had been undertaken at the South Cheung Chau and East Ninepins marine disposal areas in June 1993 and in the West Po Toi marine borrow area in early December 1993. This report is concerned with the First Territorial Suspended Sediment Survey which was undertaken between 16th and 19th August 1993 during a period of spring tides. The survey was intended to gather data on the distribution of naturally-occurring suspended sediment in Hong Kong waters during the wet season and to identify, at a relatively coarse scale, disturbances of the natural sediment regime arising from the extensive dredging and dredged material disposal operations which were in progress at the time of the survey.
- 1.5 Some additional data relevant to the interpretation of the survey results have yet to be obtained. These include:
- a) details of the volumes of material placed in the marine disposal areas;
  - b) some detailed data concerning the movement of dredgers in marine borrow areas;
  - c) data from the Royal Observatory concerning weather conditions immediately before and during the survey;
  - d) historical measurements of suspended sediment made prior to the commencement of the major PADS dredging and reclamation projects.

These data will be included in the final report.

## 6. DISCUSSION AND SUMMARY OF CONCLUSIONS

### *Suspended Sediment*

- 6.1 The sediment survey has confirmed what has been known for many years about the general natural sediment regime in Hong Kong waters although it is the first time that such a large amount of data has been gathered over most of the territorial waters in such a short space of time. The survey clearly shows the influence of the Pearl River on solids concentrations in the wet season. At low tide large amounts of Pearl sediment are present in the waters north of Lantau and extend well into the Western Harbour. In addition, natural sediment from the Pearl is swept around the western end of Lantau towards, but not quite reaching, the South Cheung Chau disposal area. At high tide, the concentrations in the north-western and south-western waters are significantly lower.
- 6.2 Superimposed on the natural sediment regime are two types of feature:
- a) local elevations of sediment concentration which are clearly attributable to dredging and dredged material disposal;
  - b) apparent concentration elevations that are probably attributable to wave action and to discharges from sewers and storm drains.

*Disposal Areas*

- 6.3 Concentration elevations around the South Cheung Chau disposal area are noticeable but are restricted in magnitude and extent. A rather small area is affected and this accords with the findings of the Initial Survey at South Cheung Chau which was undertaken in June 1993 (Dredging Research Ltd., 1993 - C). No concentration elevations which can be attributed to the East Ninepins disposal area were observed but the closest survey line to the area was about 3 km to the west. A survey undertaken in the area in June 1993, when the amount of material being directed there was similarly small, showed almost no detectable increase of solids concentration.

*Dredging Areas*

- 6.4 The effects of dredging, rather than disposal, operations are generally more prominent but not in all cases. These are summarised below:

The New Airport at Chek Lap Kok

- 6.5 A considerable amount of dredging was in progress at the airport site itself (mud removal prior to filling) and at the East Sha Chau borrow area (overburden stripping). The effects of this can clearly be seen at high tide but sediment from the airport site was not detected at low tide.

North Lantau Development

- 6.6 The effects of the extensive dredging and filling operations along the north Lantau coastline, including dredging in the North of Lantau borrow area were not observed with the exception of a small area of elevated concentrations in the immediate vicinity of a working trailer at high tide. However, this is probably due to the fact that it was not possible to collect data in the relatively shallow water close to the North Lantau coastline.

Kap Shui Mun

- 6.7 The survey did not detect any elevated concentrations in the immediate vicinity of the borrow area but sediment from the area may have been carried south by the ebb tide towards Lamma Island where very high concentrations were observed.

West Po Toi

- 6.8 A large and clearly-defined sediment plume was observed at high tide which extended from the southern part of the borrow area as far as the southern end of East Lamma Channel. The area of the plume was approximately 30 km<sup>2</sup>. At low tide, a modest concentration elevation was observed in the immediate vicinity of Po Toi.

Tathong Channel

- 6.9 A very small, about 1 km<sup>2</sup>, area of modestly increased concentrations was observed near Tung Lung Chau where a small trailer was working.

East Tung Lung Chau

- 6.10 An area of about 20 - 25 km<sup>2</sup> of increased concentrations appears to be associated with dredging operations in this area but, except for the immediate vicinity of a working dredger, the concentrations were generally low.

- 6.11 Overall, it appears that a large proportion of the southeastern quadrant of the Territorial waters are affected by concentration increases which can rather clearly be associated with dredging operations. However, the depth-averaged concentrations are generally low and in the range 5 - 25 mg/l, only exceeding 25 mg/l very close to the dredging sites. Bearing in mind that a large proportion of this sediment will be concentrated near the seabed (see the backscatter profiles), this is not considered to be greatly significant. The increase should also be viewed in the light of the figure of 80 mg/l which, we understand, is the concentration which has tentatively been identified by EPD as being the maximum permissible concentration in mariculture areas.

*Other Features*

- 6.12 Of the other features observed during the survey, perhaps the most significant are the very high concentrations seen in the shallow waters of the southern and eastern coasts of Lantau. These are near-bed features which are interpreted to be due to wave action particularly at high tide when wave penetration would be expected to be greatest. The depth-averaged concentrations recorded in these areas are amongst the highest seen during the surveys. Surface run-off may also have contributed to this feature and will be checked against Royal Observatory records before compilation of the Final Report.
- 6.13 Concentrations in Victoria Harbour are generally elevated and this is likely to be mainly due to discharges from sewers and storm drains. The coincidence between the extent of the concentration elevations in the Harbour and in the Tathong Channel and the predicted extent of particulate effluent has already been discussed in 4.22 above. Whilst we do not know in quantitative terms how the ADCP responds to suspended particulate effluent, it appears quite probable that the greater part of the concentration elevation is due to this type of material. Examination of the high tide contour plot of depth-averaged solids concentration suggests that, if it were not for discharges into the Harbour, most of the area would exhibit concentrations of the order of 2.5 - 5.0 mg/l. Hydraulics Research Ltd. predicted particulate effluent concentrations in the range 5 - 15 mg/l with localised peaks in excess of 20 mg/l. Combining of these two figures gives concentrations very similar to those observed during this survey.
- 6.14 In addition, the aeration of the near-surface waters by marine traffic is likely to have resulted in apparent concentration elevations particularly in the area around Central, Wanchai and West Kowloon.

*Dissolved Oxygen*

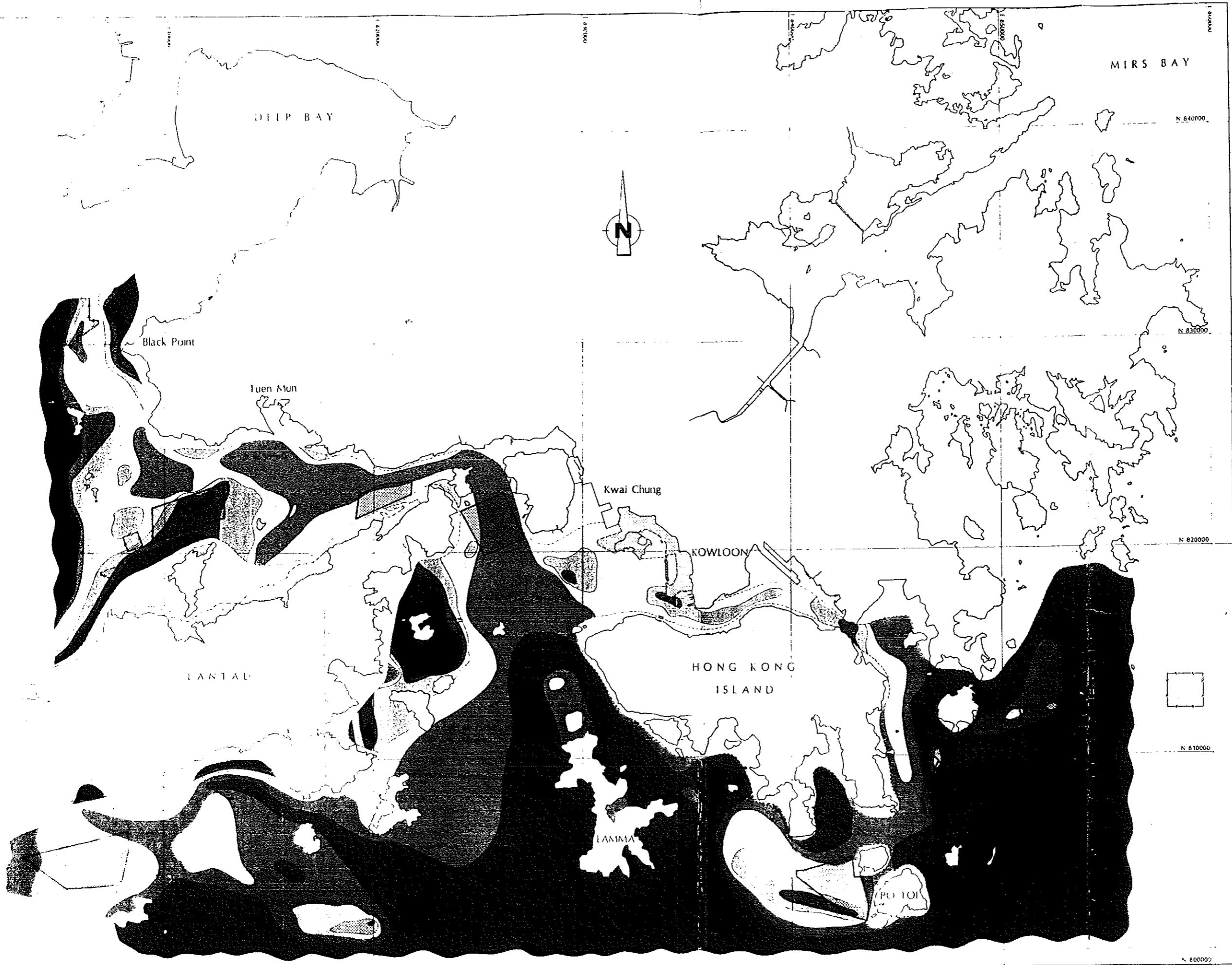
- 6.15 In general, it would be expected that with the exception of the surface water, the oceanic water entering Hong Kong from the east would have lower dissolved oxygen levels than those derived from the Pearl Estuary despite the demands which must be made of the Pearl River water. Superimposed on this regional pattern, it might be expected that the Harbour waters would exhibit relatively low oxygen levels in view of the large number of outfalls in the area and the continued discharge of raw sewage into the Harbour.
- 6.16 In broad terms, this is exactly what was observed but several features of the DO survey are notable and, perhaps, surprising. The most notable feature is the very low degree of saturation south of Lamma Island which was observed at both high and low tides. In this area, DO levels are distinctly lower than those measured in Victoria Harbour
- 6.17 The second feature of note is an apparent increase of DO levels in the vicinity of the South Cheung Chau disposal area. Although the amount of data is limited, it appears that the disposal area itself may be the cause of the DO increase, if only because of its coincidence with the disposal area and the apparent limited extent of increased DO levels. There is some indication that the DO elevations extend westwards from the area at high tide and eastwards at low tide. We would not expect the oxygen demand due to the sediment which is being placed at South Cheung Chau to be significant particularly

in view of the fact that the vast majority, at the time of the survey, was derived from the New Airport site and is therefore clean. However, an increase of DO is somewhat unexpected and may be due to the fact that much of the mud which was being dumped at the time had been dredged by trailer and is likely to have been thoroughly aerated. An additional possibility is the aeration due to the vessel wakes.

- 6.18 The apparent reduction of DO levels in the vicinity of the Chai Wan outfall may be due to the effluent discharge.

#### *Summary of Conclusions*

- 6.19 The surveys have demonstrated the following:
- a) the controlling influence of the sediment supply from the Pearl Estuary on the general sediment regime in Hong Kong's western waters,
  - b) that sediment concentrations are greatly elevated in the vicinity of the New Airport at high tide and this is probably due to a combination of the dredging operations at the site of the Airport itself and in the East Sha Chau marine borrow area;
  - c) that the effects of disposal at South Cheung Chau are limited in extent and magnitude; sediment concentrations are low except in the immediate vicinity of dumping operations; DO levels may actually be locally increased as a result of dumping;
  - d) that sediment concentration increases are associated with the dredging of sand at West Po Toi, mid-Tathong and East Tung Lung Chau,
  - e) that very high, apparently natural and predominantly near-bed concentrations exist at some states of the tide in the shallow water areas to the east and south of Lantau.
  - f) that effluent discharge into Victoria Harbour is probably responsible for an increase of solids concentrations of the order of 5 - 15 mg/l over the whole of the Harbour area. In some areas this figure might be significantly greater.
- 6.20 The conclusions which can be drawn from these surveys concerning the effects of dredging and dredging material disposal are clearly specific to the conditions at the time of the survey and the amount of dredging and disposal which was in progress at the time. Some additional data concerning these activities will be included in the Final Report.



NOTES

1. This plan presents the results of a territory-wide survey of suspended solids concentration. The survey was undertaken over a period of four days, each day being sailed within two hours of slack water.
2. The contours represent the depth-averaged suspended solids concentration within the area covered by the survey. It should be noted that the ADCPs used for this survey recorded data from about 2.7 metres below the sea surface to about 1 metre above seabed. In shallow waters, the depth-averaged concentrations therefore tend to be biased towards the lower part of the water column.
3. Due to the wide line spacing and the need to sail the survey using four boats over a period of four days during which conditions inevitably varied, the preparation of this plan has necessarily involved some data smoothing. Conditions between survey lines have been interpreted.
4. Refer to report text for a detailed explanation of the methods used and the limitations of this plan.

KEY

Depth-averaged suspended solids concentration

- Less than 2.5 mg/l
- 2.5 - 5.0 mg/l
- 5.0 - 10.0 mg/l
- 10 - 25 mg/l
- 25 - 50 mg/l
- 50 - 100 mg/l
- 100 - 250 mg/l
- Greater than 250 mg/l

Other features:

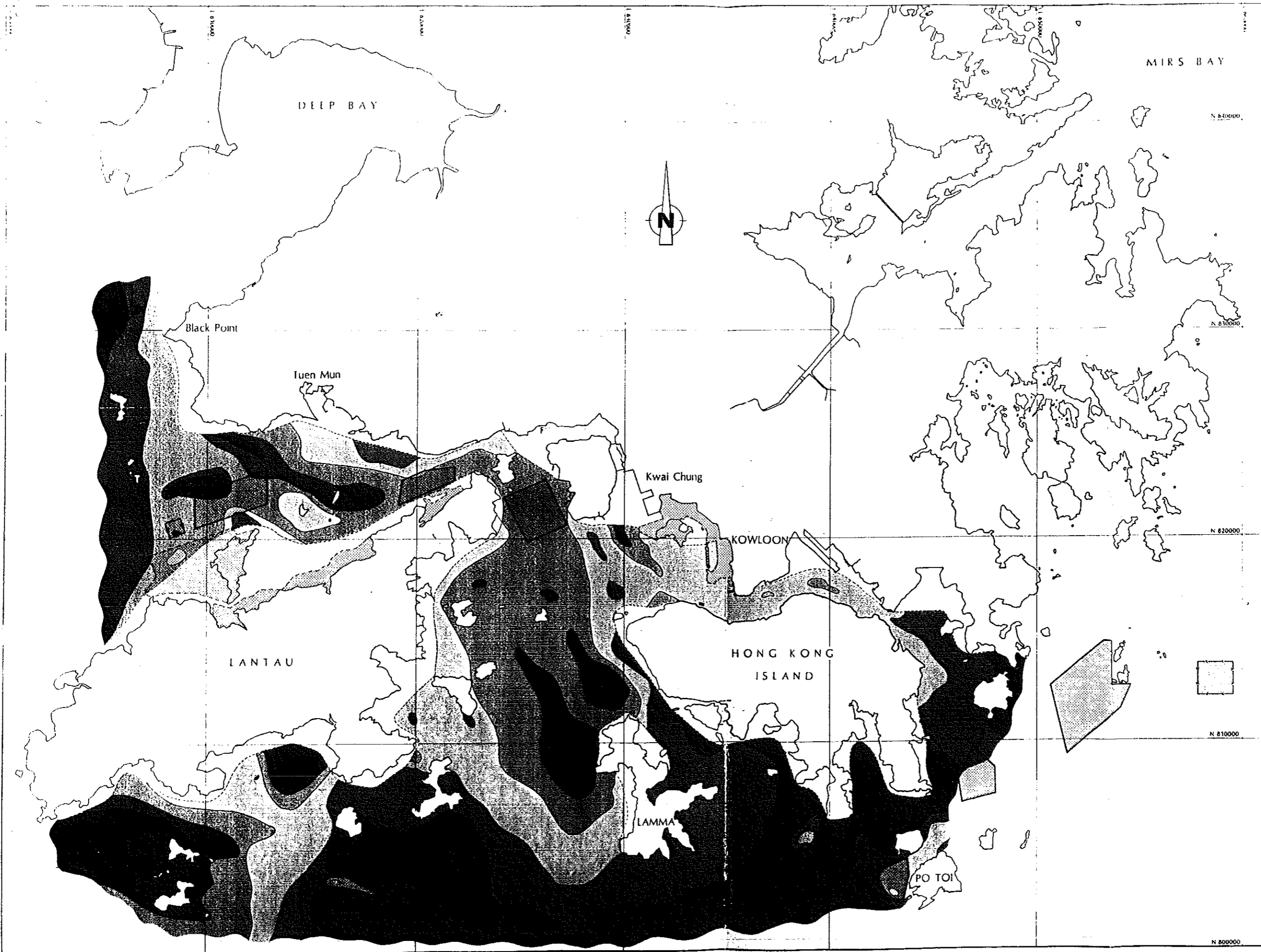
- Limit of data
- Marine borrow area
- Dredging/reclamation area
- Marine disposal area

DREDGING RESEARCH LIMITED

STUDY AND MEASUREMENT OF DREDGED MATERIALS  
FIRST TERRITORIAL SUSPENDED SOLIDS SURVEY  
PLAN OF DEPTH-AVERAGED SOLIDS CONCENTRATION  
SHEET 1  
HIGH SPRING TIDE 16/11 - 19/11 AUGUST 1995

GEOTECHNICAL ENGINEERING OFFICE  
CIVIL ENGINEERING DEPARTMENT  
HONG KONG





- NOTES
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  - 2 The contours represent the depth averaged suspended solids concentration within the area covered by the survey. It should be noted that the AEM's used for this survey recorded data from about 2.7 metres below the sea surface to about 1 metre above seabed. In shallow waters, the depth averaged concentrations therefore tend to be biased towards the lower part of the water column.
  - 3 Due to the wide line spacing and the need to sail the survey using four boats over a period of four days during which conditions inevitably varied, the preparation of this plan has necessarily involved some data smoothing. Conditions between survey lines have been interpreted. Refer to report text for a detailed explanation of the methods used and the limitations of this plan.

KEY

Depth averaged suspended solids concentration	
	Less than 2.5 mg/l
	2.5 - 5.0 mg/l
	5.0 - 10.0 mg/l
	10 - 25 mg/l
	25 - 50 mg/l
	50 - 100 mg/l
	100 - 250 mg/l
	Greater than 250 mg/l

Other features	
	Limit of data
	Marine borrow area
	Dredging/reclamation area
	Marine disposal area

DRILLING RESEARCH LIMITED

STUDY AND MEASUREMENT OF DRILLED MATERIAL  
 FIRST TERRITORIAL SUSPENDED SEDIMENT SURVEY  
 PLAN OF DEPTH-AVERAGED SOLIDS CONCENTRATION

SHEET 2  
 LOW SPRING TIDE: 16TH - 19TH AUGUST 1993

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