

環境影響評估—行政摘要  
Environmental Impact  
Assessment -  
Executive Summary

二零零零年五月  
May 2000

 土木工程署  
Civil Engineering Department

Agreement No CE 41/98

Tai O Sheltered Boat Anchorage  
Environmental and Drainage  
Impact Assessment

---

偉信顧問(香港)有限公司  
Scott Wilson (Hong Kong) Limited

環境影響評估—行政摘要  
Environmental Impact  
Assessment -  
Executive Summary

二零零零年五月  
May 2000

---

土力工程署  
Civil Engineering Department (CED)

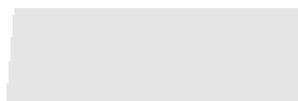
合約編號CE41/98  
Agreement NoCE41/98

大澳船隻碇泊保護區  
環境及渠道影響評估研究  
Tai O Sheltered Boat Anchorage  
Environmental and Drainage Impact  
Assessment

核實  
CHECK



黃耀東



YT Wor  
審批  
APPRO



Ander Chow

黃耀東(總監)

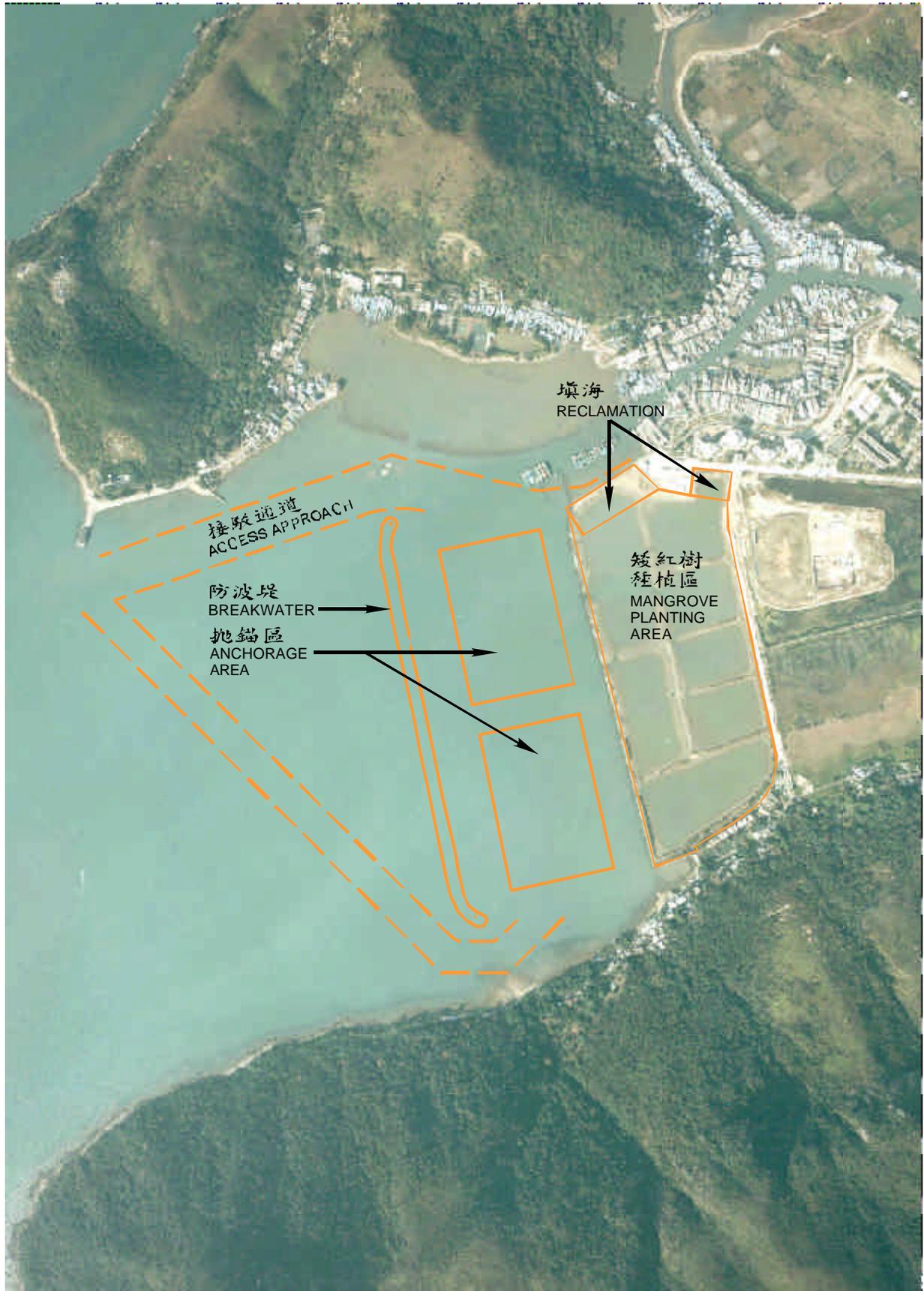
Ander Chow (總監)

周金松(總辦)

HongKongdesignoffice  
accredited by:



ISO9001:1994  
CertificationNo.CC213



擬建大澳船隻停泊區  
Proposed Tai O Sheltered Boat Anchorage

## 1. INTRODUCTION

### 1.1 Preamble

The Civil Engineering Department (CED) commissioned **Scott Wilson (Hong Kong) Ltd** in August 1998 to undertake Environmental and Drainage Impact Assessments for the Tai O Sheltered Boat Anchorage Study (Agreement No CE 41/98). This document presents an Executive Summary to the Environmental Impact Assessment (EIA) – Final Assessment Report (December 1999).

Located on the south-west coast of Lantau Island (refer to **Figure 1**), Tai O was formerly one of the largest fishing villages in Hong Kong and an historical base for fishing boats in the western approaches of Lantau Island and the Pearl River estuary. However, the importance of the fishing industry in Tai O has declined in recent decades, which has resulted in the erosion of its population base.

The proposal to develop a sheltered boat anchorage at Tai O has been under discussion for several years, and is widely seen as a means of reviving the town's local fishing industry and contributing to the revitalisation of Tai O. Given the potential benefits of the sheltered boat anchorage, the project is fully supported by the Islands Provisional District Board members. However, the project could not be implemented due to Territory boundary issues. These issues were resolved in July 1997 upon signing of the Memorandum of Understanding on setting the revised boundary between the Hong Kong Special Administrative Region (SAR) and Guangdong.

It has been decided to combine anchorage development with a mangrove restoration scheme. The construction of Chek Lap Kok airport and the associated developments on the northern shores of Lantau Island may result in the loss of 7 hectares (ha) of mangroves. As part of the New Airport Master Plan Study (1991), recommendations were made to provide a new mangrove habitat. The area investigated, and subsequently recommended by the Agriculture and Fisheries Department (AFD), comprised the Tai O salt pans, an intertidal area to the south of Tai O village (refer to **Figure 1**).

The integration of these two schemes will reduce their cumulative environmental impacts and has the potential to generate significant economic, social and environmental benefits to the Tai O community.

### 1.2 Description of the Project

The Tai O sheltered boat anchorage scheme comprises an 8ha anchorage for up to 220 vessels and a 1ha reclamation for boat back-up facilities. The proposed scheme is illustrated in **Figure 1**.

Construction of the anchorage is scheduled to begin in July 2001 and be completed in December 2003 – refer to **Figure 2** for the project construction programme. The anchorage scheme includes the following:

- construction of a breakwater (700m long), marker dolphins, public landings and other marine facilities;
- reclamation of 1ha of land, potentially for boat maintenance facilities and a loading/unloading area;
- dredging and disposal of marine mud to lower the seabed within the sheltered boat anchorage, the associated fairways/access approaches, the breakwater foundation and reclamation;
- seawall protection measures involving the construction of a sheet piling wall alongside the existing salt pan outer seawall (subject to confirmation during the detailed design); and
- associated engineering works to prepare for subsequent planting works to create a new mangrove habitat. The formation is proposed to be achieved by the addition of marine mud dredged from the adjacent boat anchorage.

Throughout the design of the anchorage, CED has aimed to minimise the dredging requirements. Prior to the initiation of this Study, CED anticipated that anchorage development would require dredging of 5.5Mm<sup>3</sup> of sediment. Through the adoption of innovative breakwater design techniques (e.g. the use of a partially dredged foundation), the volume of dredging required has been significantly reduced. It is currently estimated that approximately 2Mm<sup>3</sup> of dredged material will be generated during the works. The majority of this sediment will need to be disposed of off-site at controlled disposal sites, whilst approximately 20,000m<sup>3</sup> can be utilised "on-site" during the formation of the mangrove planting area.

Whilst the environmental impacts associated with formation of the mangrove planting area are covered by the EIA Study, the design and operational requirements of the mangrove habitat will be considered under a separate assignment by AFD.

## 2. APPROACH TO THE EIA STUDY

The EIA for the Tai O sheltered boat anchorage has been carried out in full accordance with the EIA Ordinance (Cap. 499) and the associated Technical Memorandum (EIA-TM).

Whilst there is much support for the project in principle, it has been identified that due to its nature, scale and location, the project has the potential to cause adverse environmental impacts. The EIA Ordinance sets out the legislative procedures to ensure that these potential impacts are identified, and where possible quantified, which then allows recommendations to be made such that adverse impacts can be mitigated to within acceptable levels.

The methodologies used for assessing the potential environmental impacts resulting from the construction and operation of the anchorage are as defined in the EIA-TM. Where relevant, modelling techniques have been used to predict future conditions. Such modelling techniques have been used locally and internationally and were discussed and agreed with the Environmental Protection Department (EPD) prior to being used. The accuracy of the modelling results will be tested and verified as part of an environmental monitoring and audit (EM&A) programme, as discussed below.

Consideration of the project's environmental implications began at the earliest stages of the project's inception through the preparation of a Project Profile by CED. The Project Profile provided an initial review of the potential environmental implications of the development, and was subsequently used by EPD to prepare the EIA Study Brief. The EIA Study Brief defined the scope of the environmental issues that needed to be addressed during this EIA Study, namely:

- construction noise impacts;
- water quality impacts during anchorage construction and operation;
- marine ecology impacts;
- fisheries impacts;
- impacts upon historical, archaeological and cultural heritage of the area;
- the requirement for a new Refuse Collection Point; and
- the EM&A requirements during project construction and operation.

The EIA has been carried out based upon a

Preliminary Design, as prepared by the Port Works Division of CED. Following completion of this EIA Study, the Preliminary Design will proceed to Detailed Design which will include contract documentation to enable anchorage construction.

The EIA Study has been undertaken in an iterative manner, in that preliminary design elements have been evaluated and where considered practicable and necessary, these have been revised to minimise the associated environmental impacts. In this regard, the EIA Study included an environmental evaluation of the preferred dredging techniques, methods of sediment disposal, construction plant requirements, and the definition of the requirements for the formation of the mangrove planting area. This iterative process has been facilitated through the provision of earlier submissions, namely the EIA - Initial Assessment Report and the EIA - Key Issues Report.

Following prediction and evaluation of the potential impacts caused by the preferred development option, environmental remedial measures have been recommended to address any unacceptable environmental impacts. These measures will be incorporated into the Detailed Design and where relevant, the construction contract clauses. The recommendations will also become conditions of the Environmental Permit (EP) for the Project, which will be issued to the proponent on endorsement of the EIA -Final Assessment Report.

All mitigation measures recommended by the EIA Study are supported by a programme of EM&A during anchorage construction and operation. Specific requirements for EM&A are presented in a stand alone EM&A Manual.

## 3. KEY FINDINGS OF THE EIA

The following sections summarise the key environmental investigations as undertaken during the EIA Study, and identify the significance of the impacts identified and the requirement for mitigation.

### 3.1 Noise Issues

Whilst the Tai O sheltered boat anchorage site is remote, there are some land uses such as schools and residential areas in the vicinity of the site that are sensitive to construction noise. These noise sensitive land uses include Lung Tin Estate, the Buddhist Fat Ho Memorial College and Nam Chung Tsuen – refer to **Figure 3**.

Noise generating activities will occur throughout the sheltered boat anchorage construction phase, the principal noise source being offshore dredging activities. The noise impact assessment has indicated that unless mitigated, construction activities have the potential to exceed acceptable standards for construction noise limits, as defined in the EIA-TM, at sensitive receivers closest to the works sites. Therefore, it has been necessary to design a strategy through which these noise impacts can be reduced to an acceptable level.

The noise mitigation strategy developed includes the use of quiet plant and the use of specialised noise barriers, although, the principal method of noise mitigation will be the control of the timing of certain tasks such that particularly noisy activities do not take place concurrently or during particularly sensitive periods (e.g. during school examinations).

Following implementation of the recommended noise mitigation strategy, residual noise impacts are predicted to meet the EIA-TM daytime noise criteria and thus adverse construction noise impacts are not anticipated to occur.

### 3.2 Sediment Issues

A key component of this Assignment has been the characterisation of sediment quality in Tai O Bay. This has been necessary in order to define environmentally acceptable methods of dredged sediment disposal, as well as an assessment of the acceptability of dredged material for mangrove habitat creation. In order to facilitate these assessments, comprehensive sediment quality surveys have been carried out in Tai O Bay with selected samples being submitted for targeted chemical and physical testing. The surveys also included the remote geophysical mapping of the bay.

The sediment testing programmes have indicated that the vast majority of the 2Mm<sup>3</sup> of material likely to be dredged to allow anchorage development is defined as “uncontaminated”. Such material is suitable for open marine disposal in exhausted marine borrow areas which are managed by CED. Following dredging, this material will be transported via barges to a specified disposal site. The final location for disposal will be determined during the Detailed Design in consultation with the Fill Management Committee of CED.

The sediment testing surveys did, however, indicate the occurrence of Class C contaminated material at

two discrete sites, although contamination was shown to be confined to the sediment’s surface horizon (i.e. 0 - 0.1 m). The volume of contaminated material anticipated to be generated during dredging in these areas has been estimated to be approximately 24,500m<sup>3</sup> (i.e. 1.2% of total dredged sediment volume). This small volume of contaminated material will need to be disposed of to the controlled disposal pit at East Sha Chau managed by CED.

Given that the sediment in Tai O Bay is predominantly uncontaminated, it is considered that the vast majority of the dredged material is wholly suitable for use as a mangrove planting substrate. Material from areas indicated to have contaminated sediment will not be used as a planting substrate.

### 3.3 Water Quality Issues

The creation of the sheltered boat anchorage has the potential to influence the water quality of Tai O Bay during both the construction and operational phases. Given that this is a key environmental issue, a comprehensive water quality modelling exercise has been carried out to predict impacts during these development phases. The water quality standards against which identified impacts have been assessed, are the defined Water Quality Objectives (WQOs) for the North Western Water Control Zone.

#### *Anchorage Construction Phase*

Dredging activities inevitably result in the disturbance of bottom sediments. The water quality modelling exercise undertaken illustrates that dredging will locally increase levels of suspended solids, especially within the inner parts of Tai O Bay. However, the observed elevations in suspended solids are not predicted to significantly impact upon sensitive receivers within the bay or in the upper reaches of Tai O Creek. Whilst dredging has the ability to generate sediment plumes, the modelling results indicate that the mean concentration of suspended solids outside the bay are below the relevant WQO. Whilst the dredging activities are not anticipated to significantly impact upon any identified sensitive receivers, appropriate dredging techniques have been specified together with restricted working methods to minimise the generation of sediment plumes. Other construction phase water quality impacts resulting from reclamation activities and reworking of the salt pan area, can be controlled through the adoption of appropriate working methods and construction

programming.

### **Anchorage Operational Phase**

During anchorage operation, the main water quality issue relates to the accumulation of pollutants within the anchorage area - especially pollutants associated with sewage effluents released from vessels and Tai O village. The water quality modelling exercise illustrates that whilst sewage discharges from vessels using the anchorage have the ability to impact upon water quality, sewage inputs from Tai O village and Nam Chung Tsuen (which currently are largely unsewered) are greater than those from the anchorage. Overall, despite local elevations of *E.coli* in the northern and southern parts of the anchorage during low and ebb tidal conditions, water quality impacts associated with the anchorage are not predicted to be significant and breaches of defined WQOs are not anticipated.

The EIA has indicated that water quality impacts during anchorage operation are not anticipated to significantly impact upon any identified sensitive receivers within Tai O Bay or Tai O Creek (including the mangrove habitat to be created in the salt pan area). The mangrove stands in the upper parts of Tai O Creek are routinely exposed to higher pollutant levels than those predicted to occur within the salt pan area without adverse effect. Nevertheless, methods to control the discharge of sewage effluents, boat bilge and litter in the anchorage have been proposed. Many of the mitigation measures proposed rely on the education and co-operation of anchorage users, as well as the strict enforcement of relevant water pollution control legislation.

### **3.4 Ecology Issues**

Construction and operation of the sheltered boat anchorage has the potential to affect the ecology of Tai O in two main areas, namely the offshore area designated for anchorage development (including a 1.3ha strip of seabed to be developed as the anchorage breakwater) and the 11ha intertidal salt pan area allocated for future mangrove planting (and 1ha of land to be reclaimed).

As part of this Assignment, detailed surveys have been carried out in order to characterise the existing ecological conditions at Tai O, and to enable the assessment of potential ecological impacts of anchorage construction/operation and reworking of the former salt pan area to form the mangrove restoration site.

Marine habitats in Tai O Bay support fauna typical of shallow, sub-tidal, muddy seabeds in Hong Kong. Surveys did not reveal any live species of conservation interest. Horseshoe crabs may occur in the subtidal zone of Tai O Bay, but breeding (which requires sandy beaches) has not been recorded at Tai O where soft shores are largely muddy. Whilst Chinese White dolphins do not normally frequent the shallow inner waters, limited numbers have been sighted in the outer parts of the bay area.

Surveys have highlighted that generally the Tai O area supports some habitats and species of flora and fauna that are of local and regional conservation importance. Most, however, are remote from the works area. Flora is generally scarce within the salt pan area, although scattered mangroves exist along elevated internal bunds. The salt pan area lacks a landward source of fresh water, and as such, the salt pan supports a typically intertidal marine fauna. Three species of herons and egrets have been observed to spend a small proportion of their foraging time in the intertidal zone of the salt pan area.

### **Anchorage Construction Phase**

Construction of the anchorage and approach channels would temporarily disrupt the soft seabed deposits over an area of 23ha. The findings of the ecological surveys indicate that no species of conservation interest would be significantly impacted. The benthic fauna of the dredged area is accustomed to turbid conditions and of low value, and is expected to recover soon after dredging has ceased. The residual impact of the temporary habitat loss of 22ha and the permanent loss of the 1.3ha strip of soft seabed at the site of the proposed breakwater is considered insignificant.

During dredging, a number of best practice techniques will be employed to ensure that water quality impacts are acceptable, thus preventing secondary impacts upon the surrounding subtidal ecology.

Whilst the habitats within the salt pan area are considered to have a low ecological value, reworking will inevitably impact upon the existing flora and fauna. Salt pan area reworking methods have been proposed which will allow the majority of the scattered valuable mangrove plants to be retained, whilst recommendations for construction programming have been made in order to minimise

the impacts associated with the temporary loss of the bird feeding habitat. The residual ecological impact caused by salt pan area reworking is considered to be insignificant and acceptable.

Other than the impacts highlighted above, no other important ecological resources would be significantly impacted during the construction phase, whilst all residual impacts have been found to be within acceptable limits. It should also be considered that whilst not a direct benefit of this project, the future creation of the mangrove planting area will result in an conservation benefit to the Tai O area as a whole.

### **Anchorage Operation Phase**

Accumulation of pollutants within the anchorage during its operation has the potential to impact upon nearby marine/estuarine habitats and organisms. However, the water quality modelling exercise has indicated that water quality within the anchorage is predicted to comply with most defined WQOs. This finding combined with the adoption of measures to control the discharge of sewage effluents and boat bilge should ensure that there are no significant impacts upon any identified ecological sensitive receivers – including the area's existing mangrove habitats and the mangroves to be planted in the salt pan area.

Impacts during any maintenance dredging events can be controlled to acceptable levels through the implementation of dredging and water quality protection measures as specified for the construction phase dredging event. As such, no residual ecological impacts are predicted following maintenance dredging.

Any boatyard operations on the proposed western reclamation would not pose a threat to the local flora or fauna given the requirement for effluent treatment. Thus no significant residual ecological impacts are predicted.

### **3.5 Fisheries Issues**

Whilst it is recognised that the fishing industry at Tai O has been in decline for a number of years, surveys and interviews with local fishers were carried out during the Assignment in order to fully characterise the existing situation. The fishery surveys illustrated that Tai O Bay and the salt pan area are not of key importance to fishers based in Tai O and as such the impacts to fisheries during anchorage construction and mangrove area preparation are predicted to be

minor. However, during project operation it is predicted that there will be major beneficial implications for the Tai O fishing industry due to the provision of a local boat anchorage. Creation of a large mangrove area may indirectly benefit the fishing industry given that the area may serve as a fish nursery where enhanced natural production and survival of fry and juveniles of commercial species will help sustain the recruitment of fishable stocks outside the mangrove area. Overall, the project is predicted to have a net positive impact upon Tai O fisheries.

### **3.6 Cultural Heritage Issues**

Tai O is known to have a rich cultural heritage. In addition to its fishery industry, from the 1800's Tai O was also a significant centre for salt production. The area proposed for the mangrove planting area is known to have been reclaimed from the sea after 1903 and functioned as a salt field for about fifty years. In 1969 - 1970 the area was bulldozed out to form a series of fish-traps which form the existing topography of the site. As such little remains of the site's original salt pan features – although of significant historical interest is the salt pan area's 1903 - 1904 outer seawall. Although very seriously damaged, the southern part of the outer seawall in front of Fan Kwai Tong Village survives in quite good condition and will be preserved as part of the mangrove-planting scheme (refer to **Figure 4**). It is recognised that the outer seawall is of local historical significance and as such breaches to the outer seawall to facilitate tidal flushing of the proposed mangrove habitat should be kept to an absolute minimum and should only be considered in areas where the seawall is already badly degraded and broken.

Given its coastal location, Tai O is of key importance in Hong Kong's maritime history. Shipping trade in the area dates back to the Qin (255-206 BC) and Han (206-220) periods, whilst during the Ming Dynasty (1368-1644) piracy was rife in the area. Desk studies indicated that given the recorded history of the area, the potential for off-shore archaeological relics warranted further investigation. As such, a preliminary geophysical survey was carried out in Tai O Bay in order to identify the occurrence of any large archaeological artefacts. Whilst no relics were identified during this survey, it has been agreed that a further, more detailed survey will be carried out during the Detailed Design to confirm these findings.

### 3.7 Refuse Collection

One of the key environmental issues facing Hong Kong is the control of litter, particularly that of floating refuse which is not only a pollution source, but also an aesthetic nuisance. The introduction of the sheltered boat anchorage will affect waste arisings in Tai O in two ways. Firstly, as the breakwater is designed to reduce water currents, any floating refuse in Tai O Bay will tend to accumulate within the anchorage. Secondly, the anchorage users are likely to generate domestic wastes that will need to be disposed of responsibly.

The potential for waste generation by the anchorage boat users has been predicted to be low. Nevertheless measures, such as the design of a segregated on-shore waste collection area (easily accessible to boat users) as well as provision of signs etc. to improve anchorage user education, may be implemented in order to reduce potential fly tipping overboard. In addition, recommendations have been made with regard to the control and collection of floating refuse within the anchorage – this includes the use of dedicated specialist waste collection vessels.

The EIA Study illustrates that waste generation volumes due to the sheltered boat anchorage development do not warrant a new Refuse Collection Point (RCP).

### 3.8 Environmental Monitoring and Audit

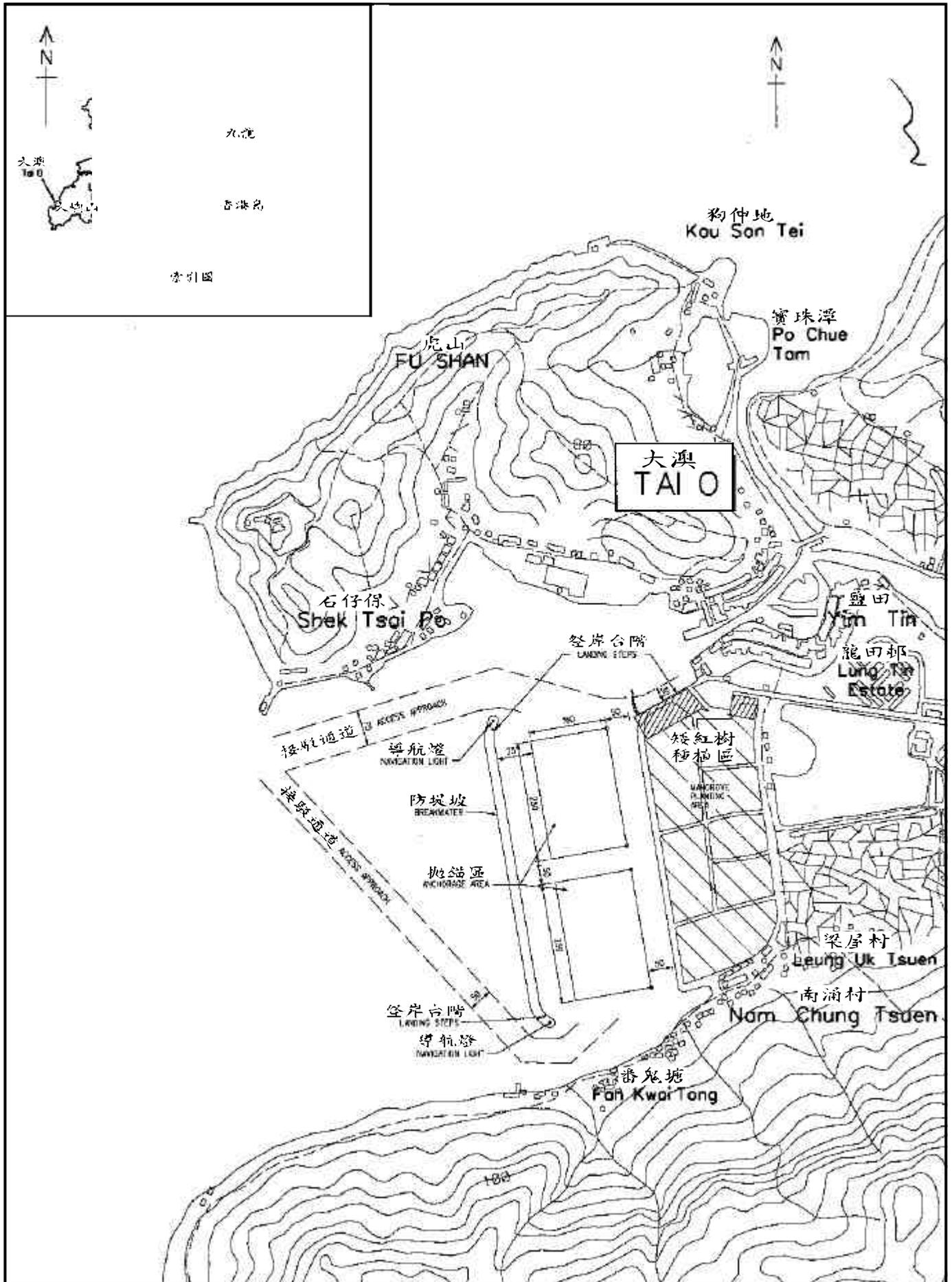
An EM&A programme will be implemented during the construction and operation of the anchorage - this will cover noise, water quality, ecology and cultural heritage. The programme has been designed to act as a mechanism to verify the predictions made in the EIA Study, but also to intercept any unforeseen adverse environmental impacts. In this regard, the EM&A Manual prepared for this development specifies “action” levels for various environmental parameters being monitored. These action levels are set below statutory limits; should these levels be breached, prompt remedial action can be taken to ensure that statutory limits are not exceeded.

## 4. CONCLUSIONS

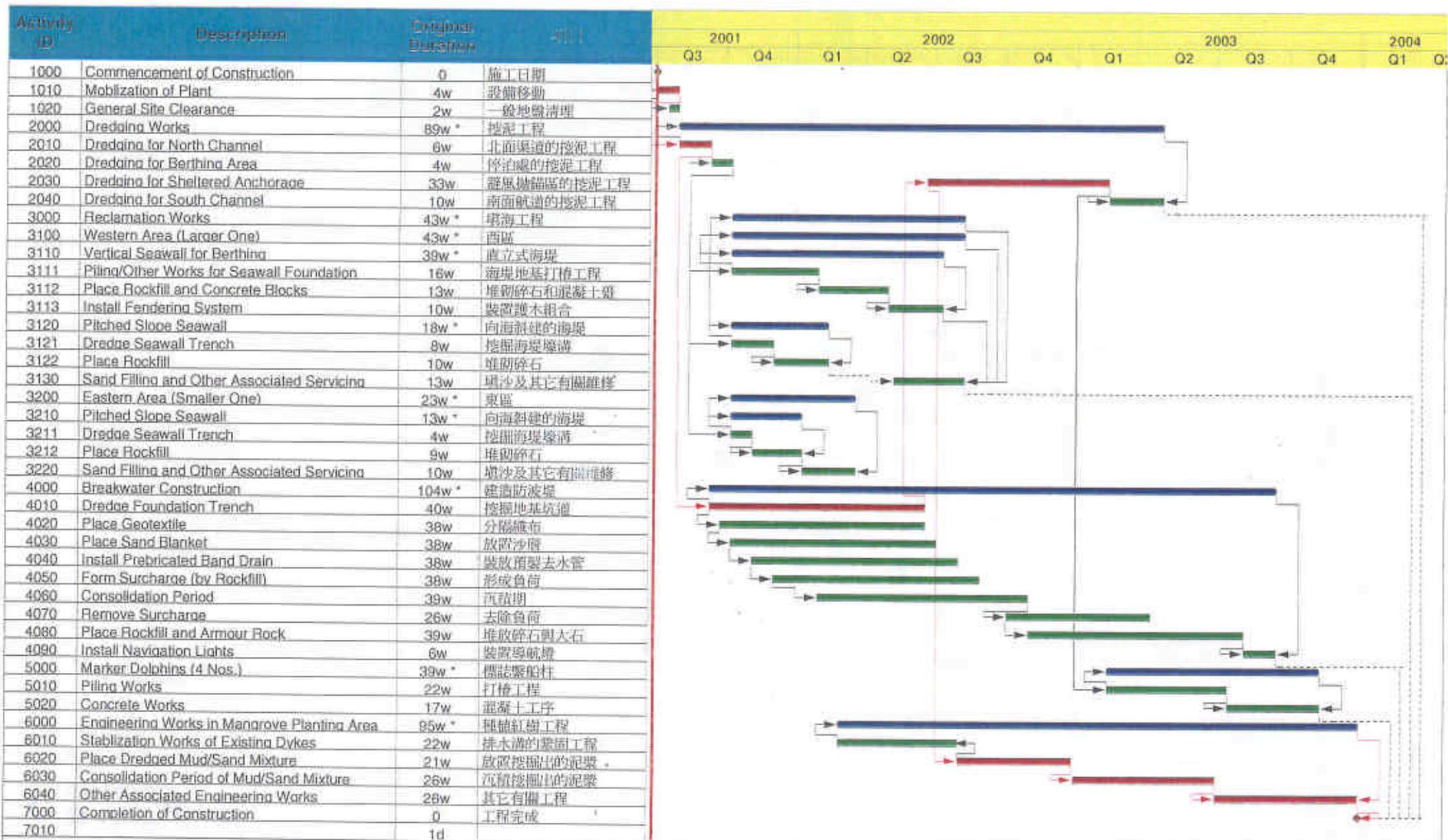
There has been longstanding support for the development of a sheltered boat anchorage at Tai O as it should provide economic and social benefits to the local community. The EIA Study has indicated

that whilst there is the potential for the occurrence of environmental impacts during the construction and operation of the anchorage, such impacts are not considered to be major or insurmountable and through the adoption of specified mitigation measures, residual impacts will be acceptable.

Whilst a number of areas surrounding the proposed development site are of ecological importance, much of the habitat affected by the proposals are of limited interest. Future development of the mangrove planting area will provide a new habitat of high ecological merit and will thus enhance the ecological value of the area as a whole. A secondary benefit of the mangrove planting area will be to provide an area for fish fry which, indirectly, may contribute to the fisheries potential of the area.



圖一 建議工作的全面設計  
 Figure 1 General Layout of Proposed Works



Start date	01JUL01
Finish date	31DEC03
Data date	01JUL01
Run date	07MAR00
Page number	1A
Primavera Systems, Inc.	

Figure 2

PWP Item No. 236CL  
 Tai O Development Package 4 Stage II  
 Tentative Construction Programme

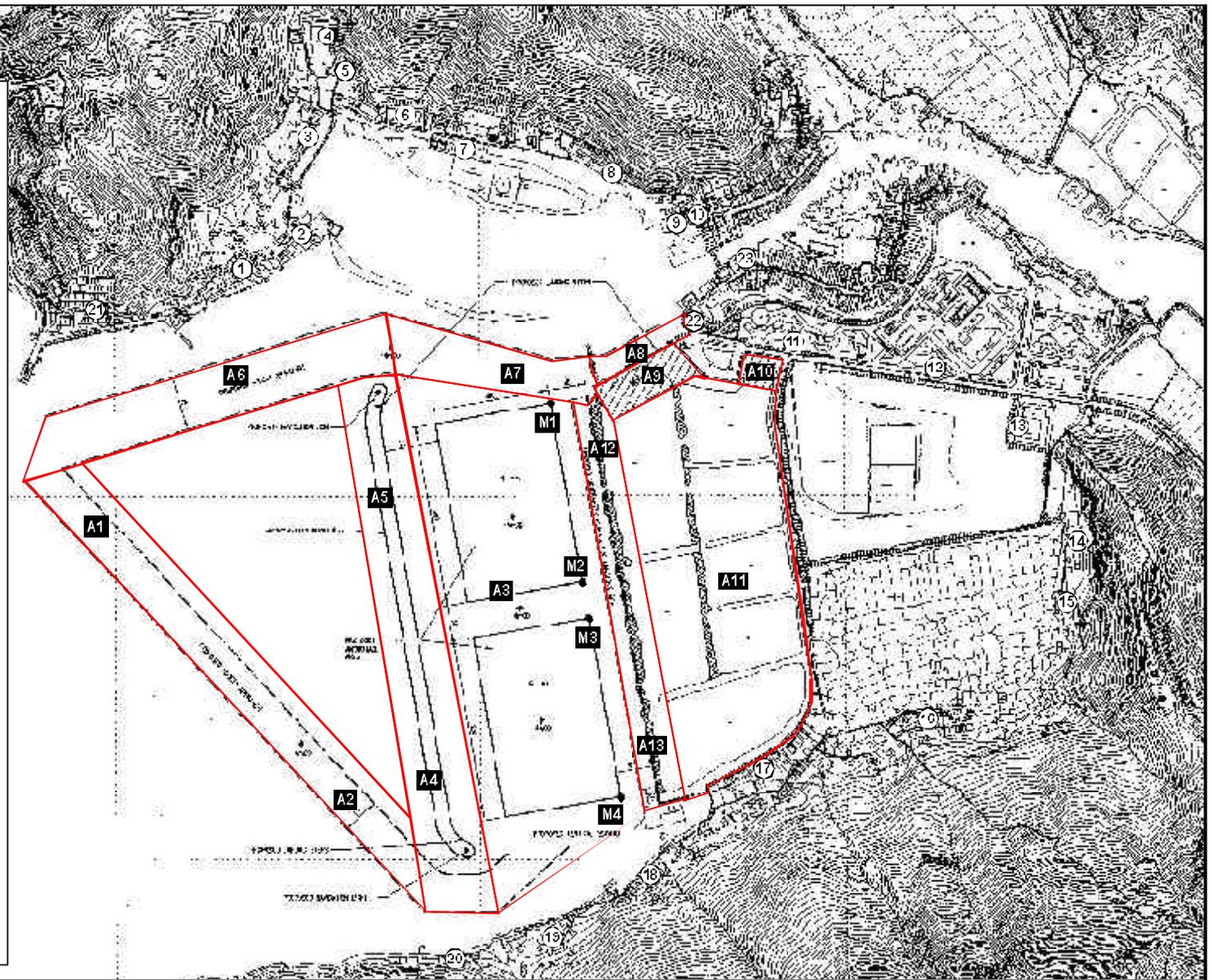
- Early bar
- Progress bar
- Critical bar
- Summary bar
- ◆ Start milestone point
- ◆ Finish milestone point

對噪音感應強的地方  
Noise Sensitive Receivers

- \* ① Village House in Shek Tsai Po
- ② Village House in Shek Tsai Po
- ③ Village House along Shek Tsai Po Street
- ④ 接近石仔沙學校  
School near Shek Tsai Po
- ⑤ Temple in Shek Tsai Po
- ⑥ 診所  
Clinic
- ⑦ 社區服務中心  
Community Centre
- ⑧ Village House
- \* ⑨ School
- ⑩ Church
- \* ⑪ 龍田村 2 期 B 區  
Lung Tin Estate Phase 2 Area B
- ⑫ Lung Tin Estate Phase 1
- ⑬ 佛慈慈可紀念中學  
Buddhist Fat Ho Members College near Tai O Road
- ⑭ Temple in San Tsuen
- ⑮ 鍾屋 / 新村  
Chung Uk / San Tsuen
- ⑯ 梁屋村  
Leung Uk Tsuen
- \* ⑰ 南涌村  
Nam Chung Tsuen
- ⑱ 南涌  
Nam Chung
- ⑲ 番鬼嶼  
Fan Kwai Tong
- \* ⑳ Village House
- ㉑ 警署  
Police Quarters
- ㉒ 村屋  
Village House
- ㉓ 村屋  
Village Housing

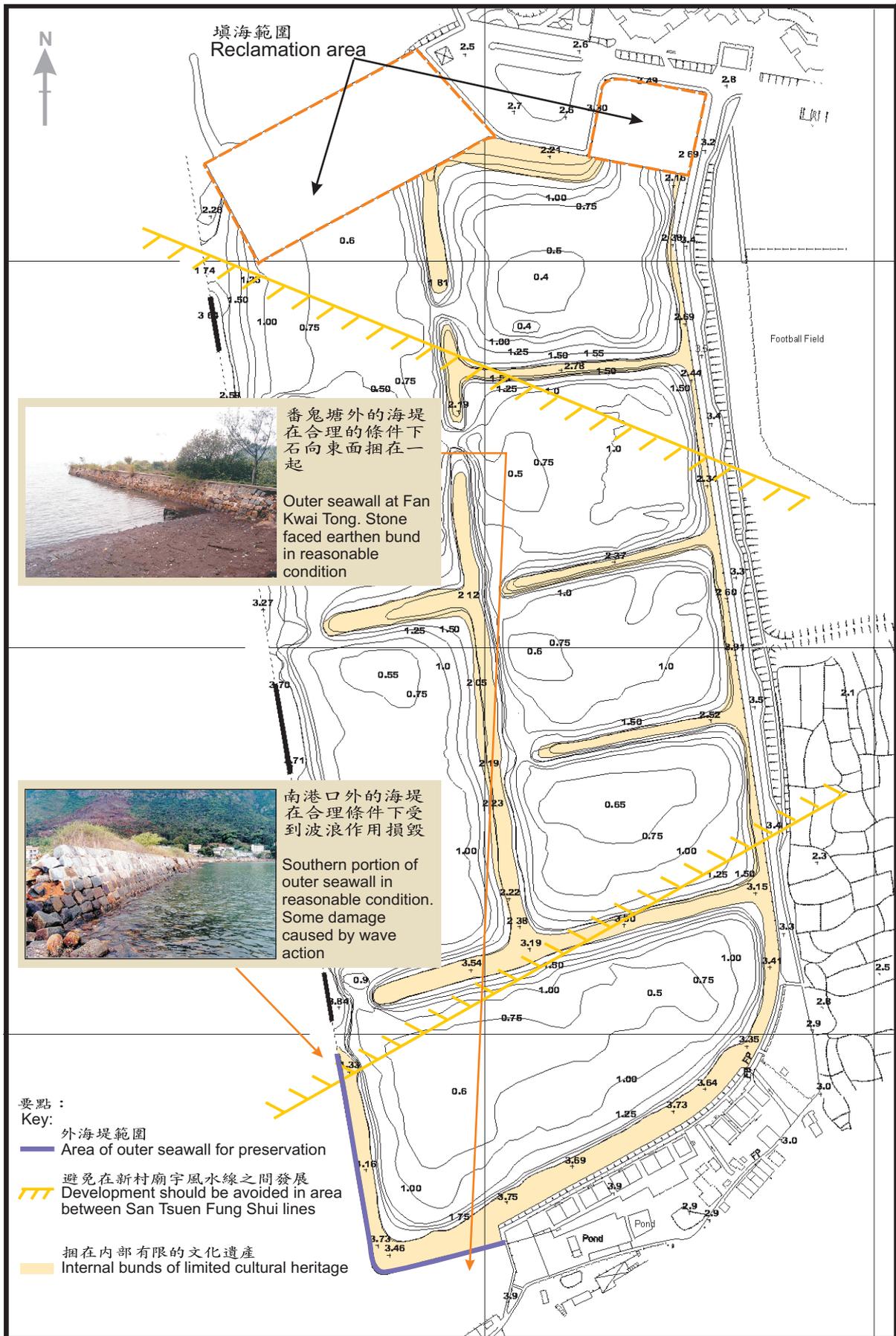
擬定基線噪音監察地方  
Proposed Baseline Noise Monitoring Locations

- A1 擬建工地  
Proposed Work Sites
- M1 繫船柱標誌  
Marker Dolphins



圖三：對噪音感應強的地方和擬建工地

Figure 3 Locations of Noise Sensitive Receivers and Proposed Work Sites



圖四：關注在鹽鍋的現存文化遺產  
Figure 4 Existing Cultural Heritage Interest of the Salt Pans