FINAL REPORT

CONSULTING SERVICES BY ENVIRONMENTAL RESOURCES MANAGEMENT

River Trade Terminal Company Limited

The River Trade Terminal at Tuen Mun Area 38 - EIA : *Final Report*

8 October 1996

ERM-Hong Kong, Ltd
6/F Hecny Tower
9 Chatham Road, Tsimshatsui
Kowloon, Hong Kong
Telephone (852) 2722 9700
Facsimile (852) 2723 5660

ERM

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8 October 1996

Reference C1469

For and on behalf of ERM-Hong Kong, Ltd

Approved by: [signature]

Position: Technical Director

Date: 8 October 1996

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1 INTRODUCTION

1.1 BACKGROUND

As sub-consultants to Scott Wilson Kirkpatrick (SWK), ERM-Hong Kong, Limited (ERM) has been commissioned by the River Trade Terminal Company Limited (RTTC), the successful tenderer for the development of the River Trade Terminal (RTT) to be located in Tuen Mun Area 38 as their environmental consultants. Government and the Advisory Council on the Environment (ACE) have previously accepted the Environmental Assessment Impact (EIA) of the *Reclamation and Servicing of Tuen Mun Area 38 for Special Industries,* as well as the *Expanded Development Study for the Tuen Mun Area 38* which included the impact of the RTT. ERM have now completed an environmental appraisal of the current design and general layout for the RTT (which does not differ significantly from the layout originally assessed) as it is intended to be constructed. This appraisal has particularly sought departure or differences arising from design development, which might adversely affect the EIA already accepted by Government and ACE.

As described above, the purpose of this EIA is to build upon the results of the previously endorsed studies which include:

- *Expanded Development Study for the Tuen Mun Area 38* (EDS) which initially addressed and confirmed the engineering and environmental feasibility of the Tuen Mun Area 38 development including the RTT (1990);

- *Reclamation and Servicing of Tuen Mun Area 38 for Special Industries EIA* (1994), hereafter referred to as the Tuen Mun Area 38 EIA, quantitatively assessed the special industrial area (SIA) and RTT developments as well as the reprovisioned Pillar Point long sea sewage outfall. The Tuen Mun Area 38 EIA concluded that both the SIA and RTT had been appropriately located in an environmentally non-sensitive area and that the environmental impacts would be kept within established environmental standards and guidelines. The EIA study also extensively modelled the reprovisioned Pillar Point long sea sewage outfall and confirmed the significant environmental improvements in terms of impacts on the bathing beaches in the vicinity of Tuen Mun, when compared with the existing short outfall. This Tuen Mun Area 38 EIA was endorsed by Government in December 1994 and ACE in 1995.

1.2 EIA SCOPE

The purpose of this EIA study is to deal with any design changes subsequent to previous EDS and Tuen Mun Area 38 EIA. The EIA for the River Trade Terminal should identify environmental impacts and mitigation necessary to ensure that the RTT construction and operation are kept within established environmental standards and guidelines and the findings of the previous EIA.

This EIA should also identify environmental improvements or benefits of the detailed RTT design brought about by involvement of environmental specialists in the RTT detailed design team.

1.3 *ENVIRONMENTAL IMPACT ASSESSMENT*

The first part of this EIA process for the RTT was the RTT Initial Environmental Impact Assessment (IEIA) submitted as part of the tender submission in February 1996. This RTT IEIA identified that the RTT layout was very similar to that quantitatively assessed in the previous endorsed studies, confirmed the previous studies conclusion with regard to the environmental acceptability of the RTT development and predicted no insurmountable or environmentally unacceptable impacts.

Since that time there has been on-going environmental input into the RTT detailed design (construction methodology, design layout and operational design).

It is important to note that the findings of this EIA are not intended to assess the overall environmental feasibility or acceptability of the RTT development at Tuen Mun as this has already been established and endorsed by Government and ACE previously in the Tuen Mun Area 38 EIA. This EIA will however, appraise the environmental consequence of any RTT detailed design proposals and identify mitigation if required to confer environmental acceptability of any such design changes.

1.4 *REQUIREMENTS OF THE EIA*

The EIA Study Team will meet these objectives by:

- carrying out the necessary background studies to identify, collect and analyse existing information relevant to the EIA study;
- carrying out any necessary environmental survey, site investigations and baseline monitoring work to achieve the objectives;
- quantifying, by use of models or other predictive methods, the residual and cumulative environmental impacts (specifying whether these are transient, long term and/or irreversible) arising from the construction, operation (and decommissioning) of the project;
- proposing practicable, effective and enforceable methods, measures and standards to effectively mitigate any significant environment impacts in the short and long term; and
- outlining a programme by which the environmental impacts of the project can be assessed, monitored and audited.

Consideration will also be given to beneficial and adverse effects, short and long term effects, secondary and induced effects, cumulative effects, synergistic effects and transboundary effects.

1.5 *STRUCTURE OF THE REPORT*

Following this introductory section, this EIA is organised as follows:

Section 1	Introduction
Section 2	Project Description
Section 3	Water Quality
Section 4	Air Quality
Section 5	Noise
Section 6	Solid Waste Management
Section 7	Ecology (Both Aquatic and Terrestrial)
Section 8	Landfill Gas
Section 9	Visual
Section 10	Conclusions

2 PROJECT DESCRIPTION

2.1 OBJECTIVES OF THE RTT

Successive Hong Kong Government planning studies, commencing with the original Port and Airport Development Strategy (PADS) Study in 1989, have recognised the importance of river trade, to and from the Pearl River Delta of the People's Republic of China (PRC), to Hong Kong's economy and the rapid growth that is now an established feature of the trade. Subsequent to PADS, the 1994 Freight Transport Study also identified problems associated with inefficient port operations, such as severe traffic congestion, as one of the six key issues encountered by the freight transport industry in Hong Kong. The RTT was therefore conceived as a means for dealing efficiently with the trade by providing specifically designed facilities.

The main objectives for the RTT are summarised as:

- to provide an efficient and reliable common river trade user facility;
- to make a major contribution to meeting the rapid growth of river trade;
- to reduce waterway congestion in the Ma Wan Channel and in Hong Kong Harbour; and
- to reduce road congestion on the Tuen Mun Highway and at border crossings.

The river trade is spread widely over many small tributaries and channels in the Pearl River Delta with the result that it is carried in a diverse fleet largely made up of small vessels which have both shallow water and air drafts. In time, with the growth of trade, the rapidly increasing penetration of containerisation and the development of land infrastructure in China, improvements to the fleet of vessels can be expected with larger carriers being introduced where possible. However, this will take time and it can therefore be confidently assumed the growth of river trade will lead to increased numbers of vessels in the short term.

Traditionally, river trade has been handled at a wide variety of waterfront facilities in Victoria Harbour which are often congested and do not lend themselves to containerisation or expansion. This results in a large number of small river vessels passing through the Ma Wan Channel to reach these facilities. The Ma Wan Channel is a narrow channel with a sharp bend, high tidal velocities and complex currents, which is further compounded by an increasing number of large ocean going vessels, and high speed ferries which pass through this channel. There is, therefore, growing concern about the capacity of this channel and the increasing risk of marine accidents, particularly due to the rise in the number of small, poorly disciplined river vessels using the channel.

The RTT is strategically located at the mouth of the Pearl River Delta (PRD) and will effectively act as a port of entry for these small river trade vessels as shown in *Figure 2.1a*. The RTT in Tuen Mun is designed to maximise the capacity of marine transport within the harbour of Hong Kong, to discourage the utilisation of Ma Wan Channel by large numbers of small river trade vessels and thereby reducing the risk of marine traffic accidents at the Ma Wan Channel. The RTT will be able to consolidate transhipment cargoes coming from the PRD by containerising a high proportion of transhipment breakbulk cargo and transport the cargo on to the main container port facilities which can be carried by sea in much larger and better controlled units than for the river trade, thereby reducing marine traffic in North West New Territory waters to the east of the RTT .

The operation of the RTT is also expected to ease the congestion problem currently encountered by the road transport network in Hong Kong by the use of large barges, each of which is capable of carrying a load equivalent to that of about 100 container lorries.

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- to reduce waterway congestion in the Ma Wan Channel and in Hong Kong Harbour; and
- to reduce road congestion on the Tuen Mun Highway and at border crossings.

2.2 *PROPOSED LAYOUT OF THE RTT*

2.2.1 *Proposed Layout*

The detailed design layout of the proposed RTT is shown in *Figure 2.2a*. The detailed design layout is very similar to the conceptual RTT layout proposal in the EDS Study (1990) and the Tuen Mun Area 38 EIA (1994) as shown in *Figure 2.2a* with the only change in design being the incorporation of a shorter length of breakwater which improves the design in terms of water quality.

2.2.2 *Internal Terminal Layout*

The concept of the internal terminal layout is shown on *Figure 2.2b* and a brief description of the main components are as follows:

Entrance for Containers - Gate 1

The main components of Gate 1 include:

- Gatehouse (60 x 20m)
- IN lanes: 1 through lane and 4 to 6 check lanes
- OUT lanes: 1 through lane and 6 to 8 check lanes
- Dual Purpose IN/OUT lanes: 2 check lanes

Container Lorry Park

The Container Lorry Park is located inside Gate 1, with echelon "drive through" parking bays for a total of 117 full size container tractor/trailer vehicles.

Entrance for Container Freight Station (CFS) and Bulk Handling Berths - Gate 2

- Gatehouse (60m x 20m)
- IN lanes: 1 through lane and 4 check lanes
- OUT lanes: 1 through lane and 5 check lanes

External Goods Vehicle Parking

There are 27 parking spaces for goods vehicles and containers outside Gate 2. These are primarily intended for vehicles which do not have the correct documentation.

Internal Goods Vehicle Parking

Adjacent to Gate 2 is an internal traffic goods vehicle park with echelon back-in parking for 100 breakbulk trucks and full size container vehicles.

For car parking there will be ample room adjacent to the CFS/Warehouse.

Operational Container Berths

A mixture of pontoon-based cranes, shore-based derrick cranes and shore-based mobile cranes are provided for loading and unloading operations at the berths.

Container Stacks

The 3 piers formed by the berth layout will be used for stacking containers using rubber tyred gantry (RTG) cranes. At this stage, the concept is to adopt the RTG stacks in a 6+1 configuration. Intermediate runways permit the transfer of RTG's from stack to stack. They also allow vehicles to exit or enter the stacks at their mid points.

Break Bulk Area

The break bulk area is at the west end of the lot where there is adequate protection to the relatively small vessels from westerly swells. The vessels at the quays will be serviced by either pontoon based cranes or similar but smaller land based cranes than deployed at the easterly berths which will generally handle containers. Three transit sheds, which have a proposed total area of about 30,000 m^2, are provided for stuffing operations.

CFS/Warehouse

This building will be sited in the northwestern corner of the RTT. Its CFS function will be to serve all LCL containers arriving at the RTT for onward transhipment as breakbulk cargo on river vessels. It will also deal with consolidation of containerised cargo.

The ground floor of the building will house the CFS function over the maximum permitted plot area of 20,000 m^2. Three upper floors will be used for transit cargo and warehousing, giving a total storage area of approximately 60,000 m^2.

Terminal Service Road

A 4-lane (16m) road will connect all operational areas of the terminal. For maximum flexibility it will have no fixed kerbs but will be delineated by a combination of painted lines and portable kerb blocks which will also be used to separate the traffic flows.

The road can be reduced to 11m along the west seawall breakwater and east seawall, and to 7.3m adjacent to the Government Berths.

Government Buildings

For which specifications have been provided will be constructed at the eastern end of the berth

Fuelling Station, Waste Management Site and Workshops

The RTT will also include a marine and land based fuelling station, a waste management site as well as permenant and temporary workshops. These are shown in *Figure 2.2b*.

2.3 RTT CONSTRUCTION

2.3.1 *Entrusted Works*

The RTT construction scope and programme also includes the construction of Government entrusted works which includes the reprovisioned Pillar Point long sea sewage outfall and the box culvert located at the western end of the RTT site. The environmental acceptability of a reprovisioned outfall and culvert have been previously assessed in the Tuen Mun Area 38 EIA, accepted by Government and ACE. Government will subsequently be responsible for the environmental monitoring and operation of the reprovisioned outfall under the EPD *Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall Study.*

2.3.2 *Construction Programme*

A construction programme is attached as *Figure 2.3a*. The construction programme has been divided into 2 phases to reflect the land grant requirements to have part of the terminal operational within 2 years. No work will start until a dumping location is confirmed by Fill Management Committee and a permit for dredged material disposal is issued by EPD and after the required one - month baseline environmental monitoring has been completed.

2.3.3 *Phased Development*

The phasing of the site is shown on *Figure 2.3b*. Phase 1 development will combine both container and break bulk operations on site designed principally for dedicated container operations at the final development stage. The planning team will therefore have to optimise the break bulk operations to reduce the cost of the later change to a fully container orientated system.

The planning team will also have to accommodate some Phase 2 construction operations within their development planning. In order to deal with construction issues in the most efficient way the contractor will liaise closely with the planning team.

It is envisaged that the break bulk operation will be temporarily located on the west end of the Phase 1 site. A temporary demountable transit shed will be deployed for stuffing and unstuffing of containers. This shed will occupy the site intended for RTG stacks at the final development stage.

As detailed in the construction programme, Phase 2 will be the remaining part of the construction activities. Although most construction material supplies for Phase 2 can be made through Gate 2, a site road between Phase 1 and 2 will be an advantage during and after completion of the construction. During construction, it will allow movement of plant and personnel between the phases of the site without the necessity of entering the public highway. After construction of Phase 2, the break bulk facility will be relocated to the western half of the site. The site road through the central Phase 2 area will then be required for the operational interfacing of the container and break bulk operations.
The temporary transit shed for Phase 2 will be reassembled. The other transit sheds will be planned and developed as cargo throughput increases.
The central part of Phase 2 will be the last stage of the works to be completed. The replacement outfall and the breakwater construction will require the careful control of marine operations and navigation channels. Vehicles bringing construction material supplies will have to cross the cargo vehicles transmitting between Phase 1 and Phase 2 areas. The planners will have to develop marine and land traffic systems which minimise downtime and do not generate queues of vehicles or vessels.

2.3.4 *Dredging*

In order to minimise the dredging quantities, and in particular the quantities of contaminated mud, dredging will only be undertaken to achieve the minimum navigation depth and ensure the stability of marine structures such as quay walls, breakwaters and along the alignment of the replacement box culvert and reprovisioned outfall. The results of the site investigation has established that a total of around 3,300,000m^3 of marine mud will have to be removed of which 200,000m^3 will be contaminated mud. Contaminated mud is to be disposed of at East Sha Chau, into the specially dredged site under strictly enforced and monitored conditions.

2.3.5 *Breakwater*

The EDS Report recommended the provision of a rock armoured embankment as the design for the breakwater. This is a standard design and has the advantage of destroying most of the wave energy rather than reflecting it in the manner of a vertical breakwater.

The primary function of the breakwater is to protect the vessels it shelters from extreme typhoon events. Preliminary calculations show the main armour requirement as two layers of 6 tonne rock. Model testing has been undertaken and the optimum breakwater layout is shown in *Figure 2.2a*. Slightly larger rock may be required at the breakwater returns if they are exposed to the most critical wave directions. Alternatively special interlocking concrete armour units, such as accropodes, can be deployed. These units have been recently placed on the Macau Airport platform embankment.

2.3.6 *Filling*

Determining the source of the reclamation filling will primarily be the responsibility of the Contractor. For filling to levels below Mean High Water Springs, the most likely source is dredged sand. The dredged sand is likely to come from China. However, a maximum fines content of fill material of 20% has been specified in the RTT Contract documents as a mitigation measure to reduce water quality impacts.

Consolidation of underlying marine mud will be accelerated by the introduction of vertical band drains through the soft strata from an accessible level in the overlying filling. Further acceleration will be achieved by surcharging the reclamation above formulation levels. Settlements will be monitored and surcharge heights and durations revised in order to induce adequate long term consolidation before the paving is laid.

2.3.7 *Construction Phasing and Phase-Specific Activities*

The RTT construction will be carried out on 3 main fronts simultaneously and these during Phases 1 and 2 of the site shown in *Figure 2.3b*. The work is being undertaken in this fashion in order to meet the two specified completion dates, namely, having a cargo capacity of 2,100,000 tonnes within 36 months of award and a full terminal capacity of 8,500,000 tonnes by the project completion date 54 months from award.

The construction programme has therefore been divided into 2 phases, but it should be remembered that work will be carried out in three main areas of the site simultaneously in order to meet the required completion dates. The eastern Phase 1 contains only a 1-4m layer of marine mud so removal of mud or consolidation will not be a major issue. In contrast, the western portion of the site contains mud layers up to 14m thick and will require major treatment and consolidation time. The central portion is the site of the new sewage outfall and work in this area will not be undertaken until the outfall is well underway.

Key parameters for each of the four main phases are presented in *Table 2.3a* below:

Table 2.3a *Key Parameters for RTT Construction*

Parameter	Phase 1	Phase 2	Breakwater	Sewage Outfall
Area (ha)	22	43	5	-
Dredging Required (m^3)	269,000	2,114,400	540,200	377,000
Rockfill Required (m^3)	550,000	1,140,000	500,000	200,000
Sandfill Required (m^3)	3,480,000	7,200,000	540,000	-
Rate of Dredging (m^3/month)	100,000	100,000	100,000	100,000
Rate of Rockfilling (m^3/week)	12,000	25,000	20,000	10,000
Rate of Sandfilling (m^3/week)	100,000	80,000	50,000	-

Phase 1

Relocation of the drainage channel which straddles the proposed entrance and dredging to allow construction of vertical seawalls are the first tasks to be undertaken. Construction of the seawalls will start when dredging is complete.

The permanent sloping seawall on the eastern edge may be constructed by end tipping from road vehicles and the vertical seawalls and their foundations will be constructed by marine plant. Once a sufficient area is bounded then reclamation can be undertaken. It is expected that bottom dumped barges from China will be used as they will not have passage restricted by the Ma Wan Channel and the fill will be supplied by the contractors' own source. Following reclamation, ground treatment, paving, drainage and E&M installations can be made. The buildings have been planned to start after the completion of ground treatment and these refer principally to offices for Customs, Fire Services and Immigration that are required before the site can become operational. At this stage the option remains open for the consortium to operate this first phase using either permanent or temporary buildings. This will be quantified upon submission of the Master Layout plan 1 year after the award of the franchise to build and operate the RTT. These events follow a largely sequential process and lead to a completion of Phase 1 by 31 July 1998.

Phase 2

In order to meet the project deadlines this Phase will need to proceed in parallel with the work for Phase 1. The first activity after approvals have been obtained will be dredging for the twin-cell box culvert requiring 600,000 m^3 to be dredged. This culvert, which bounds the western edge of the site, is required to be complete by 30 September 1997. The trench will be backfilled upon completion of the dredging and construction of the culvert will then take place.

The programme assumes that dredging in Phases 1 and 2 will be concurrent but filling will be sequential.

When sufficient seawall is available to bound the site area, reclamation will commence. Reclamation will be completed shortly after the seawalls are complete. Ground treatment will then follow the reclamation. A minimum 6 month period has been allowed for this phase because deep mud layers of up to 14 m are present in the north west corner of Phase 2.

Following completion of the ground treatment a 6 month period has been allowed for the paving, drainage and E&M works.

After completion of the outfall dredging requiring 500,000m^3 of sediment to be dredged, construction of the outfall itself will proceed largely independently. It is possible that this will be undertaken by a separate subcontractor experienced in this work. This is defined as a single activity in the programme but will include the establishment and operation of the casting yard, the provision of access between Phase 1 and 2 of the site, establishment of the launching area, the pipe pulling and placement and subsequent protection. This work will be completed by 30 May 1998 after which work in Phase 2 will concentrate on the seawalls and reclamation of that phase.

The CFS and many of the permanent buildings will be finished along with Phase 2. That is, it is anticipated that other than Government buildings the RTT will initially operate using temporary buildings until the bulk of the site is complete and room is available for the completion of the permanent buildings. All permanent buildings will be finished within the 54 month project timescale.

2.4 RTT OPERATION

Major operations for the RTT will include the following:

- customs and immigration checks;
- handling of breakbulk cargo with electrically operated derrick or gantry cranes and pontoon-based cranes;

- stuffing and unstuffing of containers;
- loading and unloading of containers with a mixture pontoon-based cranes and shore-based derrick cranes or shore-based gantry cranes;
- stacking and transfer of containers with rubber tyred gantry cranes; and
- warehousing of cargo.

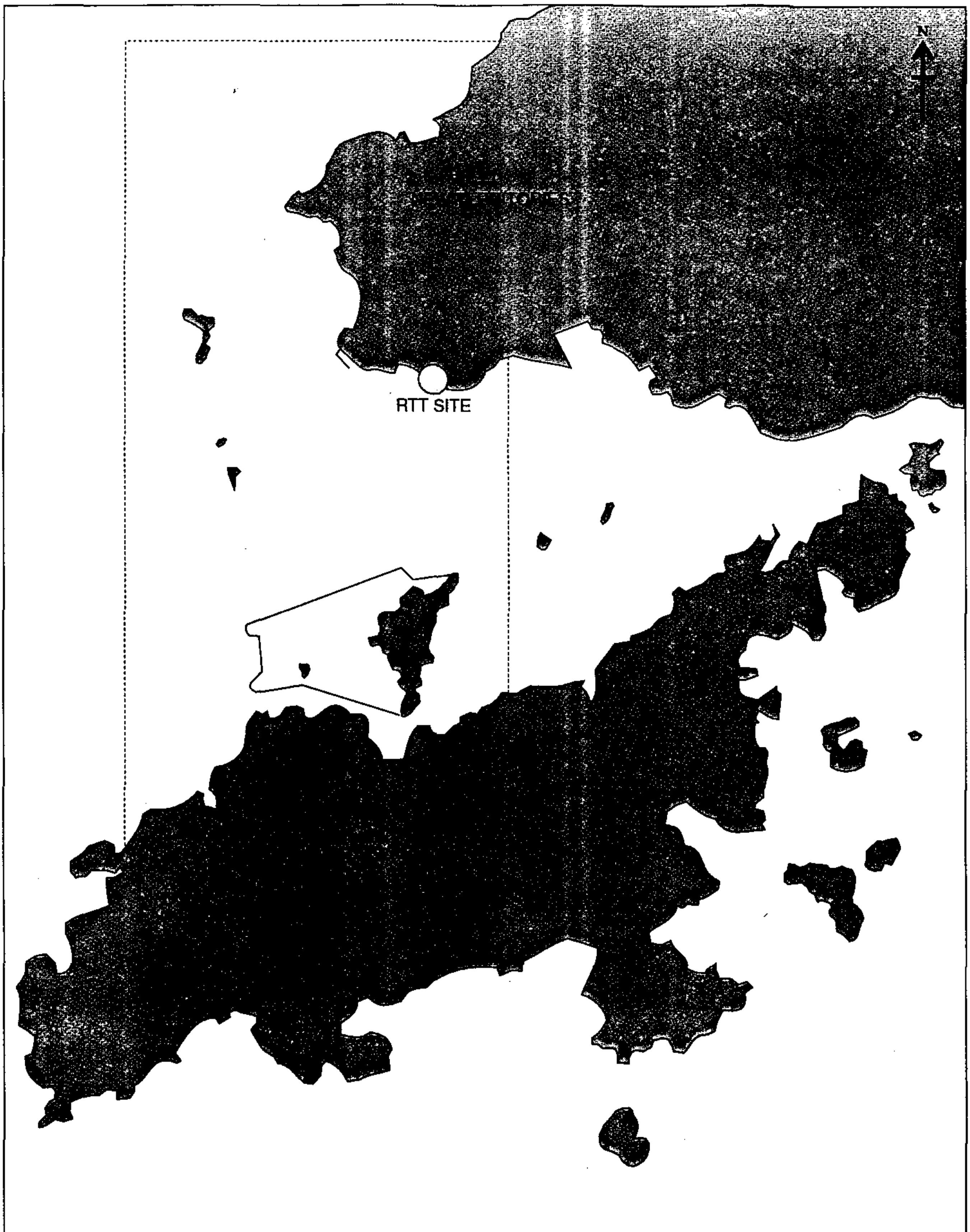
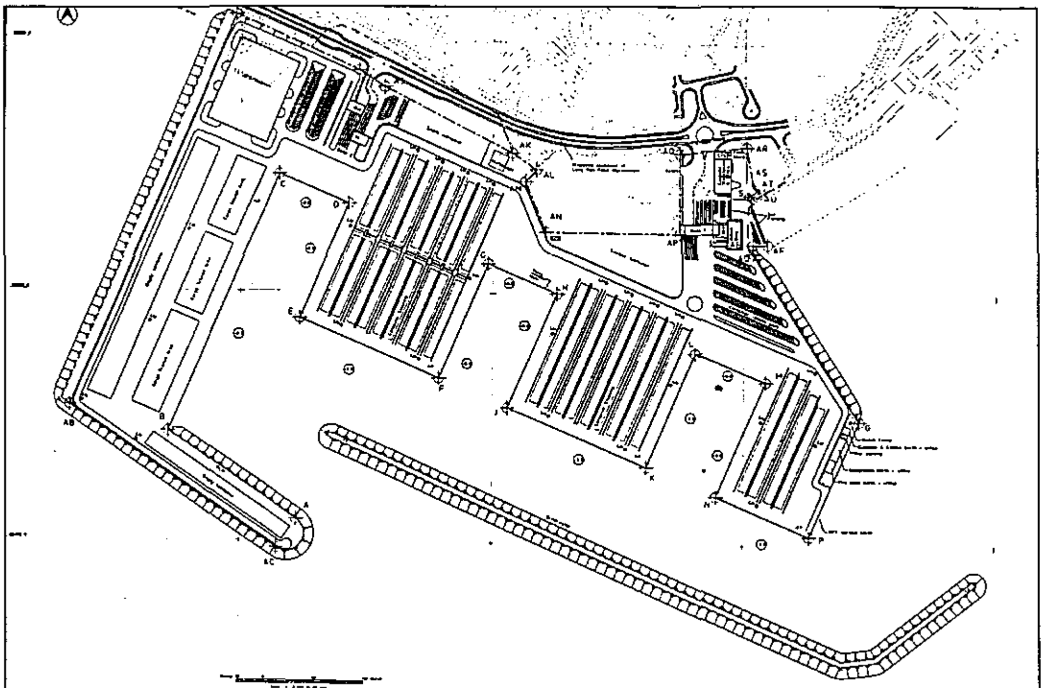
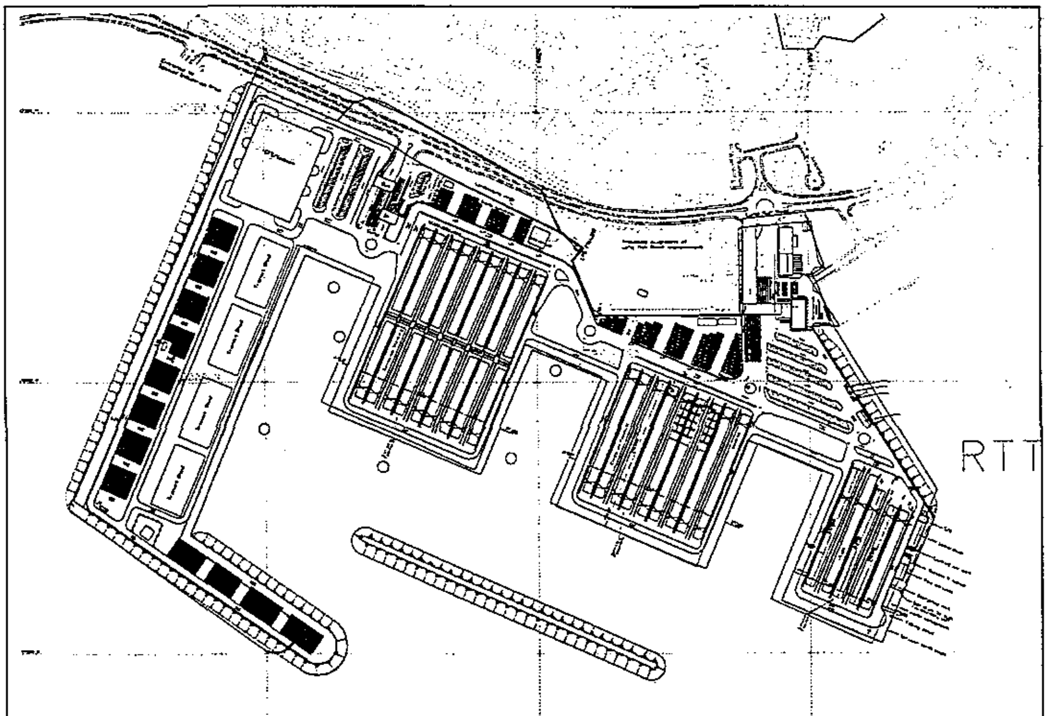


FIGURE 2.1a - LOCATION MAP

ERM Hong Kong, Ltd
6th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong
ERM



RTT LAYOUT FOR THE PREVIOUS STUDY THE RECLAMATION AND SERVICING OF AREA 38 SPECIAL INDUSTRIES STUDY (1995)

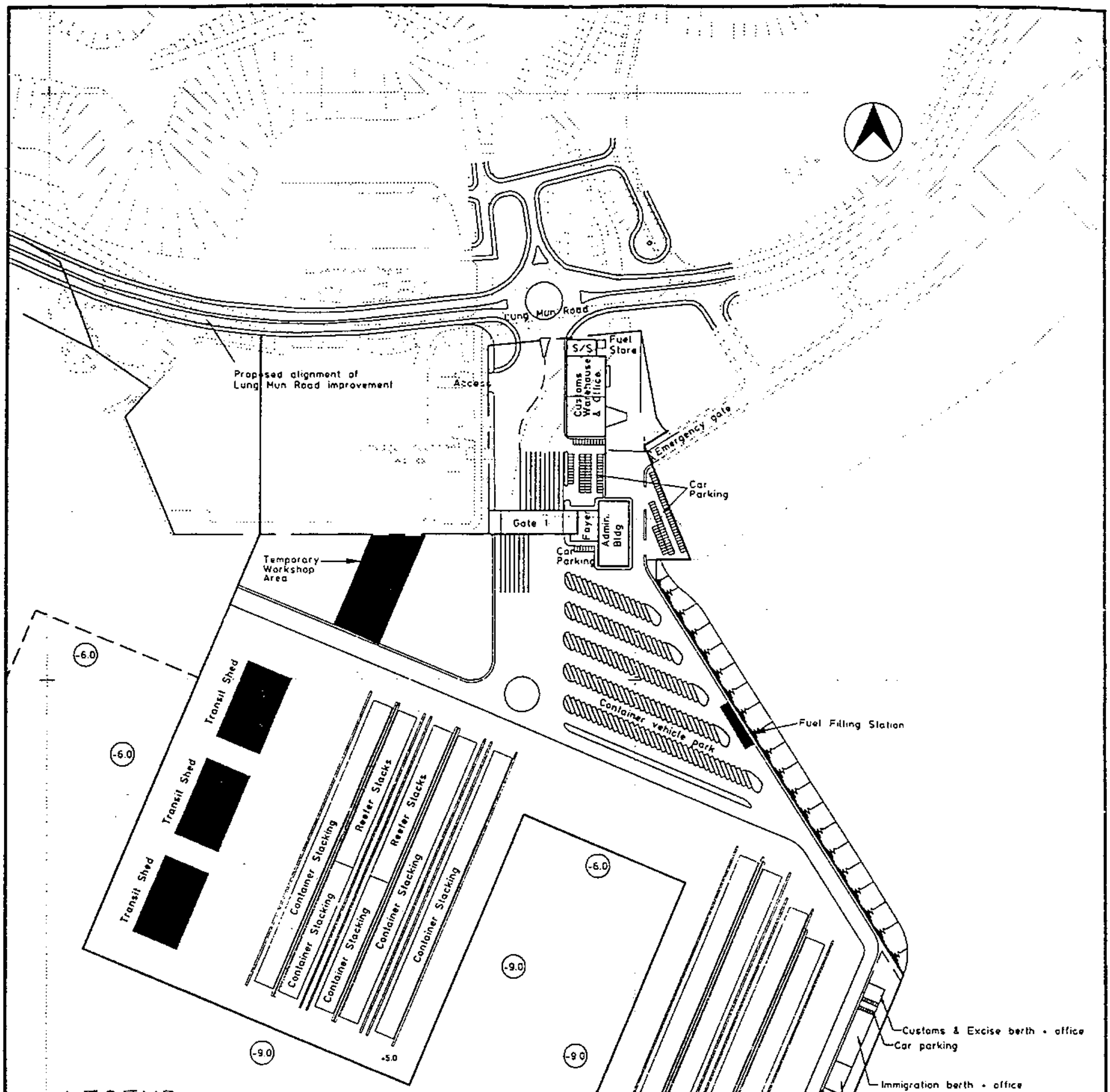


RTT DETAILED DESIGN LAYOUT FOR RTT EIA (1996)

FIGURE 2.2a - COMPARISON OF RTT LAYOUT PLANS

ERM-Hong Kong, Ltd
6th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM



LEGEND:-

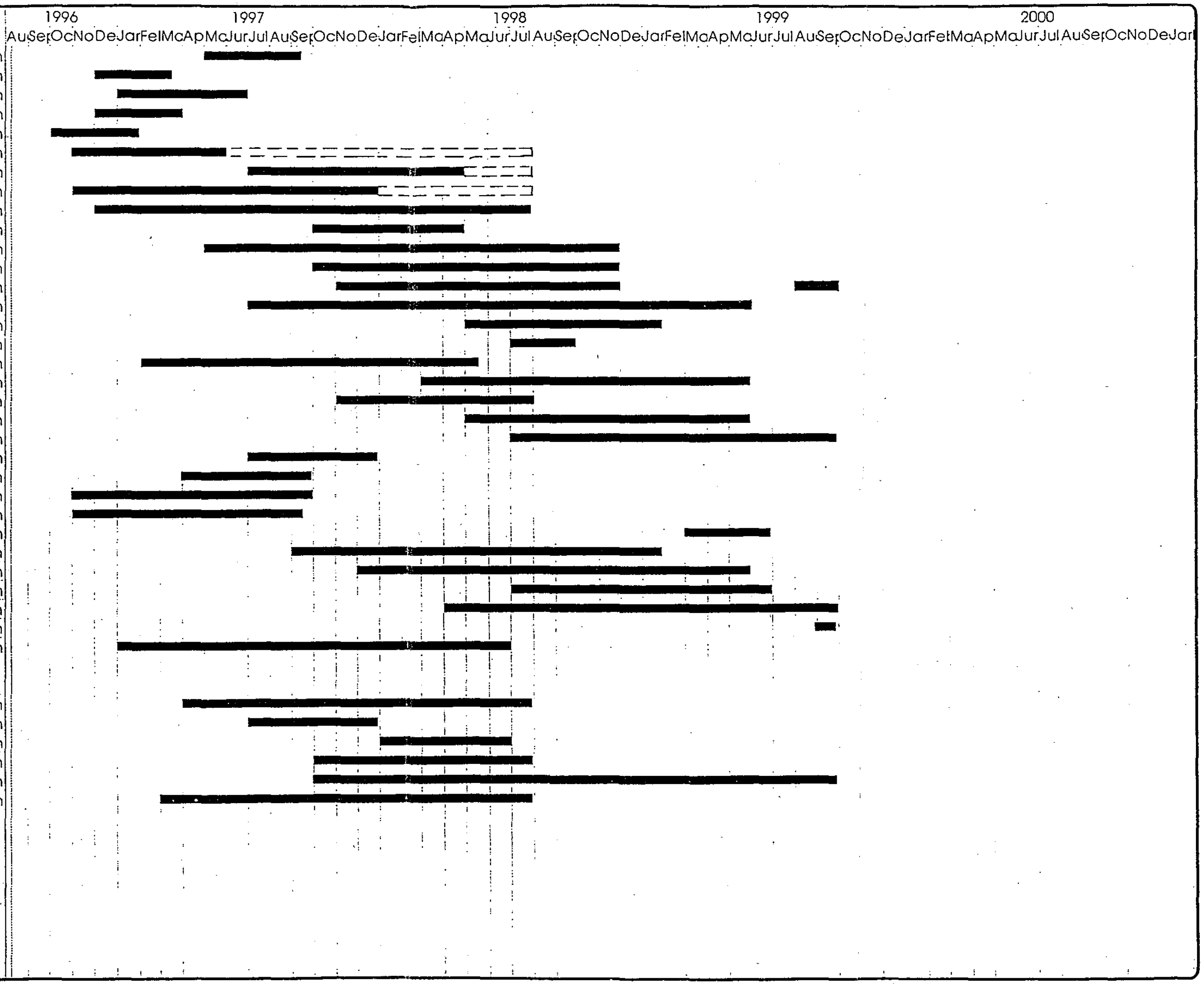
- Transit sheds (2800 sq.m each)
- Temporary workshop area (3767 sq.m)
- Fuel filling station (945 sq.m)
  Marine fuelling station (1000 sq.m)
- Waste management site (940 sq.m)

Metres 50 0 100 200 Metres

Scott Wilson Kirkpatrick CONSULTING ENGINEERS	PHASE 1 DEVELOPMENT	Figure No.	FIGURE 2.2b	
		Scale	1 : 5000	
		Drawn IMB	Approved	Revised
		Checked	Date 6.6.96	Date

FIGURE 2.3a RTT Construction Programme - Draft No.4 (9 Aug 96)

Area	Task Name	Duration
RO	Roadway to S.T. Works	4.50 m
GF	Government Green Area	3.50 m
BA1/TRA1	Area for Gate 1	6.00 m
BA2/TRA2	Area for Administration Building	4.00 m
BA6/TRA6	Area for C & E / Warehouse	4.00 m
Y5	Entry Area	7.00 m
Y1	Loaded Container Area	10.00 m
Y2	Container Vehicle Park	14.00 m
C1	1st Terminal Area	20.00 m
G1	Government Berth Buildings	7.00 m
C2	2nd Terminal Area	19.00 m
C3	3nd Terminal Area	14.00 m
C4/TRA	4th Terminal Area	15.00 m
SS	Substation	23.00 m
RE	Reefer Stack (E & M)	9.00 m
Y6	Overflow Area	3.00 m
D1	R.S.O.	15.50 m
C5	5th Terminal Area	15.00 m
Y3	Empty Containers	9.00 m
C6	6th Terminal Area	13.00 m
C7	7th Terminal Area	15.00 m
BA3/TRA3	Area for Gate 2	6.00 m
BA4/TRA4	Area for Workshop	6.00 m
BA5/TRA5	Area for CFS/ Godown	11.00 m
D2-1	Government Culvert	10.50 m
D2-2	Finishing/ Surfacing Works	4.00 m
T1	1st Cargo Transit Area	17.00 m
T2	2nd Cargo Transit Area	18.00 m
Y4	Empty Container Area	12.00 m
BR	Breakwater	18.00 m
DR	Dredging General	1.00 m
TT	RTGC Commissioning Area	18.00 m
(BA2)	Administration Building	16.00 m
(BA1)	Gate 1	6.00 m
(BA3)	Gate 2	6.00 m
(BA4)	Workshop	10.00 m
(BA5)	CFS / Godown (assumed)	24.00 m
(BA6)	C & E Office / Warehouse	17.00 m



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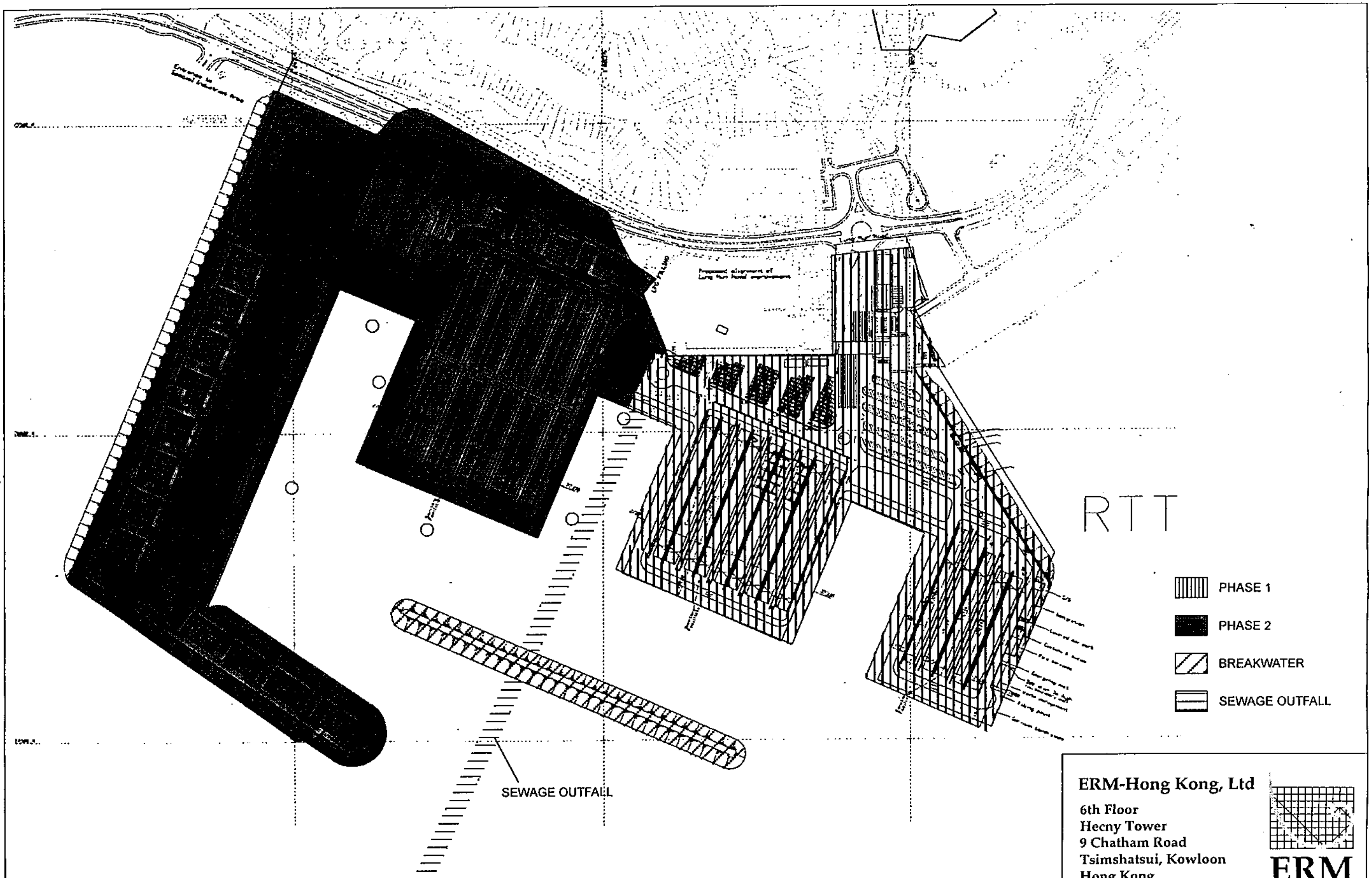


FIGURE 2.3b - CONSTRUCTION PHASING

3 WATER AND SEDIMENT QUALITY

3.1 INTRODUCTION

The RTT IEIA indicated that no insurmountable water quality impacts would result from the conceptual design and RTT operation. During construction comprehensive mitigation measures to reduce water quality impacts to acceptable levels, as defined by statutory requirements, were also described. Overall, the IEIA concluded that RTT construction and operation would not result in exceedance of statutory requirements of the Water Pollution Control Ordinance.

As described in *Section 1* the Tuen Mun Area 38 EIA quantitatively modelled both the construction and operation of the RTT and the reprovisioned Pillar Point outfall and confirmed their environmental acceptability. Therefore, the objectives of this EIA are to comparatively assess the implications of any design changes on water quality and evaluate the potential impacts to water quality. The assessment also included identification of mitigation measures to ensure compliance with water quality objectives and, where appropriate, baseline and impact water quality monitoring and audit requirements to ensure their efficacy. Environmental inputs into the detailed design have ensured that the final RTT layout represent an environmental improvement over the conceptual designs of the RTT described in IEIA[1]. The detailed design will have a shorter breakwater and, thus, a semi-embayed western portion of the RTT harbour will be eliminated. The final layout has been designed to facilitate marine water movement and harbour flushing within the RTT.

Following detailed discussion with the Environmental Protection Department (EPD) it has been decided that it would not be necessary re-run the hydraulic and water quality model (WAHMO) for this EIA as:

- comprehensive and detailed water quality modelling (including RTT construction / operation sediment plume modelling, tidal flow modelling, and replacement outfall bacterial plume modelling) has been conducted in the previous Reclamation and Servicing of Tuen Mun Area 38 for Special Industries - EIA[2] (hereafter, referred to as the Tuen Mun Area 38 EIA);

- no significant changes in RTT construction methods have been proposed from those determined to be acceptable in the Tuen Mun Area 38 EIA water quality modelling. The RTTC have also committed to carry out the RTT construction works in such a manner as to minimise adverse impacts on the water quality during their execution;

- the replacement outfall's acceptability was already confirmed in the previous Tuen Mun Area 38 EIA; and

- the change of the RTT final design layout (shorter breakwater) and the Pillar Point Sewage Treatment Works Outfall design (same outfall length but the nearest effluent discharge point located further away from the sensitive

(1) TM TL No 393. River Trade Terminal at Tuen Mun Area 38, Volume 2, Initial Environmental Impact Assessment, February 1996, Hong Kong River Trade Terminal Limited.

(2) Reclamation and Servicing of Tuen Mun Area 38 for Special Industries - Environmental Impact Assessment Study: *Main Report*, ERM-Hong Kong, Ltd., December 1994.

receivers near Tuen Mun) compared with that modelled in the Tuen Muen Area 38 EIA is anticipated to further improve the water quality compared to the conceptual design;

Additionally, EPD will be commissioning a monitoring consultancy entitled Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall in late 1996 to verify the performance of the outfall and also to consider the need and timing for any upgrade to sewage treatment.

As a result of the above it has been agreed by the EPD that the comprehensive water quality component of this EIA should comprise a comparative assessment based on the results of the comprehensive water quality modelling of the Tuen Mun Area 38 EIA comparing the water quality of the final design layout of the RTT in relation to the conceptual design described in the Tuen Mun Area 38 EIA.

3.2 *GOVERNMENT LEGISLATION AND STANDARDS*

3.2.1 *Marine Water*

The Water Pollution Control Ordinance (WPCO) is the legislation for the control of water pollution and water quality in Hong Kong. Under the WPCO, Hong Kong waters are divided into 10 Water Control Zones (WCZ). Each WCZ has a designated set of statutory Water Quality Objectives (WQO). The proposed RTT site falls within the North Western WCZ. The WQOs for the WCZ, which are presented in *Table 3.2a*, therefore, comprise the relevant evaluation criteria The parameters of particular concern are suspended solids (SS), sediment oxygen demand, temperature, dissolved oxygen, *Escherichia coli (E. coli)*, oxidised nitrogen, ammoniacal nitrogen, organic nitrogen, phosphates, sulphide, chlorophyll-a, and biochemical oxygen demand (BOD).

Table 3.2a *Water Quality Objectives for North Western WCZ*

		Water Quality Objective	Part or parts of Zone
A.	AESTHETIC APPEARANCE		
	(a)	There should be no objectionable odours or discolouration of the water.	Whole zone
	(b)	Tarry residues, floating wood, articles made of glass, plastic, rubber or of any other substances should be absent.	Whole zone
	(c)	Mineral oil should not be visible on the surface. Surfactants should not give rise to a lasting foam.	Whole zone
	(d)	There should be no recognisable sewage-derived debris.	Whole zone
	(e)	Floating, submerged and semi-submerged objects of a size likely to interfere with the free movement of vessels, should be absent.	Whole zone
	(f)	The water should not contain substances which settle to form objectionable deposits.	Whole zone
B.	BACTERIA		
	(a)	The level of *Escherichia coli* should not exceed 1,000 per 100 ml, calculated as the geometric mean of all samples collected in a calender year	Secondary Contact Recreation Subzones

Water Quality Objective	Part or parts of Zone
(b) The level of *Escherichia coli* should be less than 1 per 100 ml, calculated as the running median of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Tuen Mun (A) and Tuen Mun (B) Subzones and Water Gathering Ground Subzones
(c) The level of *Escherichia coli* should not exceed 1,000 per 100 ml, calculated as the geometric mean of the most recent 5 consecutive samples taken at intervals of between 7 and 21 days.	Tuen Mun (C) Subzone and other inland waters
(d) The level of *Escherichia coli* should not exceed 1,000 per 100 ml, calculated as the geometric mean of all samples collected from March to October inclusive. Samples should be taken at least 3 times in one calender month at intervals of between 3 and 14 days.	Bathing Beach Subzones
C. COLOUR	
(a) Waste discharges should not cause the colour of water to exceed 30 Hazen units.	Tuen Mun (A) and Tuen Mun (B) Subzones and Water Gathering Ground Subzones
(b) Waste discharges should not cause the colour of water to exceed 50 Hazen units.	Tuen Mun (C) Subzone and other inland waters
D. DISSOLVED OXYGEN	
(a) The level of dissolved oxygen should not fall below 4 mg per litre for 90% of the sampling occasions during the whole year, values should be calculated as the annual water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1m above seabed). In addition, the concentration of dissolved oxygen should not be less than 2 mg per litre within 2 m of the seabed for 90% of the sampling occasions during the whole year.	Marine waters
(b) Waste discharges shall not cause the level of dissolved oxygen less than 4 mg per litre.	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones and other inland waters
E. pH	
(a) The pH of the water should be within the range of 6.5 - 8.5 units. In addition, human activity should not cause the natural pH range to be extended by more than 0.2 unit.	Marine waters excepting Bathing Beach Subzones
(b) Waste discharges should not cause the pH of the water to exceed the range of 6.5 - 8.5 units.	Tune Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones
F. TEMPERATURE	
Human activity should not cause the daily temperature range to change by more than 2.0 °C.	Whole zone
G. SALINITY	
Human activity should not cause the salinity level to change by more than 10%.	Whole zone

	Water Quality Objective	Part or parts of Zone
H.	SUSPENDED SOLIDS	
	(a) Waste discharges should neither cause the suspended solids concentration to be raised more than 30% nor give rise to accumulation of suspended solids which may adversely affect aquatic communities.	Marine waters
	(b) Human activity should not cause the annual median of suspended solids to exceed 20 mg per litre.	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones and other inland waters
I.	AMMONIA	
	The un-ionized ammoniacal nitrogen level should not be more than 0.021 mg per litre, calculated as the annual average (arithmetic mean).	Whole zone
J.	NUTRIENTS	
	(a) Nutrients should not be present in quantities sufficient to cause excessive or nuisance growth of algae or other aquatic plants.	Marine waters
	(b) Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.3 mg per litre, expressed as annual water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above seabed).	Castle Peak Bay Subzone
	(c) Without limiting the generality of objective (a) above, the level of inorganic nitrogen should not exceed 0.5 mg per litre, expressed as annual water column average (arithmetic mean of at least 3 measurements at 1 m below surface, mid-depth and 1 m above seabed).	Marine waters except Castle Peak Bay Subzone
K.	5-DAY BIOCHEMICAL OXYGEN DEMAND	
	(a) The 5-day biochemical oxygen demand should not exceed 5 mg per litre.	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones
	(b) The 5-day biochemical oxygen demand should not exceed 5 mg per litre.	Other inland waters
L.	CHEMICAL OXYGEN DEMAND	
	(a) The chemical oxygen demand should not exceed 15 mg per litre.	Tuen Mun (A), Tuen Mun (B) and Tuen Mun (C) Subzones and Water Gathering Ground Subzones
	(b) The chemical oxygen demand should not exceed 30 mg per litre.	Other inland waters
M.	TOXINS	
	(a) Toxic substances in the water should not attain such levels as to produce significant toxic, carcinogenic, mutagenic or teratogenic effects in humans, fish or any other aquatic organisms, with due regard to biologically cumulative effects in food chains and to interactions of toxic substances with each other.	Whole zone

	Water Quality Objective	Part or parts of Zone
	(b) Waste discharges shall not cause a risk to any beneficial use of the aquatic environment.	Whole zone
N.	PHENOL	
	Phenols shall not be present in such quantities as to produce a specific odour, or in concentration greater than 0.05 mg per litre as C_6H_5OH.	Bathing Beach Subzones
O.	TURBIDITY	
	Waste discharges shall not reduce light transmission substantially from the normal level.	Bathing Beach Subzones

Note: Expressed normally as the arithmetic mean of at least 3 measurements at 1 m below surface, mid depth and 1 m above the seabed. However in water of a depth of 5 m or less, the mean shall be that of 2 measurements (1 m below surface and 1 m above seabed), and in water of less than 3 m the 1 m below surface sample only shall apply.

3.2.2 *Marine Sediment*

Marine disposal of dredged materials is controlled under the Dumping at Sea Ordinance 1995, which has recently replaced the Dumping at Sea Act 1974 (Overseas Territories) Order 1975 (App. III, p.DK1) in its application to Hong Kong.

Dredged sediments destined for marine disposal are classified according to their level of contamination by seven toxic metals as stipulated in the EPD's *Technical* Circular (EPDTC) No. 1-1-92, *Classification of Dredged Sediments for Marine Disposal*. The seven metals are cadmium (Cd), chromium (Cr), copper (Cu), mercury (Hg), nickel (Ni), lead (Pb), and zinc (Zn). The contamination levels presented in the Technical Circular serve as criteria for determining the disposal requirements of marine dredged sediments. Definition of the classification is as follows:

Class A - Uncontaminated material, for which no special dredging, transport or disposal methods are required beyond those which would normally be applied for the purpose of ensuring compliance with EPD's Water Quality Objectives (WQO), or for protection of sensitive receptors near the dredging or disposal areas.

Class B - Moderately contaminated material, which requires special care during dredging and transport, and which must be disposed of in a manner which minimizes the loss of pollutants either into solution or by resuspension.

Class C - Seriously contaminated material, which must be dredged and transported with great care, which cannot be dumped in the gazetted marine disposal grounds and which must be effectively isolated from the environment upon final disposal.

It should be noted that for sediments to be identified within a particular class, only the concentration of one metallic species need to be exceeded. In both cases of Class B and Class C contamination, the final determination of appropriate disposal options, routing and the allocation of a permit to dispose of material at the designated disposal site will be made by the EPD and Fill Management

Committee (FMC) in accordance with Works Branch Technical Memorandum (WBTC) No. 22/92.

EPD's criteria for the classification of dredged sediments destined for marine disposal are shown below in *Table 3.2b*. Permits from the EPD are required for marine disposal of such materials.

Table 3.2b *Classification of Sediments by Metal Content (mg/kg dry weight)*

	Cd	Cr	Cu	Hg	Ni	Pb	Zn
Class A	0.0-0.9	0-49	0-54	0.0-0.7	0-34	0-64	0-149
Class B	1.0-1.4	50-79	55-64	0.8-0.9	35-39	65-74	150-199
Class C	1.5 or more	80 or more	65 or more	1.0 or more	40 or more	75 or more	200 or more

A new set of sediment quality criteria which may include organic pollutants and other toxic substances, a revised classification of contamination level for highly contaminated sediment which is not suitable for marine disposal, and a new set of regulatory guidelines for contaminated sediments are under development and may be promulgated by the EPD and the Civil Engineering Department (CED) in late 1996/early 1997.

Fill materials will be deposited for the formation of the RTT reclamation. Since the fill material used during the reclamation works will meet the EPD's criteria for uncontaminated (Class A) material, impacts associated with fill operations will be limited to those associated with the release of suspended solids into the water column.

3.3 BASELINE CONDITIONS

3.3.1 *Marine Water*

A large volume of water quality data has been collected in the previous Expanded Development Study for the Tuen Mun Area 38 (EDS) and Tuen Mun Area 38 EIA in the vicinity of the site. The EPD monitoring stations of most relevance are NM2 and NM3. A summary of the most recently published EPD monitoring data (for the year 1994) collected at these stations is presented in *Table 3.3a*. Although providing a good indication of water quality, these monitoring stations are located in the main flow channel of the Urmston Road as opposed to the near-shore area to be reclaimed for the RTT.

The waters to the north of Lantau fall within the transition zone between oceanic and estuarine conditions. Silt and pollutant loads are brought into Hong Kong waters from the Pearl River creating seasonal variations in water quality.

The water quality in the North Lantau area of the North Western Waters is also well documented by the EPD marine water quality monitoring programme.

Table 3.3a *Summary Statistics of 1994 Marine Water Quality in the Vicinity of the Proposed River Trade Terminal*

Parameter		NM2	NM3
Temperature (°C)	Surface	23.6 (18.3 - 28.3)	23.5 (18.2 - 28.2)
	Bottom	24.8 (24.0 - 26.3)	22.8 (17.8 - 27.6)
Salinity (ppt)	Surface	26.2 (11.6 - 31.8)	25.3 (10.5 - 31.7)
	Bottom	26.8 (19.3 - 31.6)	29.7 (27.1 - 32.5)
DO (mg l^{-1})	Surface	6.1 (5.0 - 7.4)	6.2 (49 - 7.6)
	Bottom	5.4 (5.1 - 5.9)	5.6 (4.4 - 7.4)
pH value		8.1 (7.9 - 8.3)	8.1 (7.8 - 8.4)
Secchi disc (m)		0.8 (0.4 - 1.2)	0.9 (0.8 - 1.0)
Turbidity (NTU)		12.4 (5.8 - 24.0)	20.0 (6.6 - 66.9)
Suspended solids (mg l^{-1})		15.7 (6.1 - 27.0)	12.4 (5.0 - 19.0)
Silica (as Si O_2) (mg l^{-1})		2.3 (1.0 - 6.0)	2.3 (1.0 - 6.0)
BOD (mg l^{-1})		0.4 (0.3 - 0.5)	0.4 (0.2 - 0.9)
Nitrite Nitrogen (mg l^{-1})		0.05 (0.01 - 0.09)	0.05 (<0.01 - 0.09)
Nitrate Nitrogen (mg l^{-1})		0.29 (0.17 - 0.68)	0.29 (0.18 - 0.69)
Ammoniacal Nitrogen (mg l^{-1})		0.11 (0.07 - 0.15)	0.10 (0.07 - 0.13)
Total Inorganic N (mg l^{-1})		0.44 (0.31 - 0.84)	0.44 (0.33 - 0.85)
Total N (mg l^{-1})		0.81 (0.55 - 1.29)	0.78 (0.56 - 1.19)
Orthophosphate (mg l^{-1})		0.03 (0.02 - 0.04)	0.03 (0.02 - 0.04)
Total P (mg l^{-1})		0.06 (0.04 - 0.09)	0.08 (0.05 - 0.11)
Phaeo - pigment (µg l^{-1})		1.56 (0.80 - 1.90)	1.34 (0.77 - 2.00)
Chlorophyll - a (µg l^{-1})		1.11 (0.30 - 2.20)	0.84 (0.23 - 2.95)
E. coli (per 100 ml)		410 (135 - 2900)	365 (100 - 987)
Faecal Coliform (per 100 ml)		644 (220 - 4700)	537 (129 - 1388)

Note: 1. Except as specified, data presented are depth-averaged data.
2. Data presented are annual arithmetic means except for *E. coli* data which are geometric means.
3. Data enclosed in parentheses indicate the ranges.

Source: *Marine Water Quality in Hong Kong 1994*, EPD (1995)

North Western Waters are well oxygenated in both surface and bottom layers, and as can be seen from the summary the mean *E. coli* levels are around 400 per 100 ml reflecting bacterial loading from the Pearl River and the Tuen Mun Nullah.

Reclamation and sewage outfall construction activities are likely to increase the suspended solids concentration in the water in the immediate vicinity of the works. The level of suspended solids in the water varies with season and tide as well as flow and depth; the depth-averaged suspended solid concentration for the nearest routine EPD monitoring stations for 1994 was 15.7 mg l^{-1} (NM2) and 12.4 mg l^{-1} (NM3). The currents in the Urmston Road area south of Area 38 are moving offshore with velocities as high as 1 m s^{-1}.

The data provided by the EPD's NM2 and NM3 monitoring stations were used to determine the WQO for SS concentration in this study. As directed in the previous study of the impacts of suspended solids[3], the ambient value has been assumed to be the 90th percentile of reported concentrations and has been determined to be 21.2 mg l^{-1}. Therefore, since the WQO is defined as 130% of the ambient value, the WQO compliance threshold is set at 27.6 mg l^{-1} or about a 6.4 mg l^{-1} elevation of SS concentration above the ambient level.

The DO concentrations in the Study Area were found to range from 4.5 mg l^{-1} to 7.7 mg l^{-1}, with a mean value of 5.9 mg l^{-1} and a 10th percentile[4] of 4.7 mg l^{-1}.

The ambient levels of SS and DO of the Deep Bay Area[5] were also employed to determine the WQO levels of SS and DO for assessment of construction sediment plume impact within the Deep Bay area. The ambient level of SS is 35.2 mg l^{-1} and the corresponding WQO compliance threshold is set at 45.8 mg l^{-1} or about 10.6 mg l^{-1} elevation of SS concentration above the ambient level. The ambient level of DO is 5.02 mg l^{-1} at Deep Bay.

Water quality at beaches along the shoreline of Castle Peak Road is generally poor (Butterfly, Castle Peak, Kadoorie and New Cafeteria beaches) and Old Cafeteria is ranked very poor[6] as a result of sewage discharge from the Pearl River and the Sham Tseng and Tuen Mun nullahs.

3.3.2 *Marine Sediment*

A marine site investigation and a sediment quality study[7] were conducted by RTTC in June 1996 and a total of 89 vibrocore locations at 100 metre intervals were taken as shown in *Figure 3.3a*.

A laboratory analysis of the marine deposit samples was carried out in July 1996 to determine the level of contamination of the deposits. Analysis of cadmium, chromium, copper, mercury, nickel, lead and zinc was conducted in accordance with the WBTC No. 22/92 'Marine Disposal of Dredged Mud' [6].

In order to minimise potential construction stage impacts the RTT detailed design has aimed to minimise dredging activities as far as possible, in accordance with the recommendations of the Tuen Mun Area 38 EIA. The dredging will only be undertaken below seawalls, the major culvert and the sewage outfall, and in basin areas to allow sufficient draught for marine vessels; the majority of the marine sediments will be left *in situ*.

From the analysis of the marine deposits, it has been estimated that a total of around 87,775 m^3 will be moderately contaminated (Class B) mud and about 200,000 m^3 will be seriously contaminated (Class C) mud with high levels of cadmium, copper, lead and zinc from 17 of the 89 locations sampled. The total volume of uncontaminated marine deposits is estimated to be approximately 3 million m^3. The extent of dredging to remove the seriously contaminated sediment is shown in *Figure 3.3b*.

(3) EIA for Backfilling of Marine Borrow Areas at East Tung Lung Chau, November 1995, by ERM-Hong Kong Ltd., for Civil Engineering Department.

(4) This is equivalent to 90th percentile for a parameter, such as DO, which is potentially reduced as opposed to increased due to sediment disturbance impacts.

(5) Focused Environmental Impact Assessment (EIA) Study: *Laying a Second 132 kV Submarine Cable Transmission Link from Lau Fau Shan to Shekou*, ERM-Hong Kong 31 July 1996.

(6) Bacterial Water Quality of Bathing Beaches in Hong Kong, Hong Kong Environmental Protection Department, 1994.

(7) River Trade Terminal, Sediment Quality Report, Revision A. Scott Wilson Kirkpatrick, August 1996.

The classification criteria set out in EPDTC No. 1-1-92 for dredged sediments have been adopted for the present assessment, as shown in *Table 3.2b*. The contamination class for all samples tested and the full testing results are given in the Sediment Quality Report[6].

3.4 SENSITIVE RECEIVERS

In order to evaluate the potential water quality impacts during the RTT construction, the proximity of Water Sensitive Receivers (WSR) to the reclamation site has been considered. These have been identified in accordance with the *Hong Kong Planning Standards and Guidelines (HKPSG)*, which provides guidance for including environmental considerations in the planning of both public and private developments.

WSRs with potential to be affected by the RTT construction works comprise local gazetted bathing beaches, nearby water intakes and more remote sensitive water bodies and include the following:

- Castle Peak Power Station (CPPS) Cooling Water Intake 1;
- CPPS Cooling Water Intake 2;
- the gazetted Butterfly Beach;
- the gazetted Castle Peak Beach;
- the gazetted Kadoorie Beach;
- the gazetted Cafeteria Beaches (New and Old).

The locations of these sensitive receivers are shown on *Figure 3.4a*.

3.5 CONSTRUCTION PHASE

3.5.1 *Sources of Impact*

Based upon the findings of previous studies on the EDS, the Tuen Mun EIA Area 38 and the construction activities proposed for the RTT, the major water quality impacts which may arise during the construction phase of the RTT will be from:

- dredging (marine sediments) and filling (reclamation) activities leading to elevated suspended solids concentration;

- sewage outfall construction activities, including the marine dredging required to form the outfall trench leading to elevated suspended solids concentration;

- the impacts of the construction activities on the bacterial concentrations at nearby sensitive receivers and in the immediate vicinity of the RTT construction associated with sewage discharges from the old Pillar Point outfall; and

- public dumping activities currently undergoing at the adjacent Area 38 SIA, which may elevate suspended solids in the surrounding waters.

The fill material for RTT reclamation below water will be uncontaminated marine sand; a small stockpile of puliverished fuel ash (PFA) at the Site from the nearby CPPS (with unknown quantity) will be used for land formation above water.

Marine Sediment Dredging and Disposal

The engineering design of the RTT has taken a minimal dredge approach to minimize the amount of marine mud dredged from the site prior to reclamation. Based upon the findings of the Tuen Mun Area 38 EIA, the RTT detailed design generally proposes to construct the seawalls prior to major filling activities, in order to minimize potential plumes generated during filling. Dredging will only be undertaken below seawalls, the major culvert and the sewage outfall, and the majority of the marine sediments will be left *insitu* (*Figure 3.5a*). Nevertheless, dredging activities for the RTT project are still estimated to generate approximately 3 million m^3 of marine muds, of which 200,000 m^3 is expected to be seriously contaminated (Class C), and which will thus require special handling and disposal. The potential impacts to water quality from dredging and disposal of marine muds will vary according to the dredging volumes, dredging methods and level of contamination, as well as the presence and proximity of water sensitive receivers to the dredge and disposal sites. These impacts may include:

- release of previously bound organic and inorganic constituents such as heavy metals, PAHs, PCBs, ammonia sulphide, and nutrients into the water column, either via suspension or by disturbance as a result of dredging activities, disposal of muds, or depositing fill materials;

- release of any organic and inorganic contaminants from pore water and leachate forced out of sediments as a result of compaction or settlement during site formation;

- release of the same contaminants due to leakages and spillage as a result of poor handling and overflow from barges during dredging and transportation;

- disturbance and release of previously deposited organic and inorganic contaminants (such as ammonia sulphide and heavy metals) from the sea bed in the disposal pits when new dredge spoil is introduced; and

- suspension of solids in the water column during dredging activities and marine sediment dumping activities.

All of the above can result in deterioration in the receiving marine water quality and may have adverse effects on water sensitive receivers.

Physical Effects of Dredging

Water quality impacts resulting from marine dredging are directly related to the increase in suspended solids (SS) in the water column generated from dredging. Increased amounts of suspended solids in the water column will increase the turbidity of sea water and will lead to a reduction of light. The extent of physical impacts will depend on the amount of SS generated, and currents acting as dispersal forces to SS.

Physical impacts to sensitive receivers such as cooling water intakes and pump inlets are increased sediment and siltation, which can block filters, foul pipes, and wear down pumps.

These physical impacts can be minimized by imposing controls on dredging, transportation and dumping operations of spoil (*Section* 3.5.3).

Chemical and Biochemical Effects of Dredging

Material with a high oxygen demand can interact with conditions caused by high levels of SS, and increased algal growth in the upper water column promoted by additional nutrient availability, to cause substantial declines in DO. This decline may be exacerbated by increases in SS in the water column leading to diminished photosynthesis in the lower water column, and thus reducing the rate of oxygen produced and nutrients consumed by algae in the lower water column. Under extreme conditions this can lead to eutrophication, as algae blooms in the surface layer die exerting additional BOD in the lower water layer leading to anoxia.

The extent of those chemical effects listed above will depend on the contaminant levels of the marine sediments, nutrient content of the disturbed material, and the oxygen demand of the disposed material.

Sediment consolidation rates and sediment entrainment from the natural seabed after disturbance, which effect the SS concentrations present, will depend largely on the construction method employed. It is presently envisaged that the RTT reclamation fill material will be of marine origin and will be placed using hydraulic filling techniques. The dredging method for any seriously contaminated sediment will have to satisfy EPD. The contractor may propose a mechanical dredger with closed-form grabs, as this form of low impact dredger will minimize suspended solids losses. The amount of sediment dispersion during the construction period will also alter under different tidal and storm current conditions.

Sediment Pore Water

Although minimum dredging will be taken prior to RTT reclamation and the majority of marine sediment will be left undisturbed after dredging, disturbed marine sediment may still release contaminants into the water column. These may be contained in pore water being forced out of the sediments left in place during site formation, sediment compaction and consolidation. Heavy metals such as mercury, cadmium and copper are strongly chemically associated with the clay fraction and organic material in the sediments and thus do not readily enter the sediment pore water. This was verified in the Tuen Mun Area 38 EIA and the sediment quality study of Central Reclamation Phase III (CRIII) EIA[8] which reported relatively low concentration of heavy metals in pore water. Thus, in view of the relatively low levels of contaminant in the pore waters and the dilution effect due to the tidal currents of the surrounding area, it is considered that the impact on the receiving waters will be minimal.

Fill Activities

The placement of fill during the reclamation of RTT will lead to impacts associated with increase in SS within the water column. It is presently envisaged that clean marine sand will be used as fill material; biological and chemical oxygen demand of the filling sand should be minimal. Hence, the elevation of SS near the filling area is predicted to be the only major impact associated with sand filling activities.

(8) Central Reclamation Phase III, Agreement No. CE 15/94: *Environmental Impact Assessment*, Atkins Haswell September 1996.

Configuration and Phasing of Reclamation

The reclamation is proposed to be broadly divided into two phases, as shown in *Figure 2.2a*. The present phasing of reclamation is aimed at reducing the embayment potential and, thus, the deterioration of water quality within and near the construction site. Based upon the findings of the Tuen Mun Area 38 EIA, the RTTC generally proposes to construct the seawalls prior to major filling activities, in order to minimize potential plumes generated during filling.

Stormwater Discharge

Based on the RTT - Drainage Impact Assessment (July 1996) two stormwater outfalls will be reprovided for which discharge from the western edge of the site through a storm culvert running along the length of the seawall and the other proposed outfall which will discharge from the eastern section of the site away from the RTT basin (*Figure 3.5b*).

Any temporary embayment, if formed, should not receive any discharges from existing stormwater outfall areas (Areas 1 and 2, *Figure 3.5b*) as these will be adequately reprovided.

During reclamation, the outfalls from the realigned Lung Mun Road would be diverted and the stormwater runoff discharged from the interface between the RTT and the Lung Mun Road outlets to the west of the temporary seawall at the western edge of the RTT reclamation.

During reclamation, the existing outfalls from Catchment 1a (*Figure 3.5c*) and the Pillar Point STW will be installed with unlined temporary drainage channels before discharging to the sea outlets. These existing outfalls will be connected to the new drainage system as shown in *Figure 3.5c*.

As these drainage outfalls will only carry stormwater the impact of stormwater discharge will be minimal.

Interaction between the Existing / Reprovisioned Sewage Outfall and the RTT Reclamation

The existing Pillar Point Sewage Outfall will be operating during the Phase 1 and Phase 2 construction. The outfall will be reprovisioned before the construction of the breakwater. Thus, there will be a temporary period during the first RTT construction phases when sewage discharged from the existing outfall could affect water quality local to the RTT.

General Construction Activities

The Works will be primarily marine based and could, if uncontrolled, have the potential to cause water pollution. These could result from the accumulation of solid and liquid waste such as packaging and construction materials; sewage effluent from the construction workforce; discharge of construction vessel bilge water; and spillage of oil, diesel or solvents by vessels and vehicles involved with the construction. Any of these could lead to deterioration in water quality and potential impacts upon water sensitive receivers in the vicinity of the works. Increased nutrient levels resulting from polluted discharges and sewage effluent could also lead to a number of secondary water quality impacts including decreases in DO concentrations and localised increase in un-ionised ammonia

(NH_3) concentrations which could stimulate algal growth, and locally reduce oxygen levels.

3.5.2 *Impact Assessment*

Marine Mud Dredging and Sand Filling

As mentioned in *Section 3.1*, detailed hydraulic modelling of the sediment plume dispersion of marine mud dredging and sand filling is not considered necessary in the context of the RTT EIA. This is because water quality impact during the construction of the RTT is already well-assessed during the of the Tuen Mun Area 38 EIA[9]. Thus, following EPD discussion with the SS impact of dredging and filling activities is comparatively assessed with reference to the results of the water quality modelling reported in the Tuen Area 38 EIA[9].

The potential worst-case scenario for dredging and filling activities (with 20% fines content of fill) is based on the RTT construction programme (December 1996 - January 1997) that would comprise the dredging at areas of Phase 1 and Phase 2, dredging under the location of the reprovisioned outfall, and filling at the area of Phase 1 being carried out simultaneously. However, the Contractor has already indicated that dredging of different phases are unlikely to take place simultaneously and thus this potential worst-case is likely to be conservative. This worst-case scenario is compared with the worst-case scenarios (Scenario 3 and Scenario 4) of the dredging and filling activities assessed in the Tuen Mun Area 38 EIA[9] as shown in *Table 3.6a*.

Scenario 3: Filling at Area 38 Special Industries Area (SIA) Phase I and RTT Phase 2, dredging at Pillar Point's new sewage outfall.

Scenario 4: Filling at Area 38 SIA Phase II and RTT Phase 1. These include dredging and filling activities associated with expediting the early placement of the RTT seawalls and dredging associated with the early provisioning of the replacement outfall

(9) Reclamation and Servicing of Tuen Mun Area 38 for Special Industries - Environmental Impact Assessment Study: *Main Report*, ERM-Hong Kong, Ltd., December 1994.

Table 3.6a *Comparison between the RTT worst-case scenario with the worst-case scenarios of Tuen Mun Area 38 EIA study.*

Activities	Rate (m^3 per month)	Loss Rate of dredged / fill material (%)	Loss rate of dredged / fill material ($kg\ s^{-1}$)
Tuen Mun Area 38: Scenario 3			
Dredging (Pillar Point Outfall)	83,333	5%	0.79
Filling (Area 38 SIA Phase I and RTT Phase 2)	208,333	30%	15.08
Total	291,666		15.87
Tuen Mun Area 38: Scenario 4			
Filling (Area 38 SIA Phase II and RTT Phase 1)	708,333	30%	52.0
Worst-case RTT			
Dredging (RTT Phase 1, Phase 2 and new outfall's dredging)	300,000	5%	3.68
Filling (RTT Phase 1)	440,000	20%	21.61
Total	740,000		25.29
Inclusion of Filling Activities from Scenario 3	208,333	30%	15.08
	948,333		40.37

Note: The dry density of the marine mud and the fill is assumed to be 488 kg m^{-3}.

As shown in *Table 3.6a*, the generation rate of suspended solids of the RTT worst-case scenario is within the range of Scenario 3 and Scenario 4 of the EIA study of Tuen Mun Area 38[(11)].

Even if a very conservative approach of including the filling activities for Scenario 3 for both the Area 38 SIA Stage I and RTT Phase 2 Works were taken for the RTT worst case scenario predicted in this Study (a total loss rate of 40.37 kg^{s-1}), it would still be below the worst case predicted in Scenario 4 (a total loss rate of 52.0 kg^{s-1}) as shown in *Table 3.6a*. Hence, the SS impact of the RTT worst-case scenario is predicted to be between the range of Scenario 3 and Scenario 4 and will be no worse than that predicted for the worst-case scenario for the Tuen Mun Area 38 EIA.

Once the dredging activities have been completed during the early stages of construction, any filling activities undertaken for the RTT will generally be conducted behind seawalls and hence are not expected to result in a large SS loss rate.

Based on the modelling results of the Tuen Mun Area 38 EIA, the SS impact of the RTT worst-case scenario can be predicted conservatively as follows:

- At the maximum flood tide, the sediment plume will extend within the Deep Bay. The plume within the bay is diffuse with the majority of SS elevations in the range of 0 - 5 mg l^{-1}, and isolated spots in the range of 5 - 10 mg l^{-1}. The elevation of SS at Deep Bay is within the WQO limit (10.6 mg l^{-1}).

- The maximum ebb tide extent of the sediment plume is east to Ma Wan with the SS elevation in the range of 0 - 5 mg l^{-1}. The plume will travel past Ma Wan to the north and to impact on the Kowloon side coastline to the east of Ma Wan.

- During the dry season the suspended sediment plume is predicted to confine as a band between the north-west New Territories coastline and the outer edge of the deep water channel of the Urmston Road. During the wet season, the plume will spread further to the south and west. The plume in these areas is predicted to have elevation of SS not more than 5 mg l^{-1}.

- High SS concentrations are predicted to be within the vicinity of the RTT construction site and off-shore of the Castle Peak Power Station (CPPS). The CPPS is considered as a sensitive receiver in that the SS levels within 5 km radius of the intakes (Castle Peak 1 and Castle Peak 2) have to be kept below 150 mg l^{-1}. It is predicted that the maximum SS elevation above the ambient level (27.6 mgl^{-1}) at Castle Peak 1 should be within 20 mg l^{-1} for all seasons. The sediment plume will not impact Castle Peak 2 as it is sheltered by the headland. As a whole, the SS levels at the CPPS cooling water intakes is predicted to be lower than the 150 mg l^{-1} limit and, hence, the CPPS intakes will not be impacted by the RTT construction.

- There will be no SS impact of RTT construction on the sensitive receivers of Butterfly Beach and Cafeteria Beach, as predicted in the Tuen Mun Area 38 EIA.

Disposal of Dredged Material

The impacts from the generation and disposal of dredged material are a key concern for the project, particularly with regard to contaminated mud material. In general, when contaminated sediments are disturbed by dredging, the potential exists for toxic metals previously bound to the sediment particles to be mobilised into the water column. To minimise the potential impacts on water quality, seriously contaminated sediments must be dredged with great care using a low impact mechanical closed-form grab dredger. Details of recommended mitigation measures are discussed in *Section* 3.5.3.

The proposed preliminary RTT construction sequence will proceed in two phases, with rates of dredging from each particular phase estimated as follows:

- Phase 1 — 100,000 m^3 per month
- Phase 2 — 100,000 m^3 per month
- Sewage Outfall — 100,000 m^3 per month
- Breakwater — 100,000 m^3 per month

It is stressed that these rates are only indicative, based on a preliminary construction programme and, as discussed above, are likely to be conservative as the Contractor has indicated that it is unlikely for dredging at each phase to be carried out simultaneously with other phases. With reference to the worst-case scenario of RTT construction, a conservative estimation of the dumping rate is about 300,000 m^3 per month with an average estimate of about 273,839 m^3 per month of Class A uncontaminated mud, about 7,980 m^3 per month of Class B moderately contaminated mud, and 18,182 m^3 per month of Class C highly contaminated mud.

The potential environmental effects of the disposal of sediments to marine disposal sites will vary according to their level of contamination and physical and chemical nature. Other factors that may have a bearing on the significance of the impact may include:

- actual rate of construction activity i.e. volumes of material dredged and dumped per day, and the types of dredging methods employed;
- the phasing of the construction schedule and time required to complete each phase;
- quantity of pollutants discharged into the Study Area from nullahs and stormwater drains;
- dispersion, currents, and flushing characteristics of the receiving water body; and
- the number, nature, and proximity of water sensitive receivers.

As a worst-case situation, changes in sediment physical and chemical properties as a material passes through the marine water column may cause the material to dissipate such that a considerable proportion of it is suspended in the water column. The release of bound metals may also occur. However, the sediment quality study of the CRIII EIA[10] has shown that only a small amount of heavy metals contained in seriously contaminated are present in sediment porewater. It is therefore considered that the release of heavy metals from dredged marine sediments during disposal is not a key concern. Mitigation measures are suggested in *Section* 3.5.3 to minimize the impact of mud release and any associated heavy metal pollution during dredging.

General Construction Activities

The spill of oil and the accumulation of solid and liquid waste at the construction site are predicted to be significant only if the on-site treatment facilities of the spilled oil and wastes are uncontrolled and not monitored. In other words, it is considered unlikely that solid and liquid discharge from the construction site will have any impact on the water quality of the receiving waters provided that measures are implemented to control the waste generation and treat the runoff prior to discharge. Mitigation measures and site management practices are suggested in *Section* 3.5.3 to minimize the impact.

Interaction between the Existing Outfall and the RTT Construction

The existing outfall will still be operating during Phase 1 and Phase 2 construction of RTT but will be reprovisioned before the construction of the breakwater. Thus, there will be a temporary period during the first RTT construction phases when sewage discharged from the existing outfall could affect water quality local to the RTT. However, early construction of seawalls proposed, prior to major reclamation activities, will prevent entrainment of such sewage within the RTT reclamation area.

(10) Central Reclamation Phase III, Agreement No. CE 15/94: Environmental Impact Assessment, Atkins Haswell September 1996.

Interaction between the Reprovisioned Outfall and the RTT Construction

The PPSTW outfall will be reprovisioned before the breakwater construction of RTT and the new outfall will operate as soon as the construction is completed. As the discharge point and the diffuser (350 m in length) section of the outfall is further away from the site (approximately 150m) in contrast to the conceptual outfall design (500 m diffuser) the impact of the reprovisioned outfall during the construction of the RTT is predicted to be no worse than the bacterial modelling results reported in the Tuen Mun Area 38 EIA which confirmed the reprovisioned outfalls necessity and acceptability[11]:

- The bacterial plume will travel beyond Shekou to the north and impact on the Kowloon coastline to the east of Ma Wan. The plume will remain within the deep water channel of the Urmston Road and has less impact on the coastline of the north-west New Territories due to the dilution of the bacterial plume. As the new outfall will discharge effluent directly into the deeper (at about -15 mPD) faster moving waters of the Urmston Road, the dilution effect of the plume will be stronger and the extent of the plume dispersion will be further in contrast to the situation of the existing outfall;

- The plume that will intrude within Deep Bay will have *E. coli* lower than 1,000 per 100 ml and is considered as a significant improvement over the existing outfall condition;

- No impact of the reprovisioned sewage outfall plume on the waters of the RTT construction area; and

- No impact of the bacterial plume upon the sensitive receivers of Butterfly Beach or Cafeteria Beach is predicted.

3.5.3 *Mitigation Measures*

Dredging

As identified in the Tuen Mun Area 38 EIA, potential water quality impacts resulting from sediment release during dredging, backfilling, transportation of material and dumping are of concern. Therefore, in addition to minimising dredging activities, via the use of closed-grab mechanical dredgers for all seriously contaminated Class C material, advanced seawall construction prior to major reclamation filling activities and the project phasing, the Contractor will employ comprehensive pollution avoidance measures during construction which will include, but not be limited to, the following:

- mechanical grabs will be designed and maintained to avoid spillage and should seal tightly while being lifted;

- cutterheads of suction dredgers will be suitable for the material being excavated and designed to minimise overbreak and sedimentation around the cutter; and

- where suction hopper dredgers for dredging of uncontaminated marine mud are in use, overflow from the dredger and the operation of lean mixture

(11) Reclamation and Servicing of Tuen Mun Area 38 for Special Industries - Environmental Impact Assessment Study: *Main Report*, ERM-Hong Kong, Ltd., December 1994.

overboard systems (ALMOB) will not be permitted, unless expressly approved by the Project Manager.

Other mitigation measures to minimize the impact of SS include:

- the use of containment structures such as silt curtains or screens around the dredging equipment, as appropriate, and consideration of works timing to limit sediment release to the water column;

- if such equipment is utilised, the use of closed clamshell grab dredgers to remove seriously contaminated (Class C) material; and

- the prohibition of stockpiling of any moderately or seriously contaminated (Class B and C) material, and careful control of stockpiling of any uncontaminated (Class A) material to prevent runoff, resuspension and odour nuisance.

It should be noted that high current speed, in excess of 0.5 m s^{-1}, will increase dispersion of sediment and potential contaminants, as well as reduce the overall efficacy of silt curtains as the means of controlling sediment loss during dredging operations. Currents generated from the vessels cruising near the operating dredgers can be controlled by limiting the speeds of the working vessels near or within the construction site. Other ships, boats or vessels should not be allowed to cruise near the vicinity of the construction site. Wind surging effect on currents are very considerable under strong monsoon winds, severe convective or frontal storms, or typhoons. No dredging should take place under such severe weather conditions.

Marine Disposal of Dredged Materials and Sand Filling

The following measures have been identified to minimise potential impacts on water quality arising during marine transportation of the dredged material and sand filling:

- all vessels should be sized such that adequate clearance is maintained between vessels and the sea bed at all states of the tide to ensure that undue turbidity is not generated by turbulence from vessel movement or propeller wash;

- all hopper barges and dredgers should be fitted with tight fitting seals to their bottom openings to prevent leakage of material;

- loading of barges and hoppers should be controlled to prevent splashing of dredged or fill material to the surrounding water, and barges or hoppers should not be filled to a level which will cause the overflow of materials or polluted water during loading or transportation; and

- the construction works should cause no visible foam, oil, grease, scum, litter or other objectionable matter to be present on the water within the site or dumping grounds.

- all pipe leakages should be repaired promptly and plant should not be operated with leaking pipes;

- excess material will be cleaned from the decks and exposed fittings of barges and hopper dredgers before the vessel is moved;

- adequate freeboard will be maintained on barges to ensure that decks are not washed by wave action; and

- EPD may monitor any or all vessels transporting material to ensure that no dumping outside the approved location takes place and that no loss of material occurs during transportation. The Contractor will ensure that EPD is provided with reasonable assistance for this purpose.

Additional provisions will be required where sediments are contaminated. The locations and depths of any areas of contaminated sediments should be indicated in the construction contract. The Contractor should be required to ensure that contaminated sediments are dredged, transported and placed in approved special dumping grounds in accordance with the EPDTC No. 1-1-92, WBTC No. 22/92 and WBTC No. 6/92 and in accordance with dumping permit conditions provided by EPD / SMC. Typical mitigation measures to minimise the loss of contaminated material to the water column are listed below, and most are also applicable to the transportation of filling material.

- use of new specialized water tight grabs to control sediment loss;

- transport of contaminated mud to the marine disposal site should, wherever possible, be by split barge of not less than 750 m^3 capacity, well maintained and capable of rapid opening and discharge at the disposal site;

- the dredged material should be placed in the pit by bottom dumping, at a location within the pit specified by the FMC;

- discharge should be undertaken rapidly and the hoppers should then immediately be closed, material adhering to the sides of the hopper should not be washed out of the hopper and the hopper should remain closed until the barge next return to the disposal site;

- the dumping vessel should be stationary throughout the dumping operation;

- the Contractor must be able to position the dumping vessel to an accuracy of +/-10 m;

- monitoring of the barge loading to ensure that loss of material does not take place during transportation;

- the Contractor should only employ barges equipped with automatic self-monitoring and positioning device as specified by the DEP for dumping operation, and should co-operate with the facilitate the DEP to inspect the device and retrieve the record stored in the device on a regular basis;

- The Contractor should follow procedures as outlined in the *Guidance Note for Dumping* and *Additional Conditions on Disposal of Contaminated Marine Mud at East Sha Chau Contaminated Mud Disposal Pits*; and

- on site audit of the equipment and plant is essential to ensure it is used in the correct manner.

Final decision-making regarding the fate of dredged and excavated material lies with various departments in Government and will depend upon the volume and quality of the material, and other factors..

The Engineer should monitor all vessels transporting material from the project site to ensure that loss of material does not take place during transportation and that no dumping take place outside the approved locations.

Ad hoc site inspections by Environmental Auditor, Engineer and Contractor shall be carried out if action / target level exceeds.

Mitigation Measures for General Construction Activities

All site construction runoff should be controlled and treated to prevent high levels of SS entering surrounding waters. The following measures, which constitute good site practices, may be considered where applicable:

- temporary ditches should be provided to facilitate runoff discharge into the appropriate watercourses, via a sediment trap/sediment retention basin, prior to discharge;
- permanent drainage channels should also incorporate sediment basins or traps, and baffles to enhance deposition rates;
- all traps (temporary or permanent) should also incorporate oil and grease removal facilities;
- sediment traps must be regularly cleaned and maintained by the Contractor. Daily inspections of such facilities should be required of the Contractor;
- concrete batching plants should be bounded to contain the surface water runoff;
- water from concrete batching plants must also pass through sediment traps and settlement tanks prior to runoff into watercourses. These must be regularly cleaned and maintained by the Contractor;
- collection of spent bentonite/other grouts in a separate slurry collection system for either cleaning and reuse/disposal to landfill;
- maintenance and plant areas should be bounded and constructed on a hard standing with the provision of sediment traps and petrol interceptors;
- all drainage facilities must be adequate for the controlled release of storm flows;
- minimising of exposed soil areas to reduce the potential for increased siltation and contamination of runoff;
- all chemical stores shall be contained (bounded) such that spills are not allowed to gain access to water bodies; and
- chemical toilets will be required to handle the sewage from the on-site construction workforce.

Outfall Reprovisioning

The Tuen Mun Area 38 EIA indicated the possibility of temporary discharge of sewage at the existing emergency bypass located only 20m from the seawall of the Pillar Point STW during the changeover from the existing to the reprovisioned outfall. However, such a condition is considered undesirable in terms of water quality. Thus the detailed design considers that at the time of decommissioning of the existing outfall and reconnection to the new reprovisioned outfall effluent flows would be temporarily diverted through the newly extended emergency by-pass outfall to discharge some 700 m off-shore at a depth of approximately -19 mPD. This may be required for a period of approximately 4 - 5 hours (maximum) until the connection could be completed from the treatment works to the new reprovisioned pipes. Thus there would be no need for direct discharge from the seawall.

3.5.4 *Management of Marine Spoil Disposal*

The excavated material dredged during reclamation and seawall construction will be dumped off-site. The total amount of excavated material will be approximately 3 million m^3, with conservative estimates of about 273,839 m^3 per month of Class A uncontaminated mud, about 7,980 m^3 per month of Class B moderately contaminated mud, and about 18,182 m^3 per month of Class C highly contaminated mud. Based on the EPDTC No. 1-1-92 disposal should be as follows:

- Open water disposal site at East of Ninepins or south Cheung Chau or marine borrow areas (MBAs), e.g. North Lantau and South Tsing Yi MBAs (for Class A and Class B mud only); and

- Contaminated mud pits (CMPs), e.g. East Sha Chau CMPs (Class C seriously contaminated mud only).

Hopper barges will be used to transport the dredged marine sediment to the designated dumping area.

In all cases, the EPD will advise on the most appropriate disposal method for the material. Any environmental conditions to be imposed with the dumping licence and special disposal arrangements will be specified at this time. The FMC will finalise and stipulate the disposal allocation of any volume of contaminated sediment. Any further conditions relating to the management of the disposal area will also be specified at this time.

For seriously contaminated sediments (Class C), special disposal arrangements comprising contained disposal in designated marine pits will be necessary. The only disposal site at present designated for the disposal of contaminated muds comprises the East Sha Chau CMPs. The Contractors should ensure that all dredging and disposal methods are in compliance with the environmental conditions imposed under the terms and conditions of EPD's marine dumping permit. Specific dredging procedures, which are required to minimise any potential water quality impacts, should be included in the contract document.

3.5.5 *Construction EM&A*

Based on the results of this quantitative assessment of construction stage water quality impacts, it is recommended that that one month baseline monitoring should be undertaken before any construction works and that thereafter impact monitoring of water quality to be undertaken throughout the RTT construction period. In accordance with EPD protocols, the water quality monitoring will identify any indications of a deterioration of water quality, via a proactive approach, in order that there may be direct feedback into the RTT construction methodology to ensure that possible adverse impacts do not eventuate. Site-specific monitoring and audit protocols have been formulated and presented in the stand alone Environmental Monitoring and Audit (EM&A) Manual. The EM&A Manual includes the location of sensitive receivers, monitoring locations, parameters and frequencies, monitoring equipment and necessary programmes for baseline monitoring, impact and compliance monitoring, data management procedures, and reporting of monitoring results.

Environmental audit specifications have been developed for the works, including organisation and management structure, procedures to ensure compliance with mitigation measures, environmental quality performance limits in the form of Trigger Action and Target (TAT) levels, procedures for reviewing results and auditing compliance with specified performance limits, Event/Action Plans, and detailed compliance, liaison, and consultation procedures. Appropriate control specification clauses have been recommended for inclusion in the EM&A Manual.

3.5.6 *Conclusion*

The key issues associated with the construction of RTT includes the elevation of suspended solids along Urmston Road, over Deep Bay and Ma Wan during dredging and filling activities; the marine disposal of dredged material; and the impact of the existing and reprovisioned outfall during the construction of RTT.

As the water quality impact of these key issues have already been well-assessed in the previously endorsed Tuen Mun Area 38 EIA[12], the EPD has considered that hydraulic and water quality modelling of the construction and operation of the RTT is not necessary. In this study, water quality impact of the RTT construction was therefore comparatively assessed with reference to the modelling results reported in the previously endorsed Tuen Mun Area 38 EIA.

Impacts of SS associated with the conservative worst-case RTT construction dredging and filling activities are predicted to be within the WQO limit (less than 6.4 mg l^{-1} elevation) at the sensitive receivers of Butterfly Beach and Cafeteria Beach, and over the waters at Deep Bay (less than 10.6 mg l^{-1} elevation). The levels of SS at the cooling water intakes of the Castle Peak Power Station is predicted to be within the acceptable limit of 150 mg l^{-1}. Mitigation measures are suggested to minimize the release, dispersion and, thus, the impact near the vicinity of the construction site.

Marine disposal of dredged mud should follow the procedures of Works Branch Technical Circular No. 22/92 for dumping permit application. As the sediment quality study[13] has shown that the marine sediment contains some Class C highly contaminated mud, the FMC will finalize the disposal allocation and contingent conditions after reviewing the Sediment Quality Report. The permit holder should take the responsibility to ensure that the permit conditions fully satisfy the Director of Environmental Protection. About 3 million m^3 of marine

(12) Reclamation and Servicing of Tuen Mun Area 38 for Special Industries - Environmental Impact Assessment Study: *Main Report*, ERM-Hong Kong, Ltd., December 1994.

(13) River Trade Terminal, Sediment Quality Report. Scott Wilson Kirkpatrick, August 1996.

mud will be dredged from the site and transported to the disposal site. Mitigation measures properly implemented will minimize the environmental impact during transportation and marine disposal of dredged material to acceptable levels.

The construction of the RTT will begin before the reprovision of the existing outfall of the PPSTW. Before reprovision of the outfall, the elevation of bacteria at the Butterfly Beach and within Deep Bay appear to have no direct relationship with the RTT construction. After outfall reprovision, significant improvement of water quality at Butterfly Beach and Deep Bay water is predicted. The reprovision of PPSTW outfall has been designed such that no seawall discharge occurs during outfall changeover, and timed to be undertaken over a very short duration to (4-5 hours maximum) to minimise adverse water quality impact of the discharge from the outfall emergency by-pass, and the RTT contract should specify such an arrangement. This would comprise the recommended mitigation measure necessary to protect local water quality during this changeover period.

Based on the results of this comparative assessment of water quality impacts, it is recommended that a water quality monitoring and audit programme be conducted during the reclamation works to detect any deterioration in water quality in a proactive manner. The stand alone Environmental Monitoring and Audit (EM&A) Manual has been prepared to provide guidelines to monitor any variation of water quality during construction and to control proper implementation of mitigation measures.

3.6 *OPERATION PHASE*

3.6.1 *Sources of Impact*

Reprovisioned Outfall

As described in *Section 2*, the RTT construction also includes the construction of a long replacement outfall for the existing Pillar Point outfall as shown in *Figure 3.6a*. This replacement outfall will be approximately twice the existing outfall length at around 2,070 m. This replacement outfall will discharge into the faster moving (>1m/s) waters of the main Urmstom Road channel at approximately -15 mPD which is deeper than the existing outfall discharge depth as well as providing a specified effluent dilution factor of 1:85.

The PPSTW outfall will be reprovisioned before the breakwater construction of RTT and will begin operation as soon as construction is completed. The location of this detailed designed reprovisioned outfall is shown in *Figure 3.6a*. This detailed design is very similar to the conceptual reprovisioned outfall proposed and modelled in the Tuen Mun Area 38 EIA, as shown in *Figure 3.6a*. The only changes comprise a diffuser configuration of the detailed design (from 500m in length to 350m) to minimise damage to the diffusers from marine traffic which results in the relocation of the closest outfall discharge point relative to the shore to approximately 300 m further out to sea. Additionally, a minor revision has been made to the detailed design reprovisioned outfall orientation intended to avoid the need for underwater blasting. This detailed design change will minimise construction impacts, in particular to marine mammals, including the Chinese White Dolphin (*Sousa chinesis*). The impact of the reprovisioned outfall during the construction of the RTT is anticipated to be no worse than the bacterial modelling results reported in the Tuen Mun Area 38 EIA[14]:

(14) Reclamation and Servicing of Tuen Mun Area 38 for Special Industries - Environmental Impact Assessment Study: *Main Report*, ERM-Hong Kong, Ltd., December 1994.

- The bacterial plume will travel beyond Shekou to the north and impact on the Kowloon coastline to the east of Ma Wan. The plume will remain within the deep water channel of the Urmston Road and has less impact on the coastline of the north-west New Territories due to the dilution of the bacterial plume. As the new outfall will discharge effluent directly into the deeper (at about - 15 mPD) faster moving waters of the Urmston Road, the dilution effect of the plume will be stronger and the extent of the plume dispersion will be further in contrast to the situation of the existing outfall.

- The plume that will intrude within Deep Bay will have *E. coli* lower than 1,000 per 100 ml and is considered as a significant improvement over the existing outfall condition.

- No impact of the bacterial plume upon the sensitive receivers of Butterfly Beach or Cafeteria Beach is predicted.

Sewage may also be discharged from the emergency by-pass if the new outfall is blocked or overflowed. The discharge point of the proposed new emergency by-pass will be located about 700 m off-shore with depth of about -14 mPD compared to the existing emergency outfall which is approximately 20 m from the sewage treatment works seawall. Provided that the emergency by-pass operates infrequently and during emergency conditions, any sewage discharge from the by-pass should not produce any long-term water quality impact to local or far-field waters.

RTT Configuration Comparison

In contrast to the conceptual layout of RTT assessed in the previous Tuen Mun Area 38 EIA study, the final RTT layout has been designed with a shorter breakwater. This will eliminate the semi-enclosed water body within the western portion of the RTT, enhance water movement and tidal flushing within the harbour of RTT. Accumulation of any solid and liquid waste within the harbour is not expected, provided zero polluted discharge can be ensured during the RTT operation.

Comparison with tidal flow modelling for Tuen Mun Area 38 EIA indicates that as the RTT will be located at the small bay (between the CPPS and PPSTW) off Siu Lang Shui, the operation of RTT will not affect the main tidal currents along Urmston Road.

Discharge Impacts

Stormwater discharged from the RTT should be the only direct discharge from the site during normal operation of RTT. As reported in the RTT Drainage Impact Assessment Report[15], flows through the stormwater drainage system on the southern side of mountain ridge near the Site are mostly natural stormwater runoff and thus no pollution problems will eventuate. In the light of the EPD's general policy "to prohibit any form of discharge in embayment / enclosed water bodies," the locations of catchment outfalls have been designed and located through discussion between the RTT engineering and environmental teams to avoid any direct discharge of stormwater into the enclosed waters of the RTT (*Figure 3.6b*).

(15) River Trade Terminal at Tuen Mun Area 38, Draft Drainage Impact Assessment Report, Scott Wilson Kirkpatrick, July 1996.

In general the RTT operation will not impact on water quality as it will comprise primarily container handling activities and this handling should not involve any liquid discharge. However, water pollution is still possible from the following RTT sources during RTT operation, shown on *Figure 2.1a*.

- oil spillage from the marine and inland-filling stations, and from the berthing vessels and on-site vehicles;
- liquid or solid discharge from the waste management site; and
- liquid discharge from the temporary / permanent workshops on-site.

In accordance to the RTT agreement, the RTT operator should provide appropriate mitigation measures, anti-oil pollution equipment and dispersants to prevent and cope with oil pollution, trade effluent or foul or contaminated water or cooling water or solid wastes from the RTT. Appropriate mitigation measures and equipment are described in *Section 3.6.2*.

Maintenance Dredging

According to the RTT agreement, the RTT operator should dredge and maintain the sea-bed fronting the Site in order to suit the operational requirements of vessels servicing the lot. Existing seabed levels are generally significantly below design navigation levels which will result in local and infrequent maintenance dredging programmes. However, occasional dredging within the inner basins is necessary to ensure safe navigation within the area of the RTT. Although potential detrimental effects to water quality will be similar to the dredging during the RTT construction (namely the elevation of SS and release of potential contaminants from sediments as a result of dredging), the scale of dredging is expected to be much lower than the construction phase and the impact is predicted to be retained over local waters only.

3.6.2 Mitigation Measures

Sewage Outfall Impacts

The impacts associated with the reprovisioned outfall are considered to be no worse than the predictions in the Tuen Mun Area 38 EIA[16]. This is because:

- the reprovisioned outfall is approximately the same as the conceptual design studied in the Tuen Mun Area 38 EIA but with a 350 m diffuser length as opposed to the 500 m conceptual design diffuser length. Thus the effluent will be discharged further away from the shore and will be subjected to the stronger tidal dispersion along the Urmston Road than the existing outfall which is only approximately half the reprovisioned outfall length. The distance away from the sensitive receivers such as Butterfly Beach will also be greater.
- The discharge point of the reprovisioned outfall will be located further away from the RTT, into the main flow of Urmston Road, and this will aid dispersion of the discharge, and prevent the possibility of effluent being circulated back into the RTT basin or onto the water sensitive receivers along

(16) Reclamation and Servicing of Tuen Mun Area 38 for Special Industries - Environmental Impact Assessment Study: *Main Report*, ERM-Hong Kong, Ltd., December 1994.

the Tuen Mun coastline which occurs with the existing outfall which is approximately half the length of the reprovisioned outfall.

Discharge Impacts Prevention

As discussed in *Section 3.6.1*, the detailed design has included the provision of mitigation measures to prevent potential pollution from the oil spillage and solid and liquid discharge from the site during the RTT operation to achieve a "zero discharge" condition.

The mitigation measures to control inland and marine fuel filling stations include:

- concrete slab paving will be used for ease of collection of spilt fuel and reduction of damage to paving;

- all drainage from the two filling stations will pass through an oil interceptor to remove any fuel prior to discharge; and

- the RTTC will make provision for marine fuel spill equipment at a readily accessible location and will develop fuel spill deployment procedures prior to any RTT fuel filling station operation. This may include oil containing booms, oil skimmers and absorbents and chemicals for containing and absorbing oil will also be available on site to tackle any fuel spillage from a berthed vessel.

The mitigation measures at the waste collection area include:

- concrete slab paving for ease of washing and collection of leachate;

- shallow bund wall inside the shelter for storage of spilt leachate and collection to a trap;

- washing water and leachate fed into foul sewage system of adjacent toilet block; and

- interceptor to stormwater drainage system only to external areas of waste collection area.

The mitigation measures at the temporary and permanent workshops include:

- concrete slab paving for ease of collection spilt oils; and

- oil interceptor to drainage of workshop area.

Assuming the RTT ensures that 'zero' polluted discharge occurs from the operational site, the effluent standards of Technical Memorandum[17] which applies to all effluents discharged into marine or freshwater bodies and the WQOs of the marine water near the site will therefore be complied with in full. The stormwater drain located along the western edge of the RTT will discharge at the southern end of the western RTT seawall. However, with all potential RTT polluted effluents being collected and diverted for treatment off-site, this will purely discharge stormwater into the surrounding North Western WCZ and,

(17) Technical Memorandum Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters, Environmental Protection Department, January 1991.

thus, associated impacts are not envisaged. Additionally, as described in *Section 3.6.1* the location of catchment outfalls have been situated in accordance with EPD's general policy "to prohibit any form of discharge in embayment/ enclosed water bodies" as can be seen in *Figure 3.6b.*

3.6.3 *Operational EM&A*

No water quality will be required for the RTT operational phase. The operation stage of the reprovisioned outfall will be monitored as part of the forthcoming EPD *Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall* Study which is scheduled to commence in late 1996.

3.6.4 *Conclusion*

The key issues identified during the operation of the RTT will be the impact from the reprovisioned PPSTW outfall, on-site solid and liquid discharge, oil spillage, and the local and far field water movement in relation to the final RTT layout.

The final RTT layout has a shorter breakwater, thus a semi-enclosed area of RTT basin is eliminated. The final layout facilitates the tidal flushing and water movement within the RTT harbour whilst this design also minimises the potential of any solid or liquid waste accumulation within the RTT harbour. As the RTT will be located at the small bay (between the CPPS and PPSTW) off Siu Lang Shui, the operation of RTT will have no effect on the main tidal currents or local or far field water movement along Urmston Road. The assessment indicates that the operation of the RTT will not impact on water quality as RTT operations will primarily comprise the handling of containers. In terms of potential water quality impact sources, however, there will be a land and marine fuel filling station, temporary and permanent workshops and a solid waste management site, although the detailed design of these facilities have included water pollution control measures. Thus these facilities will not impact on marine water quality and will fully comply with the required EPD Water Pollution Control Ordinance discharge licence. In addition, in the light of the EPD's general policy "to prohibit any form of discharge in embayments/enclosed water bodies" the detailed stormwater drainage design has located stormwater drainage outfalls to avoid any direct discharge to the RTT basin waters, which will be beneficial in terms of water quality.

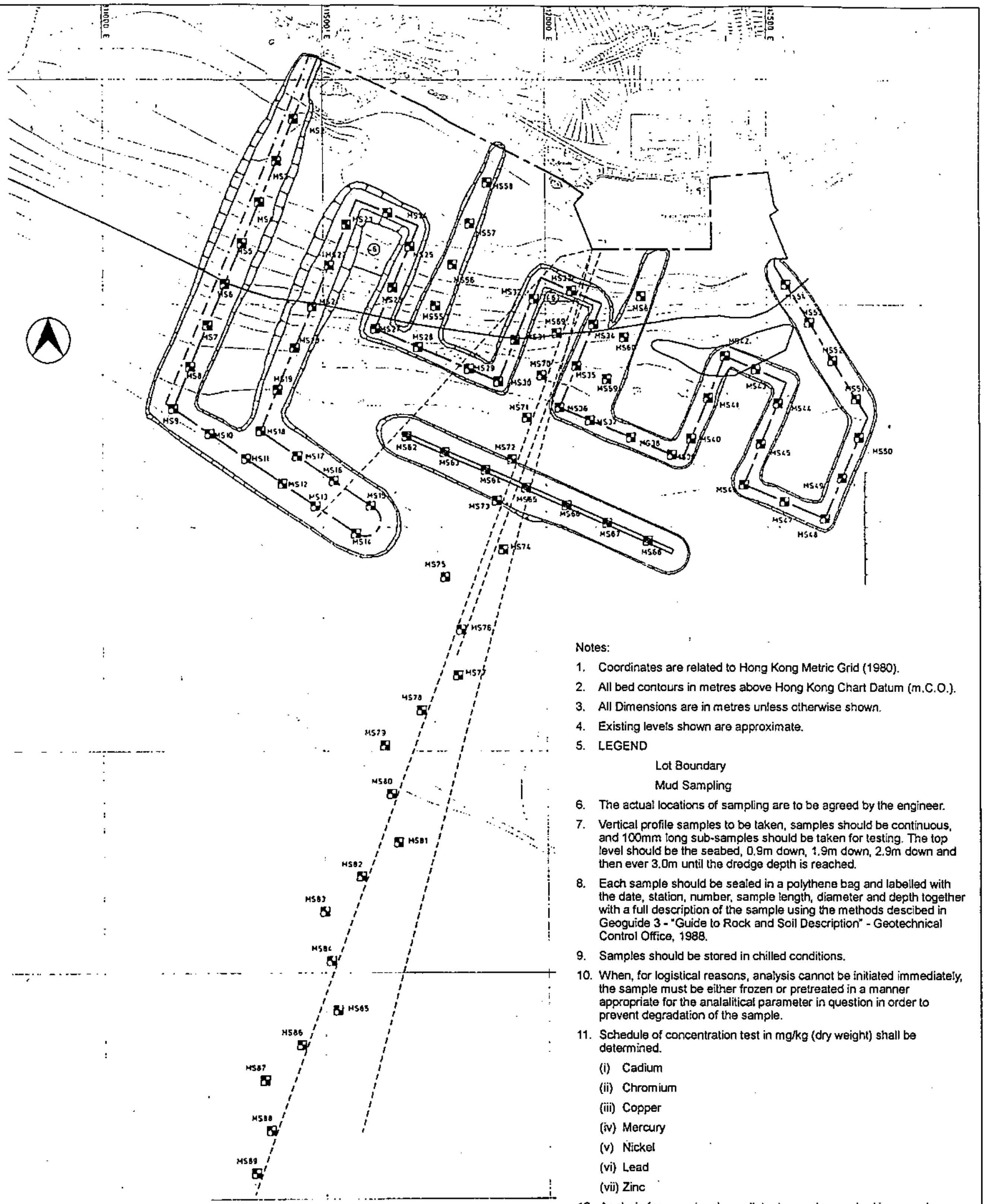
During the operational stage, sewage generated by the RTT facility and the vessels berthing at the RTT could lead to detrimental water quality impacts if released into the water column. However, provided 'zero' on-site polluted discharge is ensured by RTTC, the effluent standards of Technical Memorandum[18] which applies to all effluents discharged into marine or freshwater bodies will be complied with in full.

Reprovisioned Outfall

The previously accepted Tuen Mun Area 38 EIA comprised extensive water quality modelling of the reprovisioned Pillar Point outfall which confirmed the acceptability of the reprovisioned outfall. Comparative assessment undertaken as part of the EIA of the RTT indicated that the minor detailed design differences with regard to diffuser configuration still achieves the required 1:85 effluent

(18) Technical Memorandum Standards for Effluents Discharged into Drainage and Sewerage Systems, Inland and Coastal Waters, Environmental Protection Department, January 1991.

dilution factor and the diffuser location will also lead to discharge further from the existing Tuen Mun shoreline. The detailed design is therefore in accordance with the endorsed findings of the Tuen Mun Area 38 EIA with regard to reprovisioned outfall acceptability. Overall the assessment undertaken concludes that the reprovisioned outfall will lead to an improvement over the existing shorter outfall condition as the outfall will be in compliance with WQOs at WSRs and will no longer be responsible for bacterial pollution of the adjacent gazetted Tuen Mun bathing beaches.



Notes:

1. Coordinates are related to Hong Kong Metric Grid (1980).
2. All bed contours in metres above Hong Kong Chart Datum (m.C.O.).
3. All Dimensions are in metres unless otherwise shown.
4. Existing levels shown are approximate.
5. LEGEND
   - Lot Boundary
   - Mud Sampling
6. The actual locations of sampling are to be agreed by the engineer.
7. Vertical profile samples to be taken, samples should be continuous, and 100mm long sub-samples should be taken for testing. The top level should be the seabed, 0.9m down, 1.9m down, 2.9m down and then ever 3.0m until the dredge depth is reached.
8. Each sample should be sealed in a polythene bag and labelled with the date, station, number, sample length, diameter and depth together with a full description of the sample using the methods descibed in Geoguide 3 - "Guide to Rock and Soil Description" - Geotechnical Control Office, 1988.
9. Samples should be stored in chilled conditions.
10. When, for logistical reasons, analysis cannot be initiated immediately, the sample must be either frozen or pretreated in a manner appropriate for the analalitical parameter in question in order to prevent degradation of the sample.
11. Schedule of concentration test in mg/kg (dry weight) shall be determined.
   (i) Cadium
   (ii) Chromium
   (iii) Copper
   (iv) Mercury
   (v) Nickel
   (vi) Lead
   (vii) Zinc
12. Analysis for organic micropollutants may be required in area where contamination by such compounds is suspected.
   (i) tributyl tin (TBT)
   (ii) polyaromatic hydrocarbons (PAH's)
   (iii) polychlorinated biohenyls (PCB's)

FIGURE 3.3a - LOCATION OF VIBROCORES FOR GROUND INVESTIGATION OVER THE STUDY AREA

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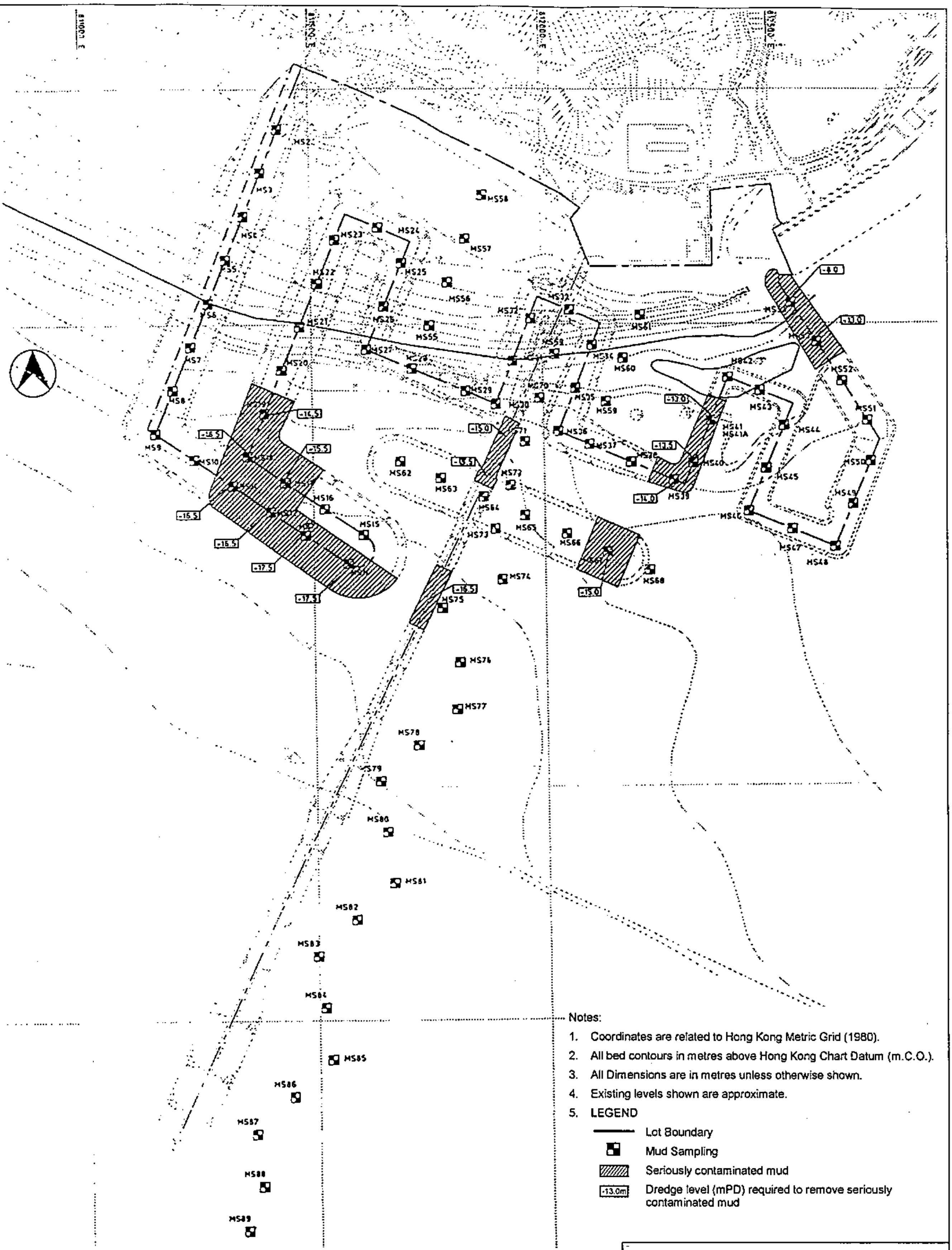

FIGURE 3.3b - LOCATION OF SERIOUSLY CONTAMINATED MUD IN THE STUDY AREA

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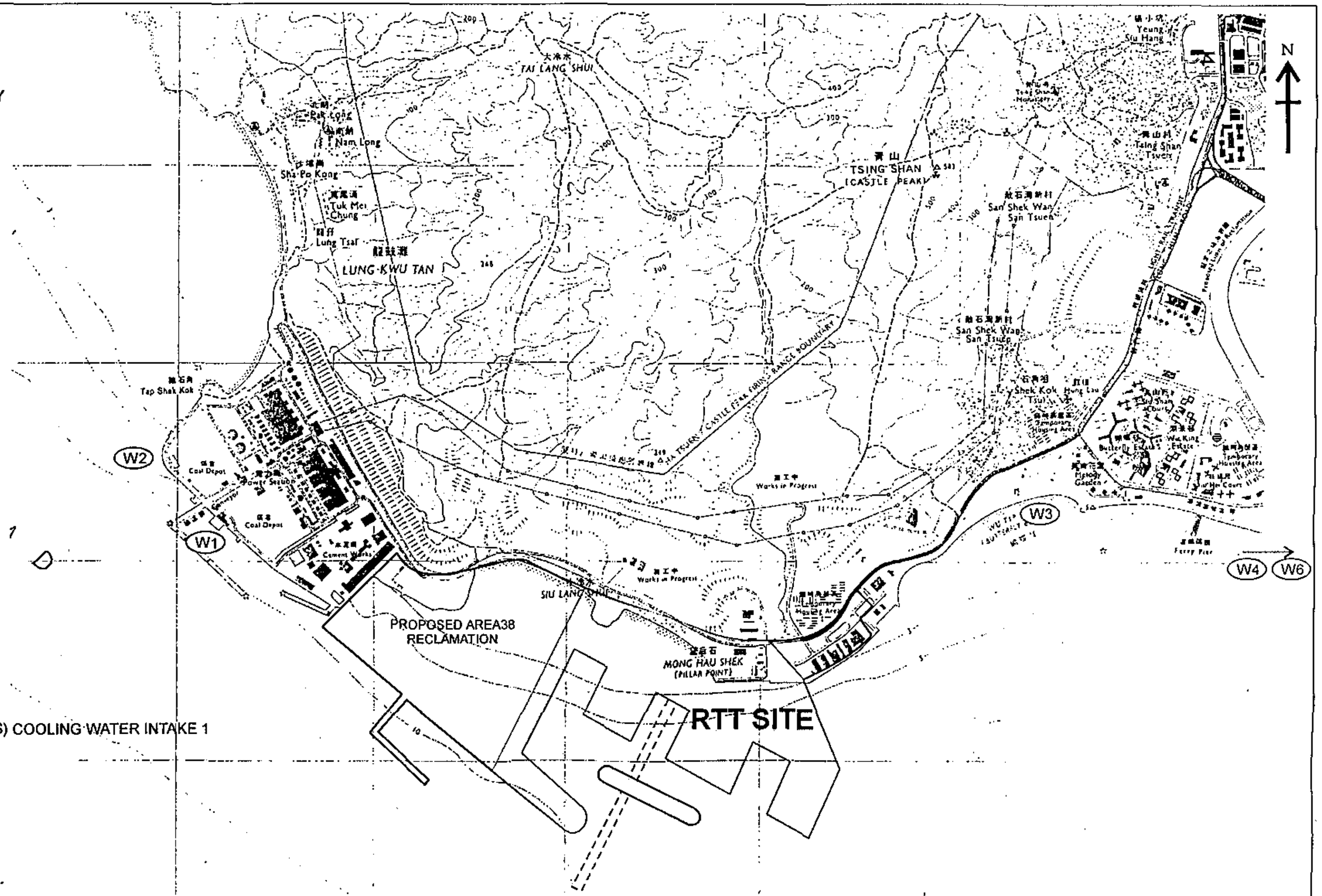

KEY

WATER SENSITIVE RECEIVERS (W1)

W1 - CASTLE PEAK POWER STATION (CPPS) COOLING WATER INTAKE 1

W2 - CPPS COOLING WATER INTAKE 2

W3 - BUTTERFLY BEACH

W4 - CASTLE PEAK BEACH

W5 - KADOORIE BEACH

W6 - CAFETERIA BEACHES (NEW & OLD)

FIGURE 3.4a - LOCATION OF WATER QUALITY SENSITIVE RECEIVERS

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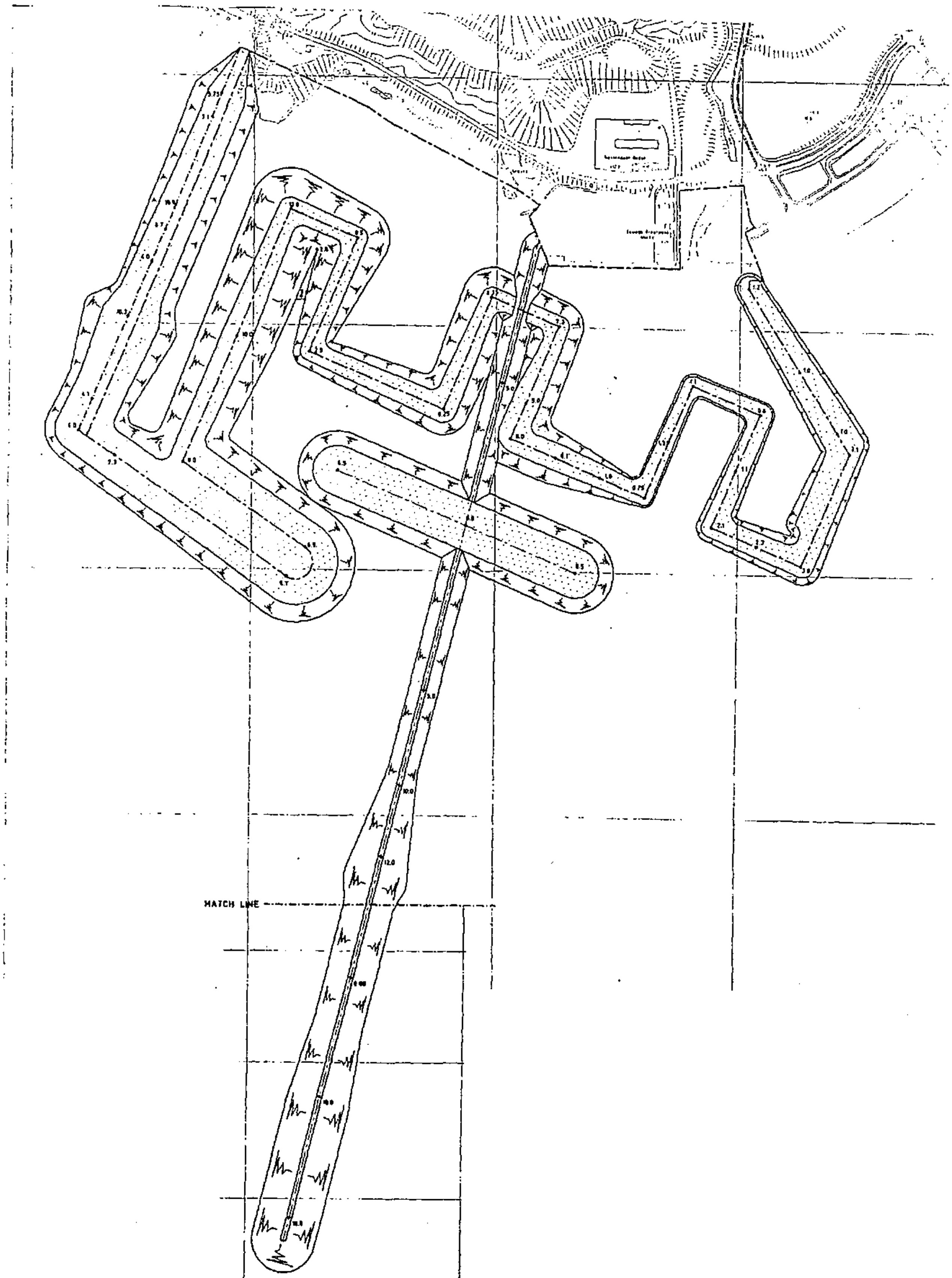

FIGURE 3.5a - DREDGING PLAN

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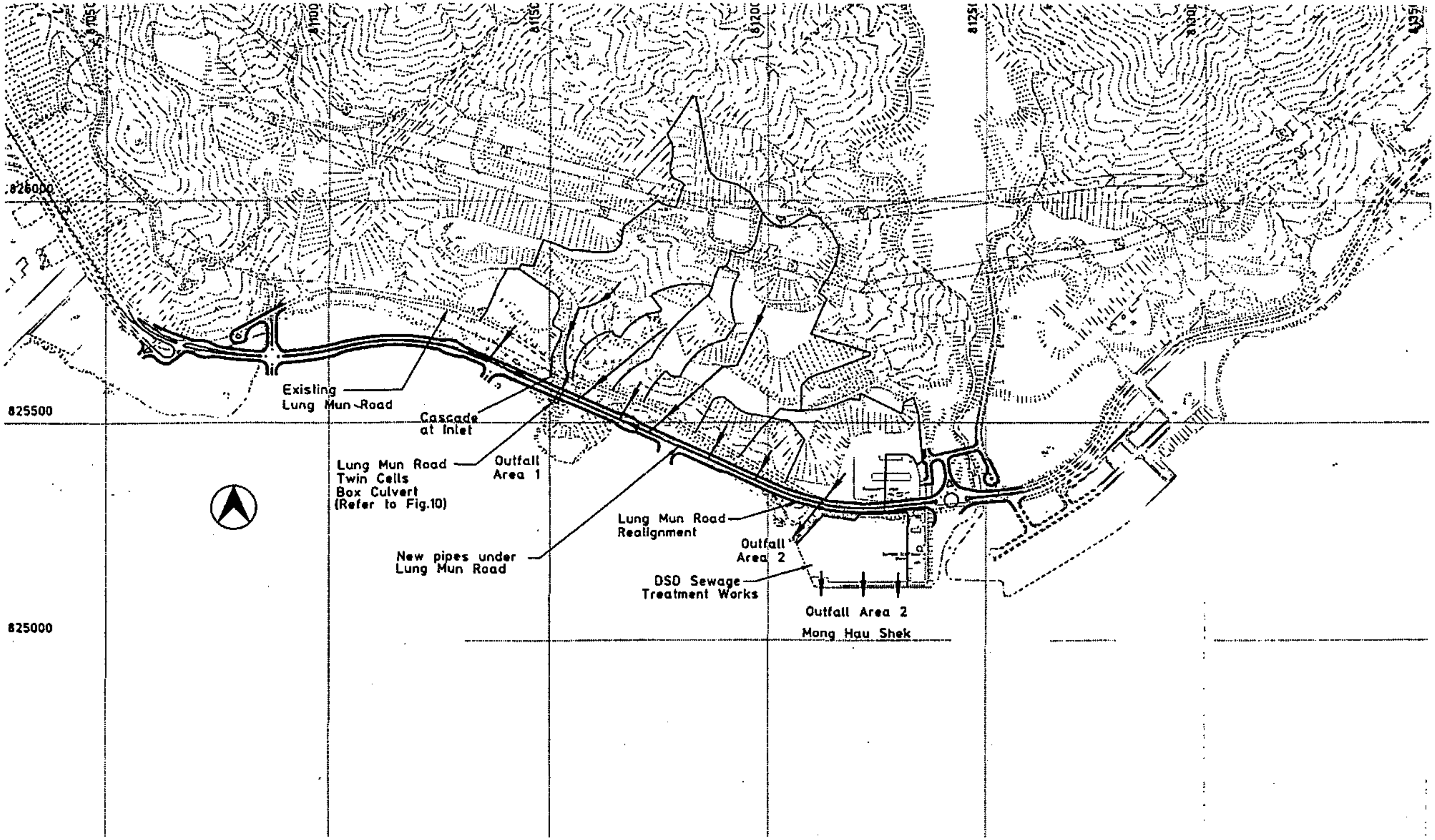

FIGURE 3.5b - CATCHMENT DRAINAGE LAYOUT WITH LUNG MUN ROAD REALIGNMENT

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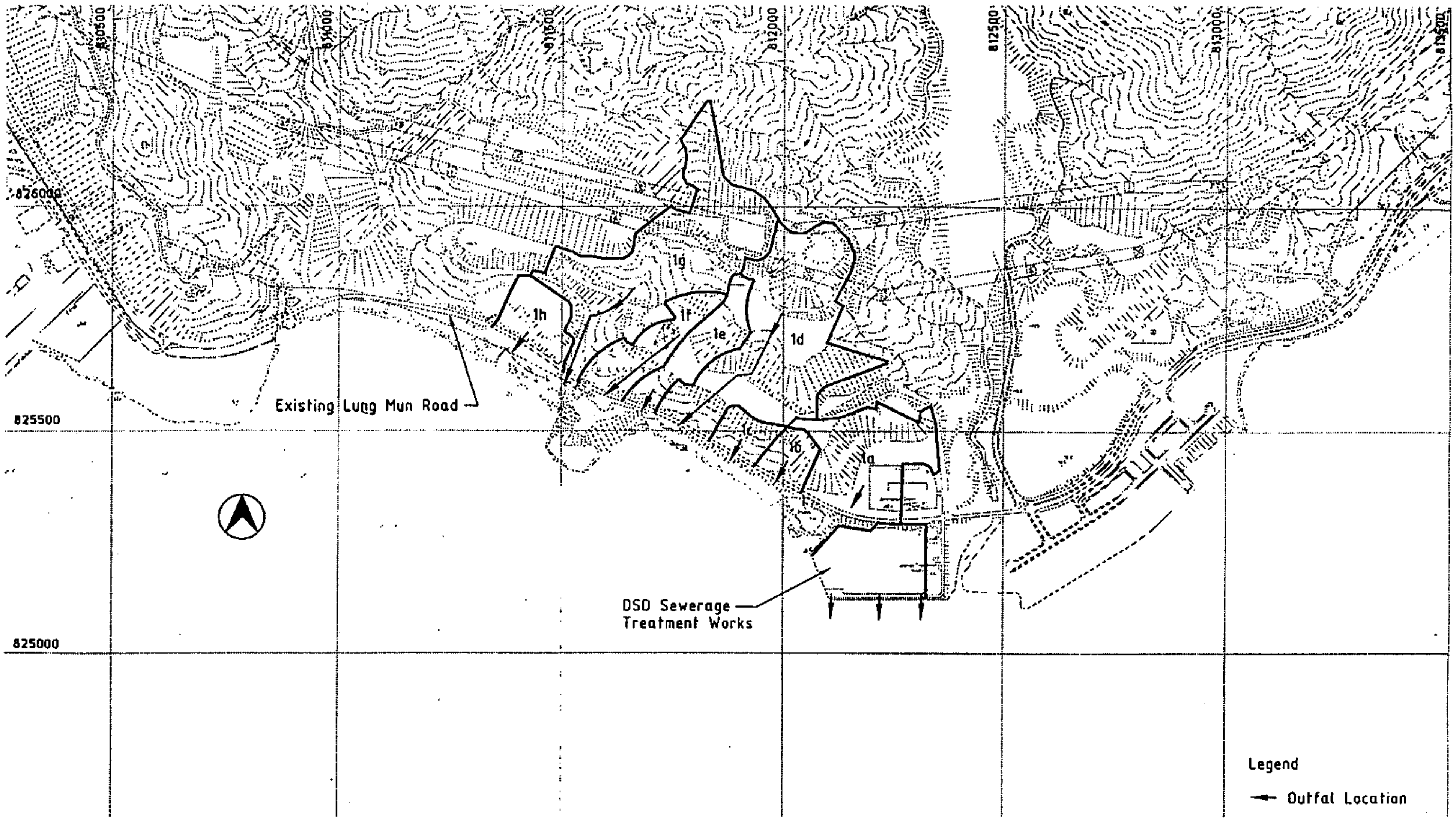

FIGURE 3.5c - EXISTING CATCHMENT DRAINAGE FLOW PATTERN

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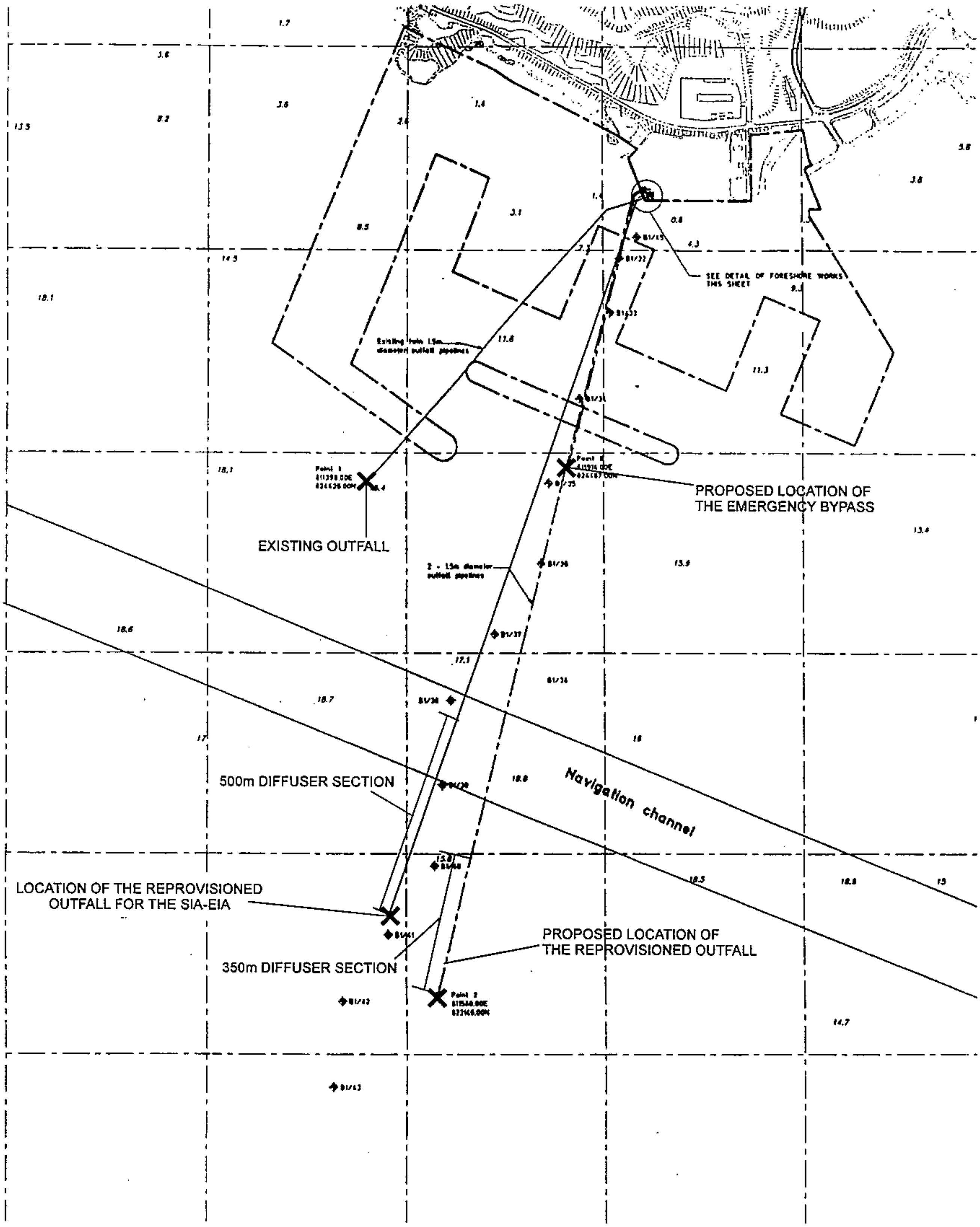

FIGURE 3.6a - COMPARISON OF THE LOCATION OF THE PILLAR POINT SEWAGE OUTFALL

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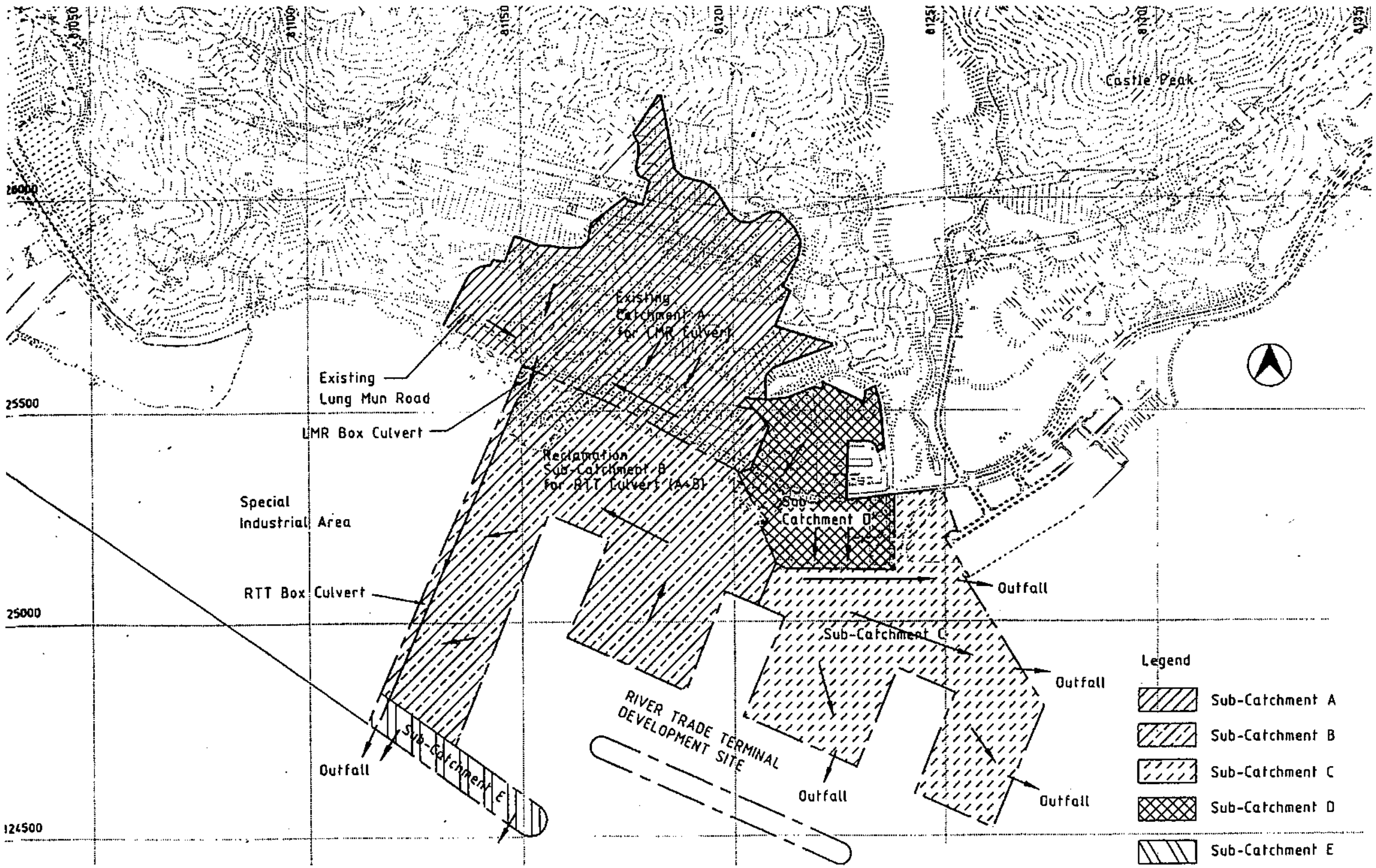

FIGURE 3.6b - EXISTING AND PROPOSED DEVELOPMENT CATCHMENT AREAS

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4 AIR QUALITY IMPACTS

4.1 INTRODUCTION

In terms of air quality, the Tuen Mun Area 38 EIA focused on the air pollution arising from the SIA construction and operation. Therefore, as part of this EIA for the RTT, a quantitative assessment of the air quality impact associated with the construction and operation of RTT was undertaken. Air Sensitive Receivers (ASRs) were identified and worst case impacts on these receivers have been modelled and presented. Dust impact upon the ASRs was considered to be the key concern during construction phase. For the operational phase, emissions from the land and marine traffic comprise pollutant sources. The benefits in terms of air quality for the RTT due to the reduction in marine traffic were also addressed.

4.2 GOVERNMENT LEGISLATION AND STANDARDS

The principal legislation for the management of air quality is the Air Pollution Control Ordinance (APCO) (Cap 311). The whole of the Hong Kong Territory is covered by the Hong Kong Air Quality Objectives (HKAQOs) which stipulate the statutory limits of some typical air pollutants and the maximum allowable numbers of exceedence over specific periods. The HKAQOs are shown in *Table 4.2a* below.

Table 4.2a *Hong Kong Air Quality Objectives*

Pollutant	Concentration in micrograms per cubic metre (i)			
	Averaging Time			
	1 Hour (ii)	8 Hours (iii)	24 Hours (iii)	1 Year (iv)
Total Suspended Particulates (TSP)			260	80
Respirable Suspended Particulates (v) (RSP)			180	55
Nitrogen Dioxide (NO_2)	300		150	80
Carbon Monoxide (CO)	30,000	10,000		

Note:
(i) Measured at 298K (25°C) and 101.325 kPa (one atmosphere).
(ii) Not to be exceeded more than three times per year.
(iii) Not to be exceeded more than once per year.
(iv) Arithmetic means.
(v) Respirable suspended particulates means suspended particles in air with a nominal aerodynamic diameter of 10 micrometres and smaller.

The Environmental Protection Department (EPD) also recommends a maximum level of 500 $\mu g/m^3$ for 1-hr TSP at ASRs for construction dust impact assessment criterion. .

4.3 BACKGROUND CONDITIONS

The existing air quality of the site is defined as generally good, although this has been temporarily affected by the ongoing SIA Reclamation Works located to the west of the RTT site. Other potential air sources in the area include industrial emissions from China Cement Works and Castle Peak Power Station located around 1,500 m away as well as vehicle emissions from Lung Mun Road.

Future conditions of the Study Area is likely to change with the operation of Centralised Incineration Facilities (around 700 m away) and Shiu Wing Steel Mill (around 1,000 m away) and other associated facilities. In addition, traffic generated by the additional facilities will also affect the air quality of the area.

4.4 AIR SENSITIVE RECEIVERS

Representative Air Sensitive Receivers (ASR) have been identified, through site inspection and review of landuse plans, in accordance with the criteria set out in the *Hong Kong Planning Standards and Guidelines (HKPSG)* and the *Air Pollution Control Ordinance (APCO)*.

The site is located well away from residential developments and recreational area of Tuen Mun Town. The only identified ASR is the adjacent industrial site located at 10 m from northwest site boundary (Area 40 Industrial Area) and is shown in *Figure 4.4a*.

Air quality monitoring data taken from the *Foothill Bypass, Tuen Mun Road/Wong Chu Road Interchange and Other Junction Improvement Works - EIA* showed that the area has been temporarily affected by the SIA reclamation works. The data from this study was not considered to be suitable as a representative of the background air quality conditions and therefore the EPD air quality data was used.

At present, there is no fixed air quality monitoring station in the Tuen Mun area. The ambient air quality of Hong Kong was used to provide an indication of air quality of the RTT site. The annual averages of pollutants in Hong Kong for the year 1995 have been used as the baseline levels for this Study and are summarized in *Table 4.4a*.

Table 4.4a ***Air Quality of Hong.Kong in 1995***

Pollutant	Concentration ($\mu g/m^3$)
SO_2	20
NO_2	57
CO	1,220
O_3	26
TSP	96
RSP	60

4.5 CONSTRUCTION PHASE

4.5.1 *Potential Sources of Impact*

The major air quality impact arising from the construction of RTT will be from activities that generate dust. Pollutants such as SO_2 and NO_2 will be emitted from diesel-powered mechanical plant. Since the number of such plant used on site will be limited, the gaseous emissions are expected to be minor and therefore not expected to exceed the AQO for these gases.

The potential dust generating activities of the RTT site are described as follows:

Dredging and Reclamation

Dredging works are required prior to the construction of seawalls. However, as the moisture content of dredged materials will be high, dust emission from this activity is expected to be low.

Rock and sand filling will also be undertaken during the reclamation phases. It is expected that barges will be used to transfer marine sand to the site as fill material during reclamation. When the reclamation works are carried out below sea level, dust emissions from the site will be minimal. As the reclamation height reaches above sea level, dust emissions from the site are expected to increase. The increase in emissions will be generated from activities such as dropping materials onto receiving surfaces. However, due to the high moisture content of the marine sand expected to be used as fill material, dust generation from reclamation is also expected to be limited.

Stockpiling and Surcharging

Once the reclamation for each phase is completed, large volumes of surcharge materials will be transferred and stockpiled onto them. Wind erosion over the exposed stockpiles and surcharges is expected to be a major source of dust emissions.

Truck Movement on Unpaved Haul Road

It is expected that the filling materials will be delivered to the site by barges. Bulldozers will also be employed to handle the surcharge materials. It is likely that haulage of truck within the site will be minimized.

4.5.2 *Assessment Methodology*

The Fugitive Dust Model (FDM) has been used in this Study to predict the likely dust impacts at ASRs from the construction of RTT. Potential dust impacts in term of TSP level were modelled for both the hourly and daily averages at ground level. Particulate emission rates for the identified dusty sources were determined based on the USEPA publication *Compilation of Air Pollution Emission Factors (AP-42) 5th edition 1995*, as shown in *Table 4.5a*.

Table 4.5a ***Dust Emission Factors***

Activity	Emission Rate	Remarks
Material handling	0.00518 g/s	Moisture content: 50%
Bulldozing	0.5 g/s	Silt content: 7% Moisture content: 8%
Wind erosion	2.7×10^{-6} g/s/m^2	

Ref: Compilation of Air Pollution Emission Factors (AP-42) *5th edition 1995*, An average dust density of 2,500 kg/m^3 and particle size distribution based on *AP-42* for each activity were assumed in the model. A worst case daytime meterological data of stability class D and wind speed of 1 m/s were employed for the model run.

As discussed in *Section* 2.3, the construction of RTT will be carried out in two phases. The areas nearest to the existing seashore will be reclaimed in Phase 1 and will be the worst dusty period. Air quality impact of Phase 1 was modelled and it is assumed that all the dust generating activities of material handling, bulldozing and wind erosion will be carried out in parallel.

4.5.3 *Evaluation of Impacts*

Concentrations of dust at the ASR as well as the site boundary have been modelled and their location are shown in *Figure 4.4a*. Both the 1-hr and 24-hr averaged TSP concentrations for the worst case dusty period have been modelled and are given in *Table 4.5c* .

Table 4.5c ***Predicted Unmitigated TSP Levels at ASRs and Site Boundary***

ASR	Location	Predicted TSP Concentration ($\mu g/m^3$)(1)	
		1-hr	24-hr
A1	Area 40 Industrial Area	211	133
A2	Northwest boundary	247	149
A3	North boundary	414	240

Note: (1) These results include the background level of 96 $\mu g\ m^{-3}$

Modelling results have predicted that the dust criteria will be satisfied at the ASR as well as the site boundary during the worst case period. Highest 1-hr TSP of 414 $\mu g/m^3$ and 24-hr TSP of 240$\mu g/m^3$ have been predicted at the north boundary near Lung Mun Road (A3) .

4.5.4 *Mitigation Measures for Construction Activities*

The following dust suppression measures are recommended to be incorporated in the Contract Specifications as good construction practice and implemented to minimise dust impact arising from the works.

- Water sprays should be used during the handling of fill material at the site where dust is likely to be created.
- The heights from which excavated materials are dropped should be controlled to a minimum practical height to minimize the fugitive dust arising from unloading.
- Stockpiles of aggregate and spoil should be enclosed or covered and water applied in dry or windy condition;
- Effective water sprays should be used on site at potential dust emission sources such as unpaved areas.
- Wheel washing facilities should be provided at exits of the sites.

4.6 *EM&A*

It has been recommended that a construction stage monitoring station be set up at the Area 40 Industrial Area only during the first phase of the RTT construction works. Quarterly reviews of this monitoring should be conducted to assess the need for continual dust monitoring. Regular audits of the site should also be carried out to minimise the dust emissions from construction activities.

4.7 OPERATIONAL PHASE

4.7.1 *Potential Sources of Impacts*

The RTT will be used as a 'transfer station' for cargo handling vessels. Small PRC vessels will unload their cargoes at the terminal and the containers will be consolidated into a large vessel shuttling between the RTT and container terminals in Kwai Chung.

Emissions such as NO_2, CO, and RSP are expected from vessels and vehicles and will be the major air pollutants during the operation of RTT. The diesel-powered plants operating inside the RTT will also generate pollutants. However, since the number of plant and the duration of their operation are limited, gaseous emissions from the plants are expected to be minor.

Marine traffic volume for the two scenarios, without RTT and with RTT, are presented in *Table 4.7a*. An estimated total of 509 vehicles (in and out) will be generated during the peak hour of RTT operation as shown in *Table 4.7b*, based on *Appendix B* of the *Traffic Impact Assessment* submitted as part of the Tender[19].

Table 4.7a ***Marine Traffic Volume***

Vessel	Capacity	Number per year	
		Without RTT	With RTT
Breakbulk	100t	7,000	
Container	500t	18,200	
Marine Shuttle Lighter	100 TEU		6,400

Source: TM TL No 393 River Trade Terminal at Tuen Mun Area 38, Volume 3 - Traffic Assessment, Section 2.3.

Table 4.7b ***Peak Hour Vehicle Traffic***

	Peak Hour Traffic Flow (In and Out)	
	pcu/hr	Veh/hr
Goods Vehicle	625	226
Private Cars/Taxi	236	236
Public Transport	142	48
Total	557	509

(19) TM TL No 393 River Trade Terminal at Tuen Mun Area 38, Volume 3 - Traffic Assessment. Hong Kong River Trade Terminal Limited.

4.7.2 *Assessment Methodology*

Diesel engines are typically used for cargo carrying vessels. However, the relative lack of standardisation makes it difficult to derive standard emission factors of vessels. The marine freight will be conveyed by vessel. In Hong Kong, engine size of an average vessel is about a few kilowatts. Estimations of emission factors have been made in accordance with *Compliance of Air Pollutant Emission Factors, 4th edition* developed by USEPA, and are shown in *Table 4.7c.*

The distance between RTT and Kwai Chung Container Terminals is about 25 km. For this assessment, it is assumed that the vessel would be moving at a speed of about 6 knots and required 2 hours for the freight transport.

Without the RTT, the cargo will be transported on land by container trucks. It is estimated that the handling capacity of one container truck is equivalent to 1/50 of the carrying capacity of an RTT vessel. Fleet average emissions factors of trucks for the year 1996, based on EURO 2 Model, are listed in *Table 4.7c.*

Table 4.7c ***Emission Factors of Freight Transport***

Pollutant	Emission Factor	
	Tug boat (g/s)	Container Truck (g/km)
RSP	0.121	1.421
CO	0.0208	8.404
NO_x	0.338	11.951

Source: Compliance of Air Pollutant Emission Factors, 4th edition, USEPA

4.7.3 *Evaluation of Impacts*

With the operation of the RTT, traffic from Tuen Mun Road will be reduced. In general, freight movement by water is more efficient than movement by road in terms of emissions per freight tonne moved. *Table 4.7d* shows the benefit of using shuttle barge as the medium of transport.

Table 4.7d ***Estimates of Amount of Pollutant Generated***

Pollutant	Amount of Pollutant Generated (tonne / year)		Benefit (tonne / year)
	Marine Traffic	Land Traffic	
RSP	11.2	22.7	-11.5
CO	1.9	134.5	-132.6
NO_x	31.1	191.2	-160.1

With the shuttle barge, the amount of NO_x and CO could be reduced by 160 tonnes and 130 tonnes per annum respectively. The RSP generated will also be reduced by 50%. It should also be noted that the emissions of vessels generally occurred in situations where dispersal is rapid and similar sources are not concentrated in close proximity to each other, as is typically the case with road transport. Therefore, marine traffic is a better means of transport in terms of air quality.

Air quality impacts of the traffic related to the RTT has been assessed in the *Expanded Development Study of Tuen Mun Area 38*[20], *Reclamation and Servicing of Tuen Mun Area 38 for Special Industries - EIA*[21] and *Foothill Bypass, Tuen Mun Road/Wong Chu Road Interchange and Other Junction Improvement Works EIA*[22] and the AQO will be satisfied at the ASRs.

The proposed RTT arrangement will reduce road traffic by carrying freight by water and hence reduce the emissions per its air quality impact. It is estimated that about 500 vehicle/hour and 18 vessel/day (less than 1 vessel/hour) will be generated with the RTT operation. However, with the introduction of the Foothills Bypass, vehicles will bypass the Lung Mun Road and the Tuen Mun Town Centre and therefore, it is unlikely that air quality of the ASRs will be impacted by the proposed RTT operation.

4.8 *CONCLUSIONS*

4.8.1 *Construction Phase*

The RTT site is located well away from residential developments and the recreational areas of Tuen Mun Town. The only identified ASR is the adjacent industrial site located at 10 m from northwest site boundary (Area 40 Industrial Area). Fugitive dust was expected to be the key pollutant during construction of the RTT and an EPD approved dust dispersion model (FDM) was employed to predict the impact upon the ASR located in the adjacent industrial site.

As marine plant will be employed for the reclamation and the scale of works is small, dust impacts exceeding the criteria were not predicted at the ASR or the site boundary. Major dust generating activities will be material handling, bulldozing and wind erosion over surcharge materials. Dust suppression measures and EM&A of dust emissions are to be adopted, as good site practice, to reduce the dust emission from the site during RTT construction.

4.8.2 *Operational Phase*

This quantitative RTT assessment indicates that freight carried by barge is a better mode of transportation than road transportation in terms of air quality. The proposed RTT arrangement will reduce road traffic by carrying freight by water and the function of the RTT in consolidating the container loads of approximately 10 small PRD river trade vessels on to one large barge will reduce the numbers of marine vessels trafficking the water east of the RTT to Kwai Chung by approximately 10%. The amount of nitrogen oxides generated would be reduced by 160 tonnes per annum; while the amount of carbon monoxide and particulate matter would be reduced by 130 and 23 tonnes per annum, respectively. As the pollutant generated from both the marine and land traffic are expected to be low, the air quality of the ASR will satisfy the AQO and further mitigation measures are therefore not required.

(20) Expanded Development Study of Tuen Mun Area 38 - Final Report, October 1990. Scott Wilson Kirkpatrick & ERL (Asia) Ltd.

(21) Reclamation and Servicing of Tuen Mun Area 38 for Special Industries - EIA. December 1994. ERM Hong Kong Ltd.

(22) Foothill Bypass, Tuen Mun Road/Wong Chu Road Interchange and Other Junction Improvement Works Draft EIA. 1996. ERM Hong Kong Ltd.

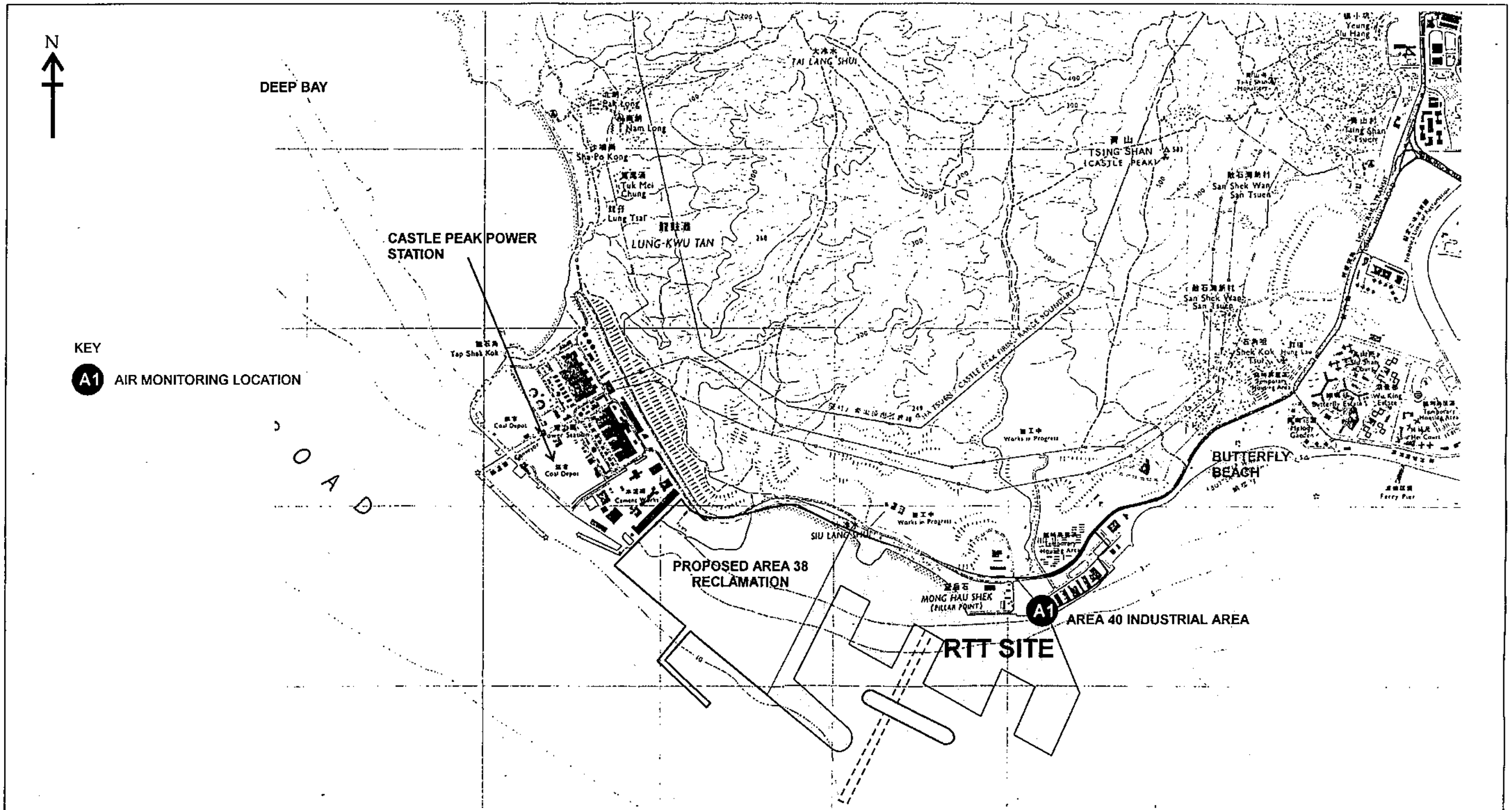

FIGURE 4.4a - LOCATION OF AIR SENSITIVE RECECIVERS

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9 Chatham Road
Tsimshatsui, Kowloon
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5 *NOISE*

5.1 INTRODUCTION

In terms of noise impact, the Tuen Mun Area 38 EIA focused on the noise arising from SIA construction and operation. Therefore, as part of this EIA for the RTT an assessment of noise impacts was conducted for construction and operational phases of the RTT. Potential noise sources during the construction phase of the RTT are mainly due to equipment used for filling, dredging, construction of seawalls, land based percussive piling and construction of buildings. For the operational phase, potential noise impacts are mainly due to equipment used for loading and unloading containers, ventilation plant in the Container Freight Station and traffic arriving and departing from the RTT facility.

The assessment of the construction noise was carried out in accordance with the *Noise Control Ordinance (NCO)* and its subsidiary Technical Memoranda:

- the *Technical Memorandum on Noise from Construction Work other than Percussive Piling (March 1996),*
- *the Technical Memorandum on Noise from Percussive Piling (July 1991),* and
- *the Technical Memorandum on Noise from Construction Work in Designated Areas (March 1996).*

For the operational phase, the noise assessment was carried out in accordance with:

- the *Hong Kong Planning Standards and Guidelines* (HKPSG, April 1991) and
- *the Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites (July 1991).*

5.2 GOVERNMENT LEGISLATION AND GUIDELINES

5.2.1 Construction Phase

Construction other than Percussive Piling

In Hong Kong, the control of noise from construction other than percussive piling outside normal working hours is governed by the NCO and *Technical Memorandum (TM1) on Noise from Construction Work other than Percussive Piling (March 1996).* The TM1 establishes the permitted noise levels for construction work depending on working hours and the NSRs' Area Sensitivity Ratings. Normal working hours are defined as from 07:00 - 19:00, Monday to Saturday.

Construction during restricted hours (1900-0700) and general holidays requires a Construction Noise Permit (CNP) which requires the Acceptable Noise Levels (ANLs) to be met at the NSRs.

Table 5.2a *Noise Criteria for Construction other than Percussive Piling during Restricted Hours*

Time Period	ANL, dB(A)		
Area Sensitivity Rating	A	B	C
All days during the evening (1900-2300) and general holidays (including Sundays) during the day and evening (0700-2300)	60	65	70
All days during the night-time (2300-0700)	45	50	55

Although the NCO currently does not provide noise criteria for construction activities during normal working hours, a limit of $L_{Aeq,(30\ min)}$ 75 dB is proposed in the *Practice Note for Professional Persons, PN2/93* issued by the Professional Persons Environmental Consultative Committee (ProPECC) in June 1993. This limit has been applied on major construction projects recently, and is now generally accepted in Hong Kong, and will therefore be adopted in this study.

Percussive Piling

For percussive piling, the control of noise is required during normal and restricted working hours. The noise criteria during normal working hours are specified in the "Technical Memorandum (TM2) on Noise from Percussive Piling (July 1991)" and are summarised in *Table 5.2b* below. Percussive piling is prohibited during restricted hours.

Table 5.2b *Noise Criteria for Percussive Pilling during Normal Hours*

NSR Window Type or Means of Ventilation	ANL, dB(A)
NSR with no windows or other openings	100
NSR with central air conditioning system	90
NSR with windows or other openings but without central air conditioning system	85

The noise criteria for percussive piling are dependent on the NSRs' window type and means of ventilation rather than the Area Sensitivity Rating. For this assessment, it has been assumed that the potentially affected NSRs have windows but without central air conditioning system, and hence a criterion of $L_{Aeq,(30\ mins)}$ 85 dB during normal working hours applies.

The TM2 also states that $L_{Aeq,(30\ min)}$ 10 dB should be subtracted from the ANL given in *Table 5.2b* for hospitals, medical clinics, educational institutions, courts of law or other NSRs which are considered by the Authority to be particularly sensitive to noise. However, none of the potentially affected NSRs in the vicinity of the proposed RTT would be classified as such and hence this additional requirement is not relevant for this study.

5.2.2 *Operational Phase*

Noise Criteria for On-Site Operations

Potential noise sources from on-site operations of the proposed RTT will be equipment used for loading and unloading containers and ventilation plant in the Container Freight Station.

The criteria for operational noise are specified in the *Technical Memorandum for the Assessment of Noise from Places other than Domestic Premises, Public Places or Construction Sites (July 1991)*. The HKPSG requires the criteria to be 5 dB below the ANLs for "fixed" noise sources.

It should be noted that the Area Sensitivity Rating of the identified nearby NSRs is likely to fall into the Category 'A' or 'B" (see *Section 5.4*), and their corresponding noise criteria are given in *Table 5.2c* below. However, the Sensitivity Rating of these NSRs will be subject to approval by Noise Control Authority (EPD) on application for a CNP.

Table 5.2c ***Noise Criteria for On-Site Operations of RTT, $L_{Aeq(30mins)}$ dB***

Time Period	Area Sensitivity Rating 'A'	Area Sensitivity Rating 'B'
Daytime (07:00 - 19:00) and Evening (19:00-23:00)	55	60
Night-time (23:00 - 07:00)	45	50

Noise Criteria for Traffic Associated with the RTT

Traffic entering and leaving the proposed RTT has the potential to increase the traffic noise at the nearby NSRs along the Lung Mun Road. The HKPSG requires traffic noise levels at affected NSRs to be within $L_{A10,(peak\ hour)}$ 70 dB. Although this criterion is not achieved in many existing areas of Hong Kong, it is enforced for new noise sensitive developments and for new developments generating increased traffic flows that could impact existing receivers.

Where the existing traffic noise levels at the NSRs are already above $L_{A10,(peak\ hour)}$ 70 dB, traffic noise levels generated from the new developments should not increase the total traffic noise levels by more than $L_{A10,(peak\ hour)}$ 1 dB in order to prevent exceedence of the 'noise insulation criterion' specified in paragraph 6 of the UK Calculation of Road Traffic Noise (CRTN) methodology.

5.3 BASELINE NOISE ENVIRONMENT

Existing Conditions

San Shek Wan, Melody Garden, Butterfly Estate, Siu Hei Court, Wu King Estate and Siu Shan Court are identified to be the nearest NSRs to the northeast of the RTT, but they are over 1.5km distant from the site. The existing noise environment in the vicinity of these NSRs is the typical of the urban environment which is predominated by road traffic.

The area surrounding the RTT is mainly occupied by industrial land uses which include: Castle Peak Power Station and China Cement Facility located to the west of the site; the Area 40 industrial area located to the east and the Pillar Point Landfill to the north of the site. The main roads in the region are Lung Mun Road and Lung Kwu Tan Road which are immediately to the north of the RTT site.

The existing noise environment near the RTT site is therefore dominated by the industrial and road traffic noise sources.

Future Conditions

The future noise environment in areas near the RTT may be affected by new developments of the Special Industrial Area (SIA) immediate to its western site boundary and widening of the existing Lung Mun Road and the introduction of Foothills Bypass.[23]

5.4 NOISE SENSITIVE RECEIVERS

NSRs, as defined by the HKPSG and NCO, have been identified from the government topographical maps, previous environmental studies in the area and site visits. The approximate distances from nearby NSRs to various construction sites of the proposed RTT are given in *Table 5.4a* and the locations of the NSRs are shown in *Figure 5.4a*.

An Area Sensitivity Rating 'A' has been assigned to NSRs at the northwest of the RTT as they are located in a rural area. An Area Sensitivity Rating 'B' has been designated to the NSRs in Tuen Mun New Town Area (northeast of the RTT) as these NSRs are located in urban fringe areas and are affected by traffic noise from Lung Mun Road.

Although the Pillar Point Refugee Camp will be the nearest NSR to the RTT, it will be phased out prior to the construction of the RTT and hence has not been considered in this assessment.

Table 5.4a *Noise Sensitive Receivers*

NSR Name	Approximate Separation between NSR and the RTT Site (m)	Area Sensitivity Rating
NSRs to the northeast of the RTT		
1. San Shek Wan	1,800 - 2,900	B
2. Melody Garden	1,700 - 2,750	B
3. Butterfly Estate	1,900 - 3,000	B
4. Siu Hei Court	2,200 - 3,300	B
5. Wu King Estate	2,200 - 3,250	B
6. Siu Shan Court	2,100 - 3,150	B
NSRS to the northwest of the RTT		
7. Lung Tsai	2,250 - 3,500	A
8. Tuk Mei Chung	2,250 - 3,500	A
9. Nam Long	2,750 - 3,750	A
10. Pak Long	2,900 - 4,000	A
11. Sha Po Kong	2,600 - 3,750	A

It should also be noted that the natural topography of the surrounding area will offer screening of the RTT from the NSRs. The NSRs to the northeast will be screened from the western site of the RTT and the whole of the site will be screened from NSRs to the northwest.

(23) Foothills Bypass, Tuen Mun Road/Wong Chu Road Interchange and Other Road Junctions Improvement Works - EIA for TDD, ERM-Hong Kong Ltd, 1996.

5.5 POTENTIAL SOURCES OF IMPACTS

5.5.1 *Construction Phase*

Potential sources of noise impact from the RTT construction will be equipment used for filling, dredging, construction of seawalls, percussive piling and construction of buildings. As the transportation of materials will be mainly by sea, and the number of construction vehicles moving on and off the site will be very limited, the potential impacts from the RTT construction vehicles should be minimal.

5.5.2 *Operational Phase*

For the operational phase of the RTT, potential noise impacts will be due to the equipment used for loading and unloading containers, ventilation plant in the Container Freight Station and traffic entering and leaving the RTT.

The RTT will be used as a 'transfer station' for small cargo handling vessels from the People's Republic of China (PRC). These vessels will unload their cargoes at the terminal and the containers will be consolidated into a larger vessel shuttling between the RTT and the container terminals in Kwai Chung. This will result in a reduction in marine traffic and therefore the noise from the existing shipping en-route to Kwai Chung.

5.6 CONSTRUCTION PHASE

5.6.1 *Assessment Methodology*

The methodology for assessing noise from construction of the proposed RTT is based on the *Technical Memorandum (TM1) on Noise from Construction Work other than Percussive Piling* and *Technical Memorandum (TM2) on Noise from Percussive Piling*. In general, the procedures are as follows:

- calculate the total sound power level from equipment used at each construction site;
- identify NSRs and their distances to the construction sites;
- calculate noise attenuation due to distance from the NSRs to each construction site;
- consider the potential screening effect of natural topography;
- calculate noise levels from each construction site and the total noise level from all construction sites at the NSRs;
- assess the predicted noise levels at the NSRs against the relevant criteria; and
- where necessary, recommend possible mitigation measures to reduce noise levels at the NSRs to comply with the criteria.

Noise levels from each construction activity and their combined noise levels were calculated for each NSR in order to quantify the impacts from individual construction activities. This allows the predominant noise source to be identified and hence effective noise control measures to be implemented where necessary to reduce the noise levels to be within the criteria.

Equipment used for percussive piling and other construction activities and their total sound power levels (SWL) are given in *Table 5.6a* below.

Table 5.6a *Total SWLs of Equipment Used for RTT Construction, dB(A)*

Equipment	TM Reference Number	Reference SWL, dB(A)	Quantity	ResultantS WL, dB(A)	Total SWL, dB(A)
Percussive Piling					
Diesel Hammer Driving Steel Pile Rig	N/A	132	2	135	135
Dredging of Marine Sediment					
Grab Dredger	CNP 063	112	2	115	119
Barge	CNP 061	106	6	114	
Tugboat	CNP 221	110	2	113	
Seawall Construction					
Grab Dredger	CNP 063	112	1	112	119
Barge	CNP 061	104	3	109	
Tugboat	CNP 221	110	1	110	
Mobile Crane (Barge Mounter)	CNP 048	112	3	117	
Placement of Marine Fill					
Bottom Dump Barge	CNP 061	104	5	111	111
Placement of Land Sourced Fill					
Barge	CNP 061	104	1	104	118
Bulldozer	CNP 030	115	2	118	
Compaction					
Mechanical Compactor	CNP 050	105	2	108	108
Building Construction Plant Inventory					
Hand Tool	CNP029	105	5	112	127
Compressor	CNP 002	100	4	106	
Generator	CNP 102	100	3	105	
Tower Crane	CNP 049	95	2	98	
Bar Bender	CNP 021	90	4	93	
Hoist (Passenger)	CNP 123	104	2	107	
Hoist (Material)	CNP 123	104	2	107	
Saw	CNP 202	114	4	120	
Concrete Pump	CNP 047	109	2	112	

Equipment	TM Reference Number	Reference SWL, dB(A)	Quantity	ResultantS WL, dB(A)	Total SWL, dB(A)
Poker Vibrator	CNP 170	112	10	122	
Lorry	CNP 141	112	10	122	

5.6.2 *Impact Assessment*

The predicted noise levels at nearby NSRs from the construction activities other than the percussive piling are given in *Table 5.6b*. Calculations are considered conservative (i.e. worst case) as the standard formula employed in the calculations for hemispherical radiation only takes into account of noise attenuation due to distance, atmospheric absorption, and ground effects. As a result, the standard formula tends to over-predict noise levels particularly over the large distances involved in the present study. In accordance with the TM, the noise reduction due to the screening has also been considered for the surrounding topography between the RTT site and the NSRs; appropriate reduction corrections have been incorporated in the calculations such a 10 dB for full screening for NSRs located to the northwest of the RTT.

Table 5.6b ***Calculated Noise Levels from Construction other than Percussive Piling,*** $L_{Aeq,(5\ mins)}$***dB***

NSR	Calculated Noise Level, dB(A)		
	Construction of Buildings	Other Construction Activities	Overall Noise Level
NSRs to the northeast of the RTT			
San Shek Wan	57	51	58
Melody Garden	57	51	58
Butterfly Estate	56	50	57
Siu Hei Court	55	50	56
Wu King Estate	55	50	56
Siu Shan Court	56	50	57
NSRS to the northwest of the RTT			
Lung Tsai	42	39	44
Tuk Mei Chung	42	39	44
Nam Long	42	38	43
Pak Long	41	37	42
Sha Po Kong	41	38	43

Table 5.6b indicates that the total predicted noise levels for all construction activities are between 56 and 58 dB at the NSRs to the northeast, and between 42 and 44 dB at the NSRs to the northwest.

These levels can comply with the daytime 75 dB ProPECC guideline and the NCO's daytime and evening (0700-2300 hours) noise criteria of 60 dB and 65 dB for the NSRs to the northwest and northeast of the RTT, respectively. In other words, the daytime and evening construction activities will not cause noise impacts upon the nearby NSRs.

As the NCO nighttime noise criteria are stringent and are 15 dB lower than the corresponding daytime/evening criteria, the predicted levels can only meet the NCO criteria at the NSRs to the northwest. There are predicted exceedances of 6-7 dB at the NSRs to the northeast. These exceedances imply that noise mitigation measures will be necessary for the noise from the nighttime construction works to meet the NCO criteria.

However, a construction noise permit must be obtained from EPD for carrying out any construction works during the evening and nighttime restricted hours (1900-2300 and 2300-0700). Details of the noise mitigation measures for noise compliance must be demonstrated in the application of the CNP. Recommended noise mitigation measures for the nighttime restricted hours working are presented in *Section 5.6.3*.

For land-based percussive piling activities, the predicted noise levels are presented in *Table 5.6c* below.

Table 5.6c ***Calculated Noise Levels from Land-Based Percussive Piling, $L_{Aeq, (5 mins)}$dB***

NSR	Calculated Noise Level, dB(A)
NSRS to the northeast of the RTT	
San Shek Wan	65
Melody Garden	65
Butterfly Estate	64
Siu Hei Court	63
Wu King Estate	63
Siu Shan Court	64
NSRS to the northwest of the RTT	
Lung Tsai	60
Tuk Mei Chung	60
Nam Long	60
Pak Long	59
Sha Po Kong	60

Table 5.6c indicates that the predicted noise levels of the percussive piling range from 59 to 66 dB, which are well below the 85 dB criterion for normal working hours. However, a CNP must be from EPD before carrying out any percussive piling, and it will specify the permitted time periods for the percussive piling activity.

It should be noted that percussive piling is prohibited outside normal daytime working hours.

5.6.3 *Mitigation Measures*

Good Site Practice

Good site practice and noise management can reduce the construction noise impacts on nearby NSRs. The following measures should be followed during each phase of construction:

- only well-maintained plant should be operated on-site and plant should be serviced regularly during the construction programme;

- machines and plant (such as trucks) that may be in intermittent use should be shut down between work periods or should be throttled down to a minimum;

- plant known to emit noise strongly in one direction, should, where possible, be orientated so that the noise is directed away from the nearby NSRs;

- silencers or mufflers on construction equipment should be utilised and should be properly maintained during the construction programme;

- mobile plant should be sited as far away from the NSRs as possible.

The noise benefits of these techniques are difficult to quantify, and whilst they would provide some attenuation, they cannot be assumed to guarantee a high level of noise mitigation. It should be noted that noise barriers, being commonly used for construction noise mitigation, is not recommended here because it is likely that the effectiveness of the noise barriers will be compromised by the substantial separation distances between the site and the NSRs. Rather than using noise barriers, it was considered that reducing the number of equipment in the plant team would be more effective in mitigating the noise levels.

Recommended Noise Mitigation Measures During Nighttime Restricted Hours

It is recommended that the number of equipment to be used for the construction activities should be reduced by half, and concreting activities which will deploy the concrete pumps, lorries and poker vibrators should be restricted, in order to mitigate the noise exceedances. These noise mitigation measures would reduce the overall noise emissions by 9 dB from the building construction, and 3 dB from other construction activities. The resultant noise levels with these measures at the NSRs to the northeast of the RTT are given in *Table 5.6d* below. It should be noted that the nighttime noise exceedances are only predicted at these NSRs.

Table 5.6d *Predicted Noise Levels with Noise Mitigation Measures $L_{Aeq\,(5\,mins)}$dB*

NSR	Calculated Noise Level, dB(A)		
	Construction of Buildings	Other Construction Activities	Overall Noise Level
San Shek Wan	48	48	51
Melody Garden	48	48	51
Butterfly Estate	47	47	50
Siu Hei Court	46	47	50
Wu King Estate	46	47	50
Siu Shan Court	47	47	50

The above indicates that the noise exceedances can be mitigated at the majority of the NSRs with the exception of 1 dB exceedance at San Shek Wan and Melody Garden, both of these NSRs will be the nearest to the RTT. It is understood that the construction schedule for the RTT will be tight, and the construction works will be undertaken around the clock. It is expected that further reducing the construction equipment in order to mitigate the residual impact will not be effective, and will not be practicable due to the tight construction schedule. In fact, the actual noise levels should be lower than the predictions as the TM method for the construction noise predictions does not take into account the atmospheric absorption and ground effect which can contribute to a few more dB noise attenuation, for a separation distance between a noise source and a receiver over a kilometre. Therefore, further noise mitigation measures in addition to the above should not be required.

It was recommended that noise monitoring and audit should be carried out at nighttime during the construction phase of the RTT. The recommended monitoring station is to be located at either San Shek Wan or Melody Garden. It should also be noted that a CNP must be obtained from EPD and demonstrated that these noise levels can be achieved before carrying out these construction works during the evening and nighttime (1900-0700 hours).

5.7 *OPERATIONAL PHASE*

5.7.1 *Assessment Methodology*

On-Site Operational Noise

At the time of the Study, a well defined equipment inventory was not available and therefore precise predictions of the operational noise levels cannot be made. The assessment has therefore defined the maximum allowable sound power level that would meet the noise criteria at the NSRs. When details of the plant inventory are known, the total equipment sound power can then be checked against this reference to determine compliance with the HKPSG noise criteria. If noise problems are identified, a noise control strategy would then be defined.

The noise predictions were preformed using procedures specified in the CONCAWE 4/81[24] at a number of representative NSRs nearest to the RTT. The procedures are summarised as follows:

- determine the distances between the nearest NSRs and the RTT (both shortest and longest separation distances were considered);
- calculate noise attenuation due to distance attenuation, atmospheric absorption, ground effects, meteorological effects, source height effects, barrier effects from topographical screening and in-plant screening.
- calculate the allowable sound power level by the following equation:

$$SWL = SPL - D + \sum k$$

where:

SPL is the noise criteria, as given in *Table 5.2c* above, at the NSR in terms of $L_{Aeq(30min)}$, dB;
SWL is the allowable total sound power level of the cargo handling equipment, dB;
D is the directivity index (assume to be zero);
k is the aforementioned attenuation due to propagation, screening, etc.

5.7.2 *Impact Assessment*

On-Site Operational Noise

The predicted total sound power levels of the equipment that will meet the HKPSG noise criteria at the NSRs are presented in *Table 5.7a* below. The total sound power level has been calculated from two separate noise contributions from the east and west sections of the site.

[24] CONCAWE 4/81. "The Propagation of Noise from Petroleum and Petrochemical Complexes to Neighbouring Communities".

Table 5.7a *Predicted Noise Levels for On-Site Operational Noise, dB(A)*

NSR	Calculated Noise Level, dB(A)							
	ANL-5, dB	d, (m)	k1, dB	k2, dB	k3+k4 +k5, dB	k6+k7 , dB	SWL , dB*	Total SWL, dB
NSRs nearest to the northeast of the RTT								
San Shek Wan	50	1800	76	1.8	-3	0	122	132
		2900	80	2.9	-3	5	132	
Melody Garden	50	1700	76	1.7	-3	0	121	132
		2750	80	2.8	-3	5	132	
Siu Hei Court	50	2200	78	2.2	-3	0	124	134
		3300	81	3.3	-3	5	134	
NSR nearest to the northwest of the RTT								
Lung Tsai	45	2250	78	2.3	-3	10	129	136
		3500	82	3.5	-3	10	134	

ANL-5 is the HKPSG criteria, the criterion above is for nighttime (2300-0700) which is more stringent ;
d are distances measured between the NSR and the nearest and further sections of the RTT ;
k are the attenuation factors (Reference source : CONCAWE)
k1 is the distance attenuation = $10\log 4\pi d^2$;
k2 is the atmospheric absorption = 1 dB/km ;
k3 is the ground effects ;
k4 is the meteorological effects ;
k5 is the source height effects ;
k6 is the natural screening effects provided By the natural topography;
k7 is the in-plant screening.
* the calculation of the SWL also included a 3 dB correction which takes into account the facade reflection effect.

Table 5.7a above indicates that the allowable total sound power level of the cargo handling equipment varies, depending on the locations of the NSRs. A maximum sound power of 132 dB can be generated by the RTT operational activities with respect to the NSRs to the northeast of the RTT, and 136 dB for the NSRs to the northwest.

The sound power limit is recommended as a guideline for the procurement of the equipment and to ensure predicted noise levels are within nighttime noise criteria.

It should be noted that the difference in the noise limiting requirements within the RTT should be taken into account during the detailed layout design of the RTT , and for determining the locations of the equipment. It is recommended that the actual noise emissions should be assessed once the inventory of the equipment is defined so that any potential noise problems can be identified in advance and mitigation measures designed as appropriate.

Traffic Noise Generated by the RTT

Existing traffic volumes during morning and afternoon peak hours at various intersections of Lung Mun Road in Tuen Mun New Town Area were surveyed on Thursday 18 January 1996, and the results were provided in a traffic impact assessment report for the RTT development[25]. As part of the traffic assessment

(25) Volume 3 of the Traffic Impact Assessment Report "TM TL No 393 River Trade Terminal at Tuen Mun Area 38, February 1996".

for the proposed RTT, future traffic volumes on Lung Mun Road in the area were also provided for the year 2011.

A comparison of existing and future traffic data indicates that although future traffic volume generated by Tuen Mun New Town Area will increase slightly due to the population growth in the area, the future traffic volume along Lung Mun Road will be sunstantially reduced. This is due to the introduction of the Foothills Bypass, which allows traffic to bypass Lung Mun Road near the Tuen Mun Town Area.

It should be noted that, without the RTT, the cargo would otherwise be transported on land by container trucks. It is estimated that the cargo handling capacity of a RTT vessel is equivalent to 100 container trucks which will substantially reduce the number of container trucks using the roads in the Tuen Mun area.

It was estimated that there would be approximately 500 light and heavy vehicles entering and leaving Container Gate 1 and Breakbulk Gate 2 of the proposed RTT during the peak hour in the year 2011. However, these vehicles will mainly be using the Foothills Bypass and hence bypassing the nearby NSRs in Tuen Mun New Town Area.

5.7.3 *Mitigation Measures*

On-Site Operational Noise

The requirement for the total sound power level of the cargo handling equipment should be limited to 132 dB and should be used as the noise specification for equipment procurement. The actual noise emissions should be assessed once the equipment inventory and deployment in the site are defined.

5.8 CONCLUSIONS

5.8.1 *Construction Phase*

Construction other than Percussive Piling

The construction noise assessment showed that construction activities from the proposed RTT will be within all applicable daytime and evening noise criteria. Nighttime construction activities can be undertaken provided suitable mitigation measures are incorporated. These measures include reducing the amount of equipment in use, especially restricting concreting activities.

It should be noted that a CNP must be obtained from EPD before carrying out any construction works during the evening and nighttime (1900-2300 and 2300-0700 hours, respectively). Details and the extent of the construction activities as well as any mitigation measures for the compliance with the NCO, are needed to be provided in the application of the CNP.

Land Based Percussive Piling

Although the construction noise assessment predicted noise emissions from land based percussive piling to be within the NCO criteria, a CNP must be obtained from the EPD prior to the undertaking of the percussive piling, and it will specify the permitted time period for the actual piling operation. However, it should be noted that the percussive piling is prohibited outside normal working hours (0700-1900 hours).

5.8.2 *Operational Phase*

On-Site Operations

Accepting that provided that the total sound power of the cargo handling equipment of the RTT will be limited to 132 dB(A), noise levels at NSRs to the northwest and northeast of the site will comply with the HKPSG criteria.

Traffic Generated by the RTT

The RTT will substantially reduce the actual number of container trucks using the roads in the area for the cargo handling by transporting freight by water. The traffic generated by the RTT operation will mainly use the Foothills Bypass which was taken on board by a separate EIA study, and therefore not increase traffic noise exposure of the nearby NSRs.

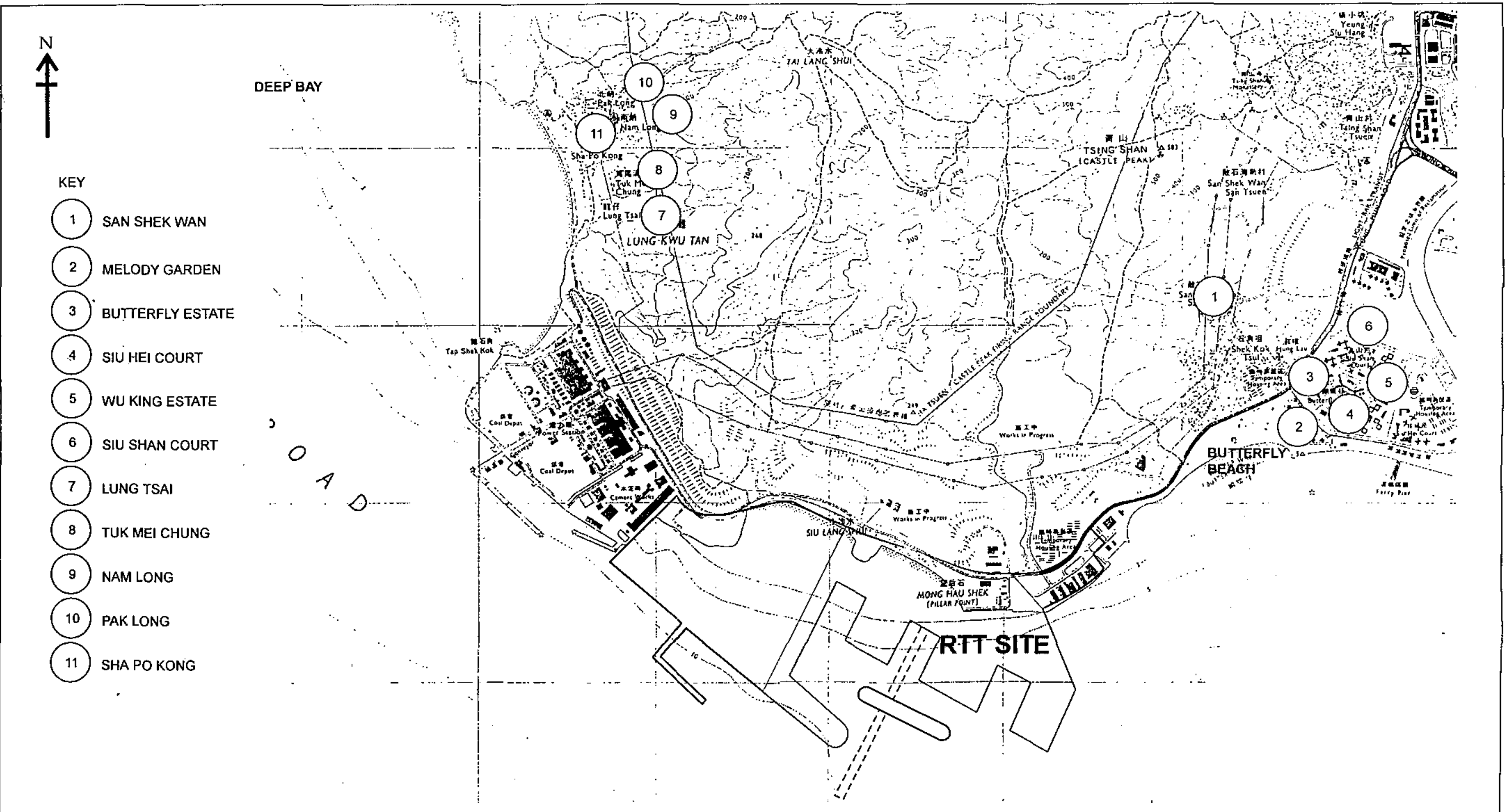


FIGURE 5.4a - LOCATION OF NOISE SENSITIVE RECECIVERS

ERM Hong Kong, Ltd
6th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

6 SOLID WASTE MANAGEMENT

6.1 INTRODUCTION

This EIA for the RTT has identified the potential waste arisings from the construction and operation of the RTT and the associated environmental impacts. Additionally, in line with Government's stated policy to minimise waste generation and maximise recycling, the options for waste minimisation, recycling, treatment, storage, collection, transport and disposal for waste arisings from the RTT have also been examined. Procedures for waste reduction and management are considered and mitigation measures for minimising the impacts of the wastes have been recommended for the implementation by the RTT operator.

6.2 GOVERNMENT LEGISLATION AND STANDARDS

6.2.1 General

The following legislation covers, or has some bearing upon, the handling, treatment and disposal of wastes in Hong Kong:

- *Waste Disposal Ordinance (Cap 354);*
- *Waste Disposal (Chemical Waste) (General) Regulation (Cap 354);*
- *Crown Land Ordinance (Cap 28); and*
- *Public Health and Municipal Services Ordinance (Cap 132) - Public Cleansing and Prevention of Nuisances (Urban Council) and (Regional Council) By-laws.*

6.2.2 Waste Disposal Ordinance

The *Waste Disposal Ordinance* (WDO) prohibits the unauthorised disposal of wastes, with waste defined as any substance or article which is abandoned. Construction waste is not directly defined in the WDO but is considered to fall within the category of "trade waste". Trade waste is defined as waste from any trade, manufacturer or business, or any waste building, or civil engineering materials, but does not include animal waste.

Under the WDO, wastes can only be disposed of at a licensed site. A breach of these regulations can lead to the imposition of a fine and/or a prison sentence. The WDO also provides for the issuing of licences for the collection and transport of wastes. Licences are not, however, currently issued for the collection and transport of construction and/or trade wastes.

6.2.3 Waste Disposal (Chemical Waste) (General) Regulation (Cap 354)

Chemical wastes as defined under the *Waste Disposal (Chemical Waste) (General) Regulation* includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the *Regulation*, if such substance or chemical occurs in such a form, quantity or concentration so as to cause pollution or constitute a danger to health or risk of pollution to the environment.

A person should not produce, or cause to be produced, chemical wastes unless he is registered with the Environmental Protection Department (EPD). Any person who contravenes this requirement commits an offence and is liable, upon conviction for a first offence, to a fine of up to HK$200,000 and to imprisonment for up to 6 months. The current fee for registration is HK$240.

Producers of chemical wastes must treat their wastes utilising on-site plant licensed by EPD or have a licensed collector take the wastes to a licensed facility. For each consignment of wastes, the waste producer, collector and disposer of the wastes must sign all relevant parts of a computerised trip ticket. The transfer of wastes from cradle to grave can therefore be traced.

The *Regulation* prescribes the storage facilities to be provided on site including labelling and warning signs. To minimise the risks of pollution and danger to human health or life, the waste producer is required to prepare and make available written procedures to be observed in the case of emergencies due to spillage, leakage or accidents arising from the storage of chemical wastes. He must also provide employees with training in such procedures.

6.2.4 *Crown Land Ordinance*

Construction wastes which are wholly inert may be taken to public dumps. Public dumps usually form part of land reclamation schemes and are operated by the Civil Engineering Department. The *Crown Land Ordinance* requires that dumping licences are obtained by individuals or companies who deliver suitable construction wastes to public dumps. The licences are issued by the CED under delegated authority from the Director of Lands.

Individual licences and windscreen stickers are issued for each vehicle involved. Under the licence conditions public dumps will accept only inert building debris, soil, rock and broken concrete. There is no size limitation on the rock and broken concrete, and a small amount of timber mixed with inert material is permissible. The material should, however, be free from marine mud, household refuse, plastic, metal, industrial and chemical waste, animal and vegetable matter and other material considered unsuitable by the dump supervisor.

6.2.5 *Public Cleansing and Prevention of Nuisances By-laws*

These *By-laws* provide a further control on the illegal tipping of wastes on unauthorised (unlicensed) sites. The illegal dumping of wastes can lead to fines of up to HK$ 10,000 and imprisonment for up to 6 months.

Additional Guidelines

Other 'guideline' documents which detail how the Contractor should comply with the regulations are as follows:

- *Waste Disposal Plan for Hong Kong (December 1989), Planning, Environment and Lands Branch Government Secretariat.*
- *Environmental Guidelines for Planning In Hong Kong (1990), Hong Kong Planning and Standards Guidelines, Hong Kong Government.*
- *New Disposal Arrangements for Construction Waste (1992), Environmental Protection Department & Civil Engineering Department.*

- *Code of Practice on the Packaging , Labelling and Storage of Chemical Wastes (1992), Environmental Protection Department.*

6.3 SENSITIVE RECEIVERS AND BASELINE CONDITIONS

The sensitive receivers for the RTT with respect to waste management, have been identified in *Sections 3, 4 and 5* which relate to water, air and noise impacts respectively. These receivers may be affected by the storage, handling, collection, transport and disposal of waste generated by the construction and operation of the RTT. Baseline conditions have also been described in the previous sections.

6.4 CONSTRUCTION IMPACT

6.4.1 *General*

The construction of the RTT will involve the following construction works for:

- dredging;
- quaywall construction;
- reclamation;
- reclamation surcharging;
- seawall construction;
- services;
- surface works; and
- terminal buildings.

6.4.2 *Potential Sources of Impact*

General

Construction activities will result in the generation of a variety of wastes which can be divided into distinct categories based on their contents, as follows:

- excavated inert material,
- construction and demolition waste;
- chemical waste; and
- general refuse.

The volumes and nature of each of these waste types arising from the construction of the RTT are identified below.

Excavated Materials

Excavated material is defined as inert virgin or reclamation fill material removed from the ground and sub-surface. The material arising at the RTT will comprise of mainly recently placed reclamation fill material.

The RTT development will generate small amounts of excavated materials, primarily as a result of foundation construction. It is likely that these materials will be reused on site.

Construction Waste

Construction waste comprises unwanted materials generated during construction, including rejected structures and materials, materials which have been over ordered or are surplus to requirements and materials used and discarded. Construction waste will arise from a number of different activities carried out by the Contractor during construction and maintenance activities, and may include:

- wood from formwork;
- equipment and vehicle maintenance parts;
- materials and equipment wrappings;
- unusable cement/grouting mixes; and
- damaged or contaminated construction materials.

It is expected that the volume of construction waste generated by the RTT construction activities will not differ significantly from other similar projects, which suggest a level of approximately 20 cubic metres per month.

At the completion of the construction works any noise enclosures erected to reduce noise emanating from construction activities will be dismantled, producing a small amount of additional construction waste.

Chemical Waste

Chemical Waste, as defined under the *Waste Disposal (Chemical Waste) (General) Regulation*, includes any substance being scrap material, or unwanted substances specified under *Schedule 1* of the *Regulation*. A complete list of such substances is provided under the *Regulation*, however substances likely to be generated by construction activities will for the most part arise from the maintenance of equipment. These may include, but need not be limited to the following:

- scrap batteries or spent acid/alkali from their maintenance;
- used engine oil from oil changing;
- hydraulic fluids;
- used air, oil and fuel filters from machinery;
- spent mineral oils/cleaning fluids from mechanical machining, including materials used in tunnel boring; and
- spent solvents/solutions, which may be halogenated, from equipment cleaning activities.

Chemical waste will arise primarily from vehicle maintenance. Estimates suggest that monthly arisings at the RTT site will be in the order of a few litres of used lubricating oils, a few batteries, and small amounts of all other chemical wastes.

General Refuse

The presence of a construction site with large numbers of workers and site offices and canteens will result in the generation of a variety of general refuse materials requiring disposal. General refuse may include food wastes and packaging, waste paper, and packaging from construction materials.

The RTT construction site is expected to have approximately five hundred workers. Estimates based on these figures suggest that the general refuse produced by RTT construction will be in the order of two to three hundred kilograms per day.

6.4.3 *Assessment Methodology*

The assessment of environmental impacts from waste generation is based on three factors:

- the type of waste generated;
- the amount of principal waste types generated; and
- the proposed recycling, storage, transport, treatment and disposal methods, and the impacts of these methods.

6.4.4 *Prediction and Evaluation of Impacts*

The nature and amount of the waste arisings from the construction of the RTT and the potential environmental impacts from waste handling, storage, transport and disposal are discussed in detail below under the headings of each waste type.

Excavated Materials

There will only be small volumes of excavated material generated by the RTT construction and these are likely to be reused on site. If excavated materials require disposal off-site they will be transported to a reclamation fill or public dump site. The potential water, air and noise impacts from the construction excavation works are covered in *Section* 3, *4 and 5* respectively.

Construction Waste

The storage, handling, transport and disposal of construction wastes have the potential to create similar visual, water, dust and noise impacts as the storage and disposal of excavated materials.

The disposal of construction wastes is unlikely to raise any long term concerns because of the inert nature of most construction wastes. To conserve void space at landfill sites, construction waste must not be disposed of at a landfill site if it contains more than 20% inert material by volume. It is therefore good practice to segregate wastes at construction sites before disposing of inert materials at public dumps for reclamation works and putrescible materials at a controlled landfill site. The production of construction wastes should be minimised by the careful control of ordering procedures to avoid the purchase of surplus materials.

The avoidance of over ordering and the segregation of materials will reduce/minimise waste arisings requiring landfill disposal which will also assist in minimising costs should landfill charges be introduced.

Construction/demolition wastes currently form approximately 35% of the annual take-up of the limited landfill void available in Hong Kong, although this proportion has varied widely over recent years. Therefore, it is important to minimise, wherever possible, the wastes being delivered to landfill.

Chemical Waste

Chemical wastes may pose serious environmental and health and safety hazards if not stored and disposed of in an appropriate manner as outlined in the *Waste Disposal (Chemical Waste) (General) Regulation* and the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*. These hazards include:

- toxic effects to workers;
- adverse effects on air, water and land from spills or leakage;
- fire hazards; and
- disruption of sewage treatment works if waste enters the sewage system.

Chemical wastes will arise principally as a result of maintenance activities. It is difficult to quantify the amount of chemical waste which will arise from the construction activities since it will be highly dependent on the Contractor's on-site maintenance intentions and the numbers of plant and vehicles utilised. However, it is anticipated that volumes will be relatively small.

General Refuse

The storage of general refuse has the potential to give rise to a variety of adverse environmental impacts. These include odour if waste is not collected frequently (eg. daily), windblown litter, water quality impacts if waste enters water bodies, and visual impact. The site may also attract insects, vermin and other animals if the waste storage area is not well maintained and cleaned regularly. In addition, disposal of wastes, at sites other than approved landfills, can also lead to similar adverse impacts at those sites.

Marine Dredged Sediments

As described on *Section* 3 a minimal dredge solution has been developed to reduce the total dredging requirements. Based on the RTT site investigations undertaken, it has been estimated that a total of around 3,300,000m^3 of mud will have to be removed of which 200,000m^3 will be seriously contaminated. It is recommended the seriously contaminated (Class C) mud will be disposed of at East Sha Chau CMPs. The disposal will be controlled by the permit conditions issued by DEP under the Dumping at Sea Ordinance. Environmental impacts arising from marine dredged sediments are discussed in *Section* 3.

The environmental impacts from the various waste types, with the exception of marine dredged sediments are summarised in *Table 6.4b*.

Table 6.4b *Summary of Waste Management Impacts*

Waste Type	General Evaluation
Excavated materials	The small volumes of excavated materials generated will be reused on site. There will be minimal environmental impact arising from the excavation and handling of excavated materials.
Construction Waste	An estimated 20 m^3 of construction waste may arise per month at the RTT site.
Chemical waste	At the RTT site, monthly arisings of a few litres of used engine oils are expected from maintenance of plant and equipment. Storage, handling, transport and disposal must be in accordance with the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes*. Provided that this occurs, and chemical wastes are disposed of at a licensed facility, the activities should be in compliance will all relevant regulations and there will be minimal environmental impact.
General refuse	200-300 kg per day of general refuse are expected to be generated. If good practice is adhered to and all feasible avoidance, reuse and recycling opportunities are taken, there should be minimal environmental impact.
Marine Dredged Material	A total of 3,300,000m3 of mud of which 200,000m3 will be seriously contaminated. This issue has been dealt with in Section 3.

6.4.5 *Mitigation Measures*

Introduction

This section sets out recycling storage, transportation and disposal measures which are recommended to avoid or minimise potential adverse impacts associated with waste arisings from the construction of the RTT under the headings of each waste type. The Contractor should incorporate these recommendations into a comprehensive on-site waste management plan. Such management plans should incorporate site specific factors, such as the designation of areas for the segregation and temporary storage of reusable and recyclable materials.

Waste Management Hierarchy

Various options within waste management can be categorised in terms of preference from an environmental viewpoint. The options considered to be more preferable have the least impacts and are more sustainable in a long term context. Hence, the hierarchy is as follows:

- avoidance and minimisation, ie not generating waste through changing or improving processes;
- reuse of materials, thus avoiding disposal (generally with only limited reprocessing);
- recovery and recycling, thus avoiding disposal (although reprocessing may be required); and
- treatment and disposal, according to relevant laws, guidelines and good practice.

The Waste Disposal Authority should be consulted by the Contractor on the final disposal of wastes.

This hierarchy should be used to evaluate waste management options, thus allowing maximum waste reduction and often reducing costs. For example, by reducing or eliminating over-ordering of construction materials, waste is avoided and costs are reduced both in terms of purchasing materials and in disposing of wastes.

Excavated Inert Materials

Excavated materials are not considered likely to cause adverse impacts, since they will be reused on site. As such, mitigation measures are not considered necessary.

Any uncontaminated inert materials which cannot be reused on site may be delivered to public dumps and fill sites. Excavated materials should be segregated from other wastes to avoid contamination thereby ensuring acceptability at fill sites or public dumps and avoiding the need for disposal at landfill.

The volumes of materials which may arise at the RTT are very small and therefore it is anticipated that no disposal difficulties will occur.

Construction Waste

It has been estimated that approximately 600m^3 of construction wastes will arise through the construction of RTT. In order to minimise waste arisings and keep environmental impacts within acceptable levels, the mitigation measures described below should be adopted.

Careful planning and good site management can minimise over ordering and waste of materials such as concrete, mortars and cement grouts. The design of formwork should maximise the use of standard wooden panels so that high reuse levels can be achieved. Alternatives such as steel formwork or plastic facing should be considered to increase the potential for reuse.

The requirements for the handling and disposal of bentonite slurries should follow the *Practice Note For Professional Persons, Construction Site Drainage Professional Persons Consultative Committee, 1994 (ProPECC PN 1/94).*

The Contractor should recycle as much as possible of the construction waste on-site. Proper segregation of wastes on site will increase the feasibility of recycling certain components of the waste stream by recycling contractors. Concrete and masonry can be ground up and used as fill and steel reinforcing bar can be used by scrap steel mills. Different areas can be designated for the storage and processing of the various materials which may be recycled depending on site specific conditions.

In accordance with the *New Disposal Arrangements for Construction Waste, Environmental Protection Department and Civil Engineering Department, 1992,* disposal of construction waste can either be at a specified landfill, or at a public dumps, with the latter being the preferred option. Construction wastes should be segregated from other wastes to avoid contamination thereby ensuring acceptability at public dumps and avoiding the need for disposal at landfill.

If landfill disposal has to be used, the wastes will most likely be delivered to the SENT and NENT Landfill.

Chemical Waste

Chemical waste that is produced, as defined by *Schedule 1* of the *Waste Disposal (Chemical Waste) (General) Regulation 1992*, should be handled in accordance with the *Code of Practice on the Packaging, Labelling and Storage of Chemical Wastes* as follows.

Containers used for the storage of chemical wastes should:

- be suitable for the substance they are holding, resistant to corrosion, maintained in a good condition, and securely closed;

- have a capacity of less than 450 l unless the specifications have been approved by the EPD; and

- display a label in English and Chinese in accordance with instructions prescribed in Schedule 2 of the Regulations.

The storage area for chemical wastes should:

- be clearly labelled and used solely for the storage of chemical waste;

- be enclosed on at least 3 sides;

- have an impermeable floor and bunding, of capacity to accommodate 110% of the volume of the largest container or 20% by volume of the chemical waste stored in that area, whichever is the greatest;

- have adequate ventilation;

- be covered to prevent rainfall entering (water collected within the bund must be tested and disposed as chemical waste if necessary); and

- be arranged such as to separate incompatible materials.

Disposal of chemical waste should:

- be via a licensed waste collector; and

- be to a facility licensed to receive chemical waste, such as the Chemical Waste Treatment Facility which also offers both a chemical waste collection service and can supply the necessary storage containers; or

- be to a reuser or recycler of the waste, under approval from the EPD.

The Centre for Environmental Technology operates a Waste Exchange Scheme which can assist in finding receivers or buyers for waste materials.

General Refuse

General refuse generated on-site should be stored in enclosed bins or compaction units separate from construction and chemical wastes. A reputable waste collector should be employed by the Contractor to remove general refuse from the site, separately from construction and chemical wastes, on a daily or every second day basis to minimise odour, pest and litter impacts. The burning of refuse on construction sites is prohibited by law.

General refuse is generated largely by food service activities on site, so reusable rather than disposable dishware should be used if feasible. Aluminium cans are often recovered from the waste stream by individual collectors if they are segregated or easily accessible, so separate, labelled bins should be provided if feasible.

Office wastes can be reduced through recycling of paper if volumes are large enough to warrant collection. Participation in a local collection scheme should be considered if one is available.

Summary

This section describes waste management requirements and provides practical actions which can be taken to minimise the impacts arising as a result of the generation, storage, handling, transport and disposal of wastes.

Waste reduction is best achieved at the planning and design stage, as well as by ensuring that processes are run in the most efficient way. Good management and control can prevent the generation of significant amounts of waste. For unavoidable wastes, reuse, recycling and optimal disposal are most practical when segregation occurs on the construction site, as follows:

- excavated material (inert) suitable for reuse or fill;
- construction waste (inert) for disposal at public dump;
- construction waste (non inert) for landfill;
- chemical waste; and
- general refuse.

The criteria for sorting solid waste is described in the *New Disposal Arrangements for Construction Waste*. Waste containing in excess of 20% by volume of inerts should be segregated from waste with a larger proportion of putrescible material.

Proper storage and site practices will minimise the damage or contamination of construction materials. On site measures may be implemented which promote the proper disposal of wastes once off-site. For example having separate skips for inert wastes (rubble, sand, stone, etc) and non-inert wastes (wood, organics, etc) would help ensure that the former are taken to public dumps, while the latter are properly disposed of at controlled landfills. Since waste brought to public dumps will not attract a charge, while those brought to landfill may be charged, separating waste may also help to reduce waste disposal costs, should landfill charging be introduced.

Specifically, it is recommended that:

- wastes should be handled and stored in a manner which ensures that they are held securely without loss or leakage thereby minimising the potential for pollution;

- only reputable waste collectors authorised to collect the specific category of waste concerned should be employed;

- removal of demolition wastes should coincide with the demolition work;

- appropriate measures should be employed to minimise windblown litter and dust during transportation by either covering trucks or transporting wastes in enclosed containers;

- the necessary waste disposal permits should be obtained from the appropriate authorities, if they are required, in accordance with the *Waste Disposal Ordinance (Cap 354), Waste Disposal (Chemical Waste) (General) Regulation (Cap 354)* and the *Crown Land Ordinance (Cap 28)*;

- collection of general refuse should be carried out frequently, preferably daily;

- waste should only be disposed of at licensed sites and site staff and the civil engineering Contractor should develop procedures to ensure that illegal disposal of wastes does not occur;

- waste storage areas should be well maintained and cleaned regularly; and

- records should be maintained of the quantities of wastes generated, recycled and disposed, determined by weighing each load or by another method.

Training and instruction of construction staff should be given at the site to increase awareness and draw attention to waste management issues and the need to minimise waste generation. The training requirements should be included in the site waste management plan.

6.5 OPERATIONAL IMPACTS

6.5.1 General

This section describes the likely waste streams arising from the operation of the RTT and details the waste management mitigation measures which are recommended.

6.5.2 Potential Sources of Impact

General

The facilities and activities which may generate wastes during operation of the RTT include:

- RTT offices, canteen and staff;
- unpacking and packing of containers;
- servicing of marine vessels;
- maintenance of building services at the RTT, such as ventilation and lifts;
- maintenance of the plant and equipment at the RTT; and
- any renovation or modification to the RTT.

Waste arisings will be generated typically consist of general refuse, industrial waste and chemical waste, although some construction wastes may arise from renovation or modification works.

A waste management area has been designated for the storage and handling of wastes at the RTT. It is envisaged that waste containers units will be located within the waste management area.

General Refuse

General refuse will be generated by the servicing of marine vessels and the offices, canteens and staff at the RTT. Based on similar operations to that of the RTT, the general refuse is likely to be composed of food waste, wood, plastic, office wastes, paper, old tins/containers, cleaning materials and miscellaneous other wastes produced during daily activities.

Industrial Waste

The main source of industrial waste will arise from the unpacking and repacking of containerised goods. Damaged or contaminated goods may also require disposal. In addition industrial waste , such as waste metals and tyres, will be generated from the maintenance workshop and the maintenance and upkeep of the plant and equipment at the RTT.

Chemical Waste

Chemical wastes will be generated from the maintenance of plant and equipment at the maintenance workshop. These may include, but need not be limited to the following:

- aste oils and solvents;
- scrap batteries or spent acid/alkali from their maintenance; and
- spent solvents/solutions, which may be halogenated, from equipment cleaning activities.

Chemical wastes may also arise from the disposal of damaged or contaminated goods.

6.5.3 *Assessment Methodology*

The assessment of environmental impacts from waste generation is based on three factors:

- the type of waste generated;
- the amount of principal waste types generated; and
- the proposed recycling, storage, transport, treatment and disposal methods, and the impacts of these methods.

6.5.4 *Prediction and Evaluation of Impacts*

General Refuse

The RTT may generate approximately 15 m^3 of general refuse per day from the offices, canteen and staff at the RTT of which a significant proportion will be paper.

The volumes of waste arisings from marine vessels cannot easily be determined. However, it is estimated that 20kg per vessel per visit, may arise . If 120 vessels per day are using the RTT facility then a total of 2,400kg/day of marine vessel waste will be generated. At a waste density of $0.1t/m^3$ the total volume of waste from marine vessels will be $24m^3$/day.

A sewage collection point will be available at the RTT for the discharge of sewage from the marine vessels using the RTT. The collection point will be located next to the marine fuelling point. This will be a pumped system connected directly to the general sewer.

There are a variety of impacts associated with the storage and handling of waste which can largely be controlled by good practice. Litter may accumulate on or near to the RTT site if waste is not properly collected, stored, handled, transported and disposed of in accordance with good management practice.

Contaminated water or leachate may arise if the waste is not properly stored in the enclosed bins or the waste management area or if it is not entirely emptied during collections. The future use of waste compaction units may also create leachate and, therefore, when installed will require that provisions should be made for its collection, storage and treatment.

Pests and vermin may be attracted to the waste if the waste is not properly contained, and if the storage area is not regularly cleaned and well maintained. Odour problems may be caused if the waste management area is not properly cleaned and emptied frequently. Other impacts may occur if wastes other than the approved types are allowed to be deposited at the waste management area (such as chemical or hazardous wastes).

Industrial waste

The main source of industrial waste will be from the unpacking and repacking of containerised goods. It has been estimated from a review of similar operations that approximately 20 to $30m^3$/day of waste may be generated, dependent upon the quantities of materials being handled at the RTT.

A total of up to 10 large waste tyres/month from major items of plant such as front loaders and up to 100 tyres/month from transport vehicles such as trailers and buses will be created. The waste tyres will be taken to landfill for disposal or may be retreaded, if they remain in a suitable condition.

It is anticipated that the maintenance workshop will generate less than $1m^3$ of ferrous and non-ferrous scrap per month. Non-chemical industrial waste arisings during maintenance activities in the workshop will usually be limited to cleaning wastes, such as rags and empty detergent containers.

Maintenance of the RTT or renovation work may generate more significant amounts of waste, on an irregular basis, depending on particular needs and projects.

Industrial wastes have the potential to create similar environmental impacts to general refuse as described above, particularly if they have a high organic content.

Chemical waste

Chemical waste may be generated from plant and equipment maintenance. It is anticipated that the workshop will generate the following chemical wastes as:

- waste oils ($6m^3$/month) and solvents; and
- waste battery liquids (40l/month) and other equipment containing chemicals.

It is considered that no unacceptable environmental impacts will occur provided that chemical wastes are handled in accordance with the *Waste Disposal (Chemical Waste) (General) Regulation* and delivered to a facility licensed to receive chemical wastes.

6.5.5 *Mitigation Measures*

General

This Section sets out the recycling, treatment, storage, transportation and disposal options which may be implemented to avoid or minimise potential adverse impacts associated with waste arisings from the operation of the RTT under the headings of each waste type. These options should be considered and the recommendations incorporated into a comprehensive on-site waste management plan. Such waste management plans should incorporate site specific factors, such as the designation of areas for the segregation and temporary storage of reusable and recyclable materials.

Waste Management Hierarchy

The waste management strategy for the RTT operation should follow the waste management hierarchy as discussed below.

- *Waste Avoidance and Minimisation* To mitigate the potential adverse impacts due to the generation of solid waste, waste reduction measures should be used where feasible, particularly if this will lead to reduced costs and increased efficiency for the RTT. Such measures may include eliminating unnecessary waste from maintenance processes and eliminating or reducing transport packaging where the operator has direct control.

- *Recycling and Reuse* For the remaining solid waste, recyclable and reusable portions should be separated out where practical. Recyclable wastes (eg paper and scrap metals) should be separated and stored until collected by a recycling contractor. Segregated materials should be stored in tidy, dry conditions to prevent intermingling and contamination of materials.

- *Treatment and Disposal* All wastes which cannot feasibly be recycled or reused, should be disposed of to landfill, or if chemical or other dangerous wastes, to the Chemical Waste Treatment Facility (CWTF), as follows:

    - general refuse and industrial waste should be transported by a reputable private waste collector and disposed of at the WENT Landfill; and

    - chemical waste as defined by *Schedule 1* of the *Waste Disposal (Chemical Waste) (General) Regulation*, should be stored in accordance with approved methods defined in the Regulations and the chemical waste, transported by a party licensed to transport chemical wastes by the EPD and disposed of at a facility licensed to receive chemical wastes by EPD.

Based on the above principles, mitigation measures for the three operational waste types are given below.

General Refuse

Considerable scope exists to take waste reduction and management into account at the detailed design stage of the RTT, particularly within the waste management area, by providing spaces or facilities for the segregation and storage of recyclable materials.

Waste collection bins will be strategically located around the site for the collection of wastes. The bins will be emptied daily by a refuse collection vehicle which may discharge the waste into a compaction unit located in the waste management area or take the waste directly to a landfill for disposal. The containerised waste held in the compaction unit or stored in the waste management area should be transported daily for landfill disposal. In the initial stages of operation the waste collection bins may be emptied by a reputable waste collector for direct disposal at landfill without passing through the waste management area.

The arisings of general refuse at the RTT may contain recyclable elements. Aluminium, paper and paperboard may be present in quantities large enough to warrant the provision of separate bins for their collection, the contents of which could be collected by or sold to recycling contractors. It may also be feasible to segregate organic materials, in particular food waste, for use as a composting medium. Organic materials have a high water content and may generate leachates and strong odours and therefore should be stored in sealed containers and collected daily.

General refuse from the RTT would most likely be taken directly to the WENT landfill by private contractors

Industrial Waste

Scrap metals can be recycled, depending upon the types of metals, the volumes arising and the ease of separation from other material types. Aluminium, copper and brass have relatively high values and if separated, a recycling contractor will probably be willing to collect and pay for the metals. Scrap iron and steel are of lower value and must be accumulated in larger volumes before collection becomes worthwhile.

Other industrial wastes should be handled, transported, collected and disposed in the same way as that for general refuse described above.

Chemical Waste

Under the *Waste Disposal (Chemical Waste) (General) Regulation*, chemical waste producers should register with EPD. Chemical wastes should be transported by a registered chemical wastes collector to a facility licensed to receive chemical wastes.

Chemical waste should be stored in appropriately safe and resistant containers, labelled, and in an appropriate store area, in accordance with the *Waste Disposal (Chemical Waste)(General) Regulation*, as discussed in *Section 6.4.5*. Enviropace, the operator of the CWTF, supplies approved containers for chemical waste which can be replaced with each collection.

Oils and solvents can be recycled, or reused as fuel, depending upon their chemical nature and level of contamination. Transportation of used oils and other chemicals for reuse, recycling or disposal requires a chemical waste licence from the EPD. Other recycling options may be arranged, for instance through the Waste Exchange Scheme operated by the Centre for Environmental Technology.

Specifically, the chemical waste streams should be handled as follows.

- The maintenance workshop should utilise effective means of capturing waste oils and lubricants during maintenance. Such materials should be handled as chemical waste and delivered to a licensed facility for recycling or disposal.

- Waste batteries and other components containing or contaminated with chemical should be disposed of by a registered chemical waste contractor.

6.6 CONCLUSIONS

6.6.1 *Construction Wastes*

With the exception of marine sediments to be dredged, which have been minimised through engineering design, it is likely that only small quantities of excavated materials and construction chemical and general waste will be generated by the construction of the RTT. However, mitigation measures relating to good practice have been recommended to ensure that adverse impacts are prevented and that the opportunities for waste minimisation and recycling are taken.

6.6.2 *Operation Wastes*

The level of general refuse produced by the RTT operation is not expected to be unduly high, but measures will be taken to avoid and recycle wastes. Chemical waste arisings from maintenance activities will be limited to plant and equipment maintenance.

Mitigation will include *ad hoc* auditing of each waste stream should be carried out periodically by the RTT contractor or operator, as appropriate, during the construction and operation of the RTT. The audit should determine if wastes are being managed in accordance with approved procedures and the site waste management plan and if waste reduction targets are being achieved and could be improved. The audits should look at all aspects of waste management including waste generation, storage, recycling, treatment, transport, and disposal.

Presuming that the recommendations put forward in this report are conscientiously acted upon, no waste related regulatory non-compliances should occur as a result of the storage, handling, collection, transport, and disposal of wastes arising from the construction and operation of the RTT.

7 ECOLOGY

7.1 INTRODUCTION

This section presents an assessment of the potential ecological impacts arising from the construction and operation of the River Trade Terminal (RTT) in Area 38, Tuen Mun. Key issues of concern are:

- Benthic Fauna;
- Commercial Fisheries;
- Chinese White Dolphin (*Sousa chinensis*); and
- Terrestrial Ecology and Littoral Habitats.

The previously endorsed Tuen Mun Area 38 EIA did not include consideration of impacts of RTT construction or operation on marine benthos, commercial fisheries or Chinese White Dolphins. Therefore, this EIA for the RTT has included an assessment of these possible impacts. A review of the terrestrial ecology has also been conducted, based on previous studies.

7.2 STATUTORY REQUIREMENTS AND EVALUATION CRITERIA

Legislative and regulatory controls which apply to marine species include:

- *The Animals and Plants (Protection of Endangered Species) Ordinance (Cap.187)* 1988, which for the marine environment of Hong Kong includes the protection of all cetaceans and sea turtles;

- *The Wild Animals Protection Ordinance (Cap. 170)* 1980 which protects all cetaceans;

- *The Fisheries Protection Ordinance (Cap.171)*, 1987, which provides for the conservation of fish and other aquatic life and regulates fishing practices;

- *The Convention on the International Trade in Endangered Species of Flora and Fauna (CITES)*, which lists the Chinese White Dolphin (*Sousa chinensis*) in Appendix One ;

- *The specific water quality (SS) criterion for the Ma Wan mariculture zone* in Hong Kong set by Agriculture and Fisheries Department (AFD) which states that SS levels should not exceed 50 mg l^{-1} or exceed by 100% the highest level recorded at the area during the five years prior to commencement of works in the vicinity.

There are no regulatory criteria to evaluate the impact of developments upon ecological resources. Therefore, for the purposes of this report, two means of evaluating such impacts have been defined. The first considers the conservation significance of individual species and communities and is based on a number of factors including rarity, ecological importance and in the case of communities, diversity. The second criteria is the commercial value of the community or species in question.

7.3 *EXISTING ECOLOGICAL CONDITIONS*

The environment in Hong Kong's western waters is largely influenced by the seasonal fluctuations in fresh water discharge from the Pearl River and is predominantly estuarine in nature. The communities in the north western waters differ from those found in the eastern waters, which are predominantly influenced by marine waters.

7.3.1 *Benthic Environment*

The ecology of southern Deep Bay, the shoreline of the Urmston Road, the eastern part of Brothers-Ma Wan Channels, North Lantau and Sha Chau consists of semi-tropical marine and estuarine biota. Coastal waters in the area lie in the transition zone between the predominantly marine waters of Hong Kong and estuarine waters dominated by the freshwater discharge from the Pearl River.

The marine ecological resources in the general area surrounding the proposed RTT are mainly concentrated along the Urmston Road Channel. The RTT site itself consists of the ongoing Area 38 SIA Reclamation to the west and the existing sloping concrete seawall of the existing Pillar Point Sewage Treatment Works.

The benthic biota of the Area 38 natural shoreline consists primarily of soft, muddy bottom species, but the diversity is typically less than that reported in more open marine conditions south of Lantau, Lamma, and Hong Kong Island, and east of Hong Kong and the New Territories. The biota is dominated by urchins, the snail *Turritella,* worms and crabs and is similar to that found in the vicinity of Castle Peak Power Station and from more easterly areas of Deep Bay. Various species of jellyfish, crabs, shrimps and fish can also be found.

7.3.2 *Commercial Fisheries*

Commercial fisheries productivity for Hong Kong waters can be generally be divided into eastern and western waters. A preliminary estimate of fisheries production in the waters around the RTT has been derived from data being collected in the ongoing AFD - *Study of Fisheries Resources and Fishing Operations in Hong Kong Waters.* Data collected from two stations in the area (T16 and T17) were used to generate a preliminary estimate of productivity (measured in $g\ m^{-2}$) and are summarised in *Table 7.3a.*

Table 7.3a ***Fisheries Productivity of RTT Waters***

Station	Date of Trawls (1996)	Area Surveyed	Catch
T16	27 February, 30 April, 23 May	7650 m^2	5901g
T17	6 March, 30 April, 23 May	7650 m^2	12156g
T2	4 March, 27 April, 20 May	7650 m^2	18548g

The current estimates of productivity (for the period March to May 1996) is 1.59 $g\ m^{-2}$ for trammel net station T17 (near Sha Chau), and 0.77 $g\ m^{-2}$ for trammel net station T16 (near the Brothers Islands). This is relatively low when compared to a typical station from the eastern waters of Hong Kong, station T2, which has the highest productivity with a productivity estimate of 2.43 $g\ m^{-2}$ (Figure 7.3a).

7.3.3 *Chinese White Dolphin (Sousa chinensis)*

More than twelve species of marine mammal occur in Hong Kong waters, however, only the Chinese White Dolphin (*Sousa chinensis*) occurs in the waters to the north of Lantau and west of Tuen Mun. Research is currently being carried out on this species by the PhD research students of the Swire Institute of Marine Science at the University of Hong Kong (SWIMS) and by Dr Thomas Jefferson of the Ocean Park Conservation Foundation, funded by AFD. However, precise estimates of population are still uncertain but abundance estimates are known to number greater than 80 [1] and reach approximately 195 [2] animals in the North Lantau region.

The ongoing surveys conducted in the north Lantau area report sightings of *Sousa chinensis* in the general vicinity of the RTT site (*Figure 7.3b*) [3]. However, these surveys have found that *Sousa* tend to concentrate further to the west of the RTT around the proposed marine park at Sha Chau and Lung Kwu Chau, the Urmston Road and the north east of the Chek Lap·Kok airport platform.

The dietary preference of *Sousa chinensis* and the importance of the area for the survival of the species is not known. Hong Kong waters comprise only part of their potential range within the Pearl River delta, however, the apparent rarity of this species confers a high level of conservation importance to its presence in the area.

7.3.4 *Terrestrial Ecology and Littoral Habitats*

An ecological review conducted for the Tuen Mun Area 38 EIA has indicated that the area consists of non-pristine areas greatly affected by human activity. Within the Study Area, no terrestrial fauna or flora have been identified as rare or endangered. The present ecology has thus been altered materially from its natural state and thus the conservation significance is considered low due to degradation as a result of the adjacent industrial land uses, including a cement works, power station and a steel mill.

7.4 *POTENTIAL IMPACTS FROM RTT CONSTRUCTION*

7.4.1 *Benthic Community*

As described in previous reports, (Tuen Mun Area 38 EIA and the RTT - IEIA) no unacceptable residual impacts on the benthic environment are expected due to the construction of the RTT facility. Sessile organisms living below the area due to be reclaimed will be either removed by dredging or buried. The species richness (as measured by the number of species present) and abundance (as measured by the number of individual organisms present) in the area are both low, and the species present are typical of soft bottom communities in Hong Kong. Therefore, the impacts arising from the construction of the RTT are not considered unacceptable.

(1) Based on the current size of the photo-identification catalogue kept by the Swire Institute of Marine Science of the University of Hong Kong

(2) Dr Thomas Jefferson (1996). Population Ecology of the Indo-Pacific Hump-back Dolphin *(Sousa Chinensis)* in Hong Kong: A Progress Report through June 1996. Presented at the Colloquium entitled " Development of a Management Strategy for Chinese White Dolphin", Hong Kong. July 1996.

(3) Dr Thomas Jefferson (1996). Population Ecology of the Indo-Pacific Hump-back Dolphin *(Sousa Chinensis)* in Hong Kong: A Progress Report through June 1996. Presented at the Colloquium entitled " Development of a Management Strategy for Chinese White Dolphin", Hong Kong. July 1996.

7.4.2 *Commercial Fisheries*

Impacts on fisheries due to the construction of the RTT could arise both as a result of increased SS levels from dredging and reclamation associated with the project, and due to the loss of available habitat (and thus the loss of available fishing grounds). There are no fisheries data available for the RTT site itself therefore, data from the two nearby stations (T16 south east of the Brothers Islands, and T17 to the east of Sha Chau and Lung Kwu Chau, shown on *Figure 7.3a*), have been used to generate an estimate of productivity for the waters around the RTT. It is emphasised that this calculation of abundance is only an estimate, as data from these two sites are only available from March to May 1996. Therefore, any variations in abundance due to seasonal changes, or long term natural population fluctuations cannot be represented.

The productivity of the area, as measured by g m^{-2}, is relatively low when compared to eastern waters. The present estimate of productivity for the area (the mean of T16 and T17) is 1.18 g m^{-2}, as opposed to 2.43 g m^{-2} for station T2 which is located at the mouth of Tolo Harbour in the eastern waters. Therefore, the proposed RTT which has an estimated area of 64.3 ha, would represent an estimated instantaneous productivity of 1.18 g m^{-2}. This number, however, may be an overestimate, as the proximity to the marine trafficked Urmston Road makes this area less conducive to fishing than the two monitoring stations used to generate this estimate.

7.4.3 *Chinese White Dolphin (Sousa chinensis)*

Sousa have been sighted in the general vicinity of the RTT site during the ongoing AFD Dolphin Survey, however they tend to be concentrated further west of the RTT site and south of the busy Urmston Road waterway. Nevertheless, based on a precautionary principle, it is assumed that construction impacts of the RTT might affect *Sousa* in the area.

The greatest potential impact to *Sousa* arising from RTT construction activities is expected to be from underwater noise. Dolphins generate sounds to locate prey, assess an area for danger, and to locate members of the same species. Many of these sounds are very high frequency (ultrasound) and are thus less prone to human noise pollution [4]. Dolphin communications, however, are mostly in the lower frequencies, and are very susceptible to under-water noise pollution and masking of sound. Since dolphins are highly social animals which need sound to integrate behaviour, especially in murky waters, industrial noises can have profound adverse effects on social structure, co-ordinate activities, and efficiency of feeding, reproducing, and rearing of young. The varied wide frequency-band noises from dredgers and shipping associated with the RTT construction may be of particular concern.

7.4.4 *Terrestrial Ecology and Littoral Habitats*

As described in *Section 1* the purpose of this EIA for the RTT was to build upon the endorsed results of previous relevant studies undertaken. Field visits to Tuen Mun Area 38 were undertaken as part of the ecological assessment in the Tuen Mun Area 38 EIA, and it was determined that the relative quality of the terrestrial ecology and littoral habitat, which would be directly lost as a result of

(4) Richardson, W.J., C.R. Greene Jr., C.I. Malme, Denis H. Thomson, S.E. Moore, and B.Wursig. 1990. Effects of Noise on Marine Mammals. Final Report to Minerals Management Service, Atlantic OCS Region, 381 Eldon St., VA 22070

SIA and RTT developments, was low. It was noted that the areas to be lost had already suffered damage to their terrestrial ecological potential and potential for nursery and spawning of marine biota.

The Tuen Mun Area 38 EIA terrestrial ecological field review indicated that the RTT area consists of non-pristine areas greatly affected by human and industrial activity. Within the RTT site area, no terrestrial fauna or flora were identified as rare or endangered. The field visits concluded that the terrestrial ecology had thus been altered materially from its natural state and thus the conservation significance in the context of Hong Kong as a whole was considered low due to degradation as a result of the adjacent industrial land uses, including a cement works, power station and a steel mill.

The Tuen Mun Area 38 EIA therefore concluded that the proposed development works would have minimal impact on the terrestrial and littoral ecology of the RTT area.

In order to verify these findings, field visits were made to the RTT site in January 1996 and July 1996. These visits confirmed the littoral and terrestrial habitat conclusions of the Tuen Mun Area 38 EIA and in fact indicated that further ecological degradation of the terrestrial and littoral habitats had occurred between the time of the Tuen Mun Area 38 EIA and the present day. It is, therefore, concluded that, with regard to the terrestrial and littoral habitat loss, the endorsed findings of the Tuen Mun Area 38 EIA are still valid.

7.5 *CONSTRUCTION STAGE MITIGATION MEASURES*

As stated previously, no unacceptable impacts are expected to either benthic or fisheries resources and therefore no mitigation measures are required. Mitigation measures are, however, suggested to minimise the potential impacts of RTT construction on *Sousa* that may be present in the vicinity. As with other projects in the area (the Airport Authority Hong Kong (AAHK) Aviation Fuel Receiving Facility (AFRF) at Sha Chau) it is suggested that a 500 m "exclusion zone" be established during the construction of the RTT. This area would be defined as an area 500 m in any direction from the marine construction activity (500 m any direction). This area should be visually monitored by trained staff before the commencement of each marine based construction activity. If *Sousa* are sighted in this "exclusion zone" work should be delayed until such time as the *Sousa* have left the area. This should reduce the chances of damage to the dolphin auditory systems and reduce stress on the animals arising from the sudden exposure of *Sousa* to noise. If *Sousa* are sighted in the "exclusion zone" after the works have commenced, no action will be needed, as it is assumed that the *Sousa* are not being adversely affected by the noise. The sole exception to this would be if marine based percussive piling were employed. If, during marine based percussive piling, *Sousa* were sighted in the "exclusion zone" it is suggested that work should cease until such time as the *Sousa* had moved beyond the 500 m zone. This zone could be effectively reduced, if other mitigation measures, such as a bubble curtain which has been used to mitigate percussive piling noise from the AAHK AFRF, were employed. However, there is no marine based percussive piling planned during construction activities for the RTT.

Additionally, Contractors should ensure that their marine plant machinery employed are well maintained, and that silenced marine construction plant are employed wherever practicable.

Finally, as described in *Section* 3, a minor revision has been made to the detailed design of the reprovisioned Pillar Point outfall in order to prevent any need for underwater blasting which would be beneficial in terms of *Sousa*.

7.6 OPERATIONAL IMPACTS OF RTT

7.6.1 *Benthic Community*

No unacceptable residual impacts on the benthic environment are expected to arise from the operation of the RTT. Once construction of the RTT has been completed, there will be an estimated length of 3000m of seawall available for colonisation by benthic organisms.

Discharges from the replacement Pillar Point sewage outfall may change the species composition of the recolonising community. Impacts of the outfall on benthic communities will be addressed in the forthcoming EPD study entitled *Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall.*

7.6.2 *Commercial Fisheries*

Results show that unacceptable impacts to fisheries arising from the operation of the RTT are avoided. The RTT may in fact reduce the marine traffic in the area, allowing fishing operations to continue with less risk of marine collisions.

Potential for the bioaccumulation of potentially toxic substances by commercially important fisheries species will result in human exposures. It is not anticipated that tissue burdens will be elevated due to the replacement of the outfall, although this will be comprehensively addressed by the outfall monitoring programme in the forthcoming EPD study entitled Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall.

7.6.3 *Chinese White Dolphin (Sousa chinensis)* [5]

Sousa may increase their use of the waters surrounding the reprovisioned outfall, due to the predicted increase in abundance of prey species resulting from the outfall.

It should, however, be noted that the reprovisioned outfall will replace the existing outfall and that no additional impacts are expected. The implications of any increased use of the waters surrounding the reprovisioned outfall on *Sousa* will be addressed in detail in the forthcoming EPD study entitled *Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall* to be commenced in late 1996.

(5) North Lantau Development Report - Topic Report TR22, June 1993, Mott MacDonald Hong Kong Ltd.

7.7 OPERATION STAGE MITIGATION MEASURES

No measures are proposed to mitigate operational impacts to terrestrial ecology, benthos or fisheries in the area, as no unacceptable residual impacts arising from the project are expected.

The operational stage of the reprovised outfall will be closely monitored and included as part of the forthcoming EPD study entitled *Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall* to be commenced in late 1996.

Regardless of whether *Sousa* presently feed in the vicinity of the proposed Pillar Point sewage outfall, it is possible that they will be attracted to the replacement outfall discharge area as the sewage discharge will attract small fish which are likely to comprise *Sousa's* preferred prey.

Impacts could arise from increased use of the waters surrounding the reprovisioned outfall and the need for upgrading of the Pillar Point STW to achieve a higher standard of treatment before discharge will be verified as part of the forthcoming *Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall* to be commenced in late 1996.

7.8 CONCLUSION

7.8.1 *Benthos*

No unacceptable residual impacts are expected to arise from either the construction or operation of the RTT. Benthic organisms present at the site are typical of that found at other soft bottom environments in Hong Kong.

7.8.2 *Commercial Fisheries*

The results show that unacceptable impacts to commercial fisheries are avoided during the construction or operation of the RTT. The loss to fisheries production, has been estimated by consideration of data from the ongoing AFD - *Study of Fisheries Resources and Fishing Operations in Hong Kong Waters* to be 1.18 $g\ m^{-2}$ which represents an instantaneous productivity of the RTT area and is relatively low compared with fisheries located in eastern waters.

7.8.3 *Chinese White Dolphin (Sousa chinensis)*

Sousa have been sighted in the general vicinity of the RTT site during the ongoing AFD Dolphin Survey, however they tend to be concentrated further west of the RTT site and south of the busy Urmston Road waterway. Nevertheless, based on a precautionary principle, it is assumed that construction impacts of the RTT might affect *Sousa* in the area and therefore construction stage mitigation measures have been recommended to protect *Sousa* including the use of a 500 m "exclusion zone" closely monitored by a trained observer. This 500 m area in any direction from the construction activity should be visually monitored by a trained observer before the commencement of each marine based construction activity. If *Sousa* are sighted in the "exclusion zone", work should be delayed until such time as the *Sousa* have left the area. Additionally, a minor revision has been made to the detailed design of the reprovisioned Pillar Point outfall in order to prevent any need for underwater blasting which will be beneficial in terms of *Sousa*. Finally, marine based piling has been avoided for the construction phase to minimise adverse impacts to *Sousa*.

In terms of operational impacts to *Sousa* the RTT itself will provide a positive impact by reducing the marine traffic in areas comprising *Sousa* habitat. *Sousa* may increase their use of the waters surrounding the reprovisioned outfall, due to the predicted increase in abundance of prey species resulting from the outfall. The operational impacts and the need for any additional measures will be closely monitored as part of the forthcoming EPD study entitled *Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall Study* which is scheduled to commence in late 1996.

7.8.4 *Terrestrial Ecology and Littoral Habitats*

The purpose of this EIA for the RTT was to build upon the endorsed results of previous relevant studies undertaken. Field visits to Tuen Mun Area 38 were undertaken as part of the ecological assessment in the Tuen Mun Area 38 EIA, and it was determined that the relative quality of the terrestrial ecology and littoral habitat, which would be directly lost as a result of SIA and RTT developments, was low. It was noted that the areas to be lost had already suffered damage to their terrestrial ecological potential and potential for nursery and spawning of marine biota.

The Tuen Mun Area 38 EIA terrestrial ecological field review indicated that the RTT area consists of non-pristine areas greatly affected by human and industrial activity. Within the RTT site area, no terrestrial fauna or flora were identified as rare or endangered. The field visits concluded that the terrestrial ecology had thus been altered materially from its natural state and thus the conservation significance in the context of Hong Kong as a whole was considered low due to degradation as a result of the adjacent industrial land uses, including a cement works, power station and a steel mill.

The Tuen Mun Area 38 EIA therefore concluded that the proposed development works would have minimal impact on the terrestrial and littoral ecology of the RTT area.

In order to verify these findings, field visits were made to the RTT site in January 1996 and July 1996. These visits confirmed the littoral and terrestrial habitat conclusions of the Tuen Mun Area 38 EIA and in fact indicated that further ecological degradation of the terrestrial and littoral habitats had occurred between the time of the Tuen Mun Area 38 EIA and the present day. It is, therefore, concluded that, with regard to the terrestrial and littoral habitat loss, the endorsed findings of the Tuen Mun Area 38 EIA are still valid.

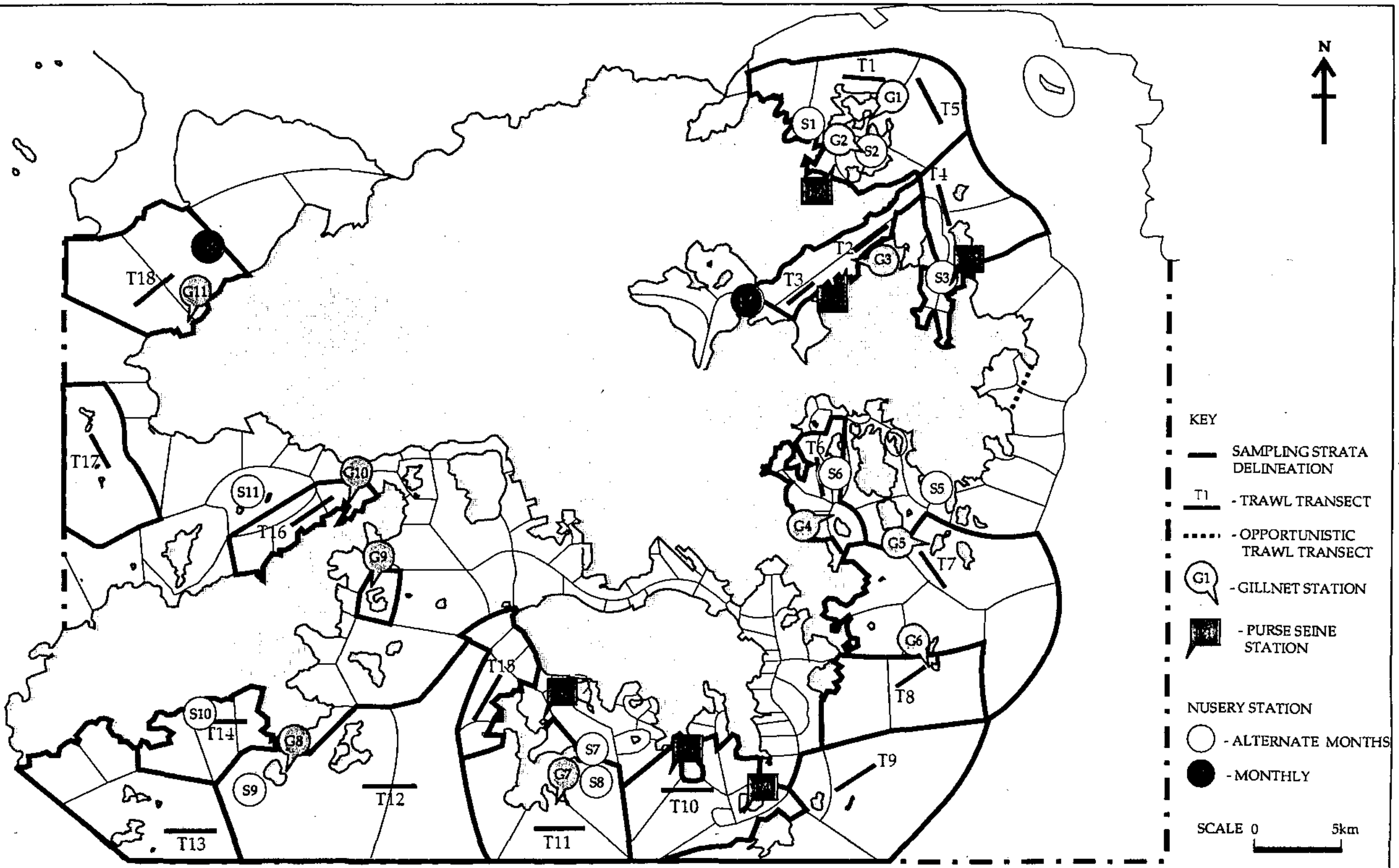
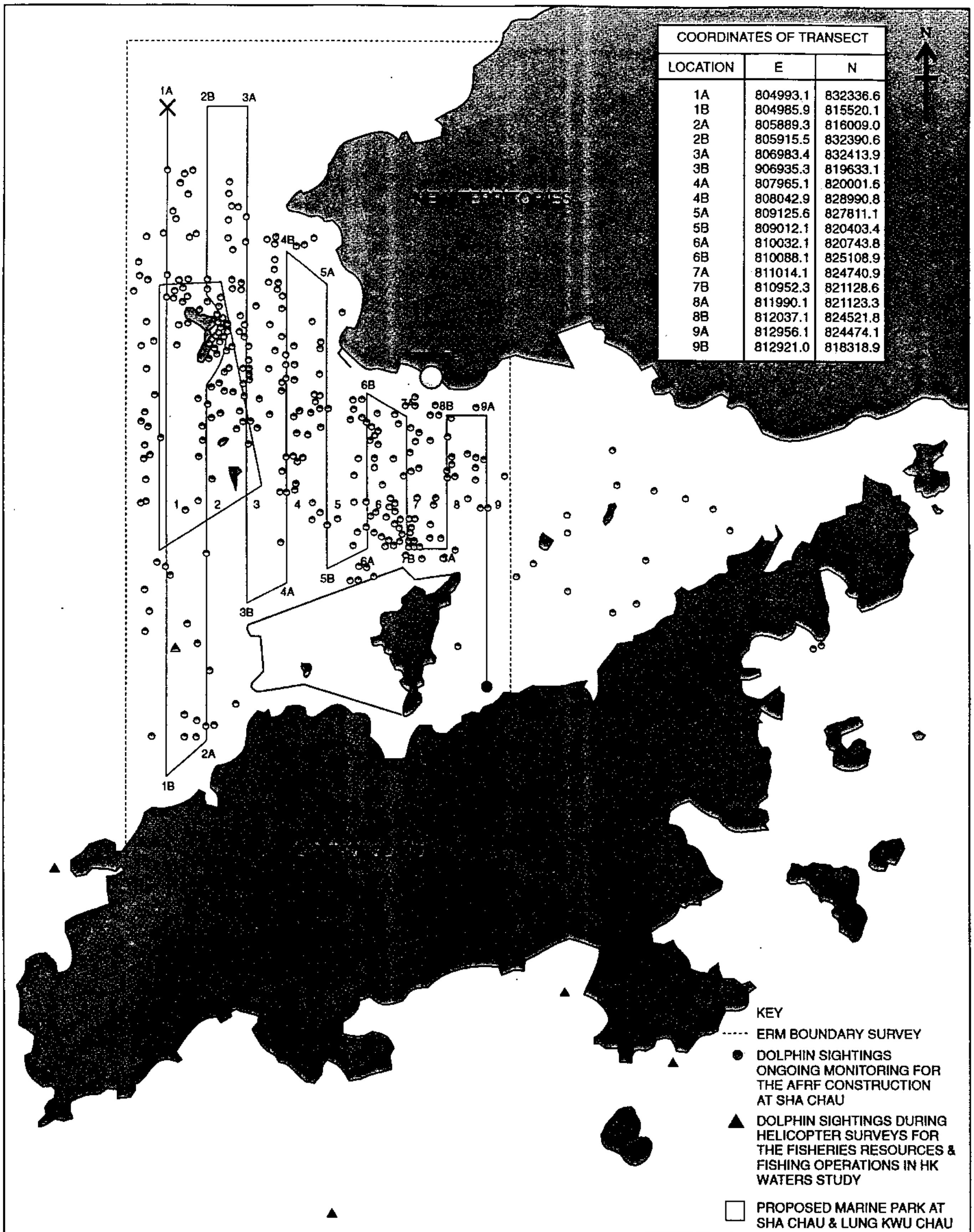


FIGURE 7.3a - TRAWL, GILL NET, PURSE SEINE AND NURSERY STATIONS

ERM Hong Kong, Ltd

6th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM



COORDINATES OF TRANSECT

LOCATION	E	N
1A	804993.1	832336.6
1B	804985.9	815520.1
2A	805889.3	816009.0
2B	805915.5	832390.6
3A	806983.4	832413.9
3B	906935.3	819633.1
4A	807965.1	820001.6
4B	808042.9	828990.8
5A	809125.6	827811.1
5B	809012.1	820403.4
6A	810032.1	820743.8
6B	810088.1	825108.9
7A	811014.1	824740.9
7B	810952.3	821128.6
8A	811990.1	821123.3
8B	812037.1	824521.8
9A	812956.1	824474.1
9B	812921.0	818318.9

FIGURE 7.3b - SIGHTINGS OF SOUSA CHINENSIS IN THE NORTH LANTAU AREA

ERM Hong Kong, Ltd
6th Floor
Hecny Tower
9 Chatham Road
Tsimshatsui, Kowloon
Hong Kong

ERM

8 LANDFILL GAS AND LEACHATE QUALITATIVE RISK ASSESSMENT

8.1 INTRODUCTION

8.1.1 *General*

There are a number of risks associated with any development close to a landfill site relating to the generation and migration of landfill gas and leachate. The landfill gas assessment provides a preliminary qualitative risk assessment on these potential hazards to the RTT site, based upon the available information from the previous North West New Territory Landfill Restoration Study and the Tuen Mun Area 38 EIA, and recommends appropriate measures to ensure the safety of the construction and subsequent of operation of the development.

The RTT site is located adjacent to Lung Mun Road, in an area between an operating landfill, Pillar Point Valley Landfill, (PPVL) and a closed landfill Siu Lang Shui Landfill (SLSL), outside the 250 m consultation zones of both landfill sites. It was considered, however, that there may still be some potential risk due to landfill gas migration as both landfills are actively generating landfill gas. The locations of the RTT, SLSL and PPVL are shown on *Figure 8.1a*.

The initial EIA recommended that the Detailed EIA should determine whether there are any pathways, either natural or man-made, through which landfill gas or leachate could migrate and reach the RTT site. Pathways may include permeable ground materials and utility or drainage conduits. Such investigations need to include assessment of the potential for leachate flow as leachate may convey landfill gas to the RTT site and could impact the development directly.

8.1.2 *Previous Studies Undertaken At the Site*

A number of previous studies have been undertaken or are ongoing at the SLSL and the PPVL. The various reports from these studies have been used as reference documents for this assessment and are listed below.

- Mouchel Asia Ltd./ERM Hong Kong Ltd, "Restoration of North-west New Territories Landfills - Contract Arrangements, Technical Notes 1 - 6", 1995 - 1996.
- Inchcape Testing Services, "North-west New Territories Landfills - Further Environmental Monitoring, Monthly Report", July 1996.
- Inchcape Testing Services, "North-west New Territories Landfills - Further Environmental Monitoring, Monthly Report", June 1996.
- Inchcape Testing Services, "North-west New Territories Landfills - Further Environmental Monitoring, Monthly Report", May 1996.
- Inchcape Testing Services, "North-west New Territories Landfills - Further Environmental Monitoring, Interim Report", April 1996.
- Scott Wilson Kirkpatrick Ltd, "Restoration of North-west New Territories Landfills, Pre-Tender Environmental Monitoring", June 1996.

- Scott Wilson Kirkpatrick Ltd, "Restoration of North-west New Territories Landfills, Initial Environmental Impact Assessment - Final Report", April 1995.

- Scott Wilson Kirkpatrick Ltd, "Restoration of North-west New Territories Landfills, Design Memorandum", November 1995.

- Scott Wilson Kirkpatrick Ltd, "Restoration of North-west New Territories Landfills, Final Report", August 1995.

- Inchcape Testing Services Ltd, "Restoration of North-west New Territories Landfills, Part 1 - Contract Arrangements : Further Environmental Monitoring, First Round Monitoring Report", October 1995.

- Scott Wilson Kirkpatrick Ltd, "Restoration of North-west New Territories Landfills, Hazard Assessment", March 1993.

- Geotechnical & Concrete Engineering (HK) Ltd, "Contract No. GC/91/11 - Site Investigation Term Contract - New Territories West Works Order No. PW7/2/36.131B : Investigation of Siu Lang Shui Landfill", July 1993.

- Lam Geotechnics Ltd, "CED Contract No. GE/93/08, Ground Investigation - New Territories West Term Contract. Work Order No. GE/93/08.52A : Restoration of North West New Territories Landfills Study - Further Site Investigation and Environmental Monitoring Field Work Report", March 1995.

- Scott Wilson Kirkpatrick Ltd, "Restoration of North-west New Territories Landfills, Pre-Tender Site Investigation and Monitoring Programme", June 1995.

The reports produced by Scott Wilson Kirkpatrick in their studies of the North-west New Territories landfills are collectively described and referenced in this report as the "Feasibility Study".

8.1.3 *Scope of this Study*

The Landfill Gas and Leachate Qualitative Risk Assessment Study included the following tasks:

- review of background information and studies related to Siu Lang Shui Landfill (SLSL) and Pillar Point Valley Landfill (PPVL);

- identification of the sources, nature and likely quantities/concentrations of hazardous emissions which have the potential to affect the development;

- identification of viable pathways through the ground, underground cavities, utilities or groundwater and the conditions of these pathways through which the hazardous emissions must pass if they are to reach the RTT;

- identification of elements of the RTT which are sensitive to the effects of the hazardous emissions;

- qualitative assessment on the degree of risk which the hazardous emissions may pose to the target for each of the source-pathway-target combinations; and

- proposal of suitable types of protection measures to mitigate the identified gas and/or leachate hazards to an acceptable level.

8.2 *Potential Landfill Gas and Leachate Hazards Associated with Developments close to Landfill Sites*

8.2.1 *Landfill Gas*

Landfill gas is generated through microbial decomposition of biodegradable matter in the wastes and is a flammable, phytotoxic and asphyxiating mixture of mainly methane and carbon dioxide. It also contains traces of higher organic compounds which are odorous and which may cause adverse health effects if present in high enough concentrations. When mixed with air, landfill gas can form flammable mixtures if the methane concentration falls within the lower and upper explosive limits (LEL and UEL, approximately 5%-15% v/v). In confined spaces and given a source of ignition, such as an electrical spark, an explosion can result.

8.2.2 *Leachate*

Leachate is the contaminated water which drains from a landfill site and, although its composition can vary significantly with the type and age of the deposited waste, it is typically highly polluting due to high concentrations of organic compounds and inorganics such as metals, chlorides, sulphates and ammonium compounds. Leachate can contaminate and be transported in groundwater and surface water. In terms of potential hazards associated with developments, leachate can have adverse effects on concrete, cause corrosion of steel and give rise to offensive odours. In certain circumstances, landfill gas may be transported in solution in leachate or may be generated from the anaerobic degradation of organic compounds in the leachate.

8.3 *Nature and Location of the Siu Lang Shui and Pillar Point Valley Landfills*

8.3.1 *Siu Lang Shui Landfill*

Landfill History

Siu Lang Shui landfill is located south of the Castle Peak Firing Range, adjacent to Lung Mun Road (See *Figure 8.1a*). SLSL occupies an area of about 12 hectares, is approximately rectangular in shape and set in a valley. The site was operational from November 1978 to December 1983 and approximately 1.2 million tonnes of domestic and industrial wastes were deposited during this period. The wastes were capped with a layer of soil, varying from 2 metres to 6 metres of compacted gravelly silty sand. Vegetation, consisting mostly of trees was planted and these currently stand up to 6 m tall. No specific afteruse has yet been proposed for SLSL.

Geology and Hydrogeology

The landfill was formed in the coastal flood plain of a small valley, and infilling directly abutted the steep valley sides. Two streams draining the hillsides were culverted prior to overlying with waste. The waste depth over the culvert is estimated to be 15 metres. The underlying parent material in the valley base is alluvium, with clay, silt, sand and gravel over the upper portion of the plain, and marine sand covering the lower portion up to the coastal area. The alluvium is replaced by sedimentary and volcanic rocks as the valley narrows upstream. Bedrock of the hill slopes comprises fine to medium grained granite on the east, and medium grained granite on the west. Groundwater flow in the vicinity of the landfill is southwards, down the valley, towards the coastline.

Landfill Gas Generation and Control

Landfill Gas Generation

Landfill gas is currently being generated at SLSL. Mathematical modelling of landfill gas generation predicted that peak production occurred in 1983. The estimated landfill gas generation at SLSL in 1993 was $285m^3/hr$. However, it is considered that generation rates will be now be much lower than this level. Positive gas pressure between 40 and 240 Pa have been observed within the waste.

Existing Landfill Gas Control Measures

There is an existing landfill gas management system comprising passive gas vents linked to gravel areas. On-site, vertical vent pipes were installed at regular intervals in the refuse, and extended and modified as tipping progressed. The final restoration involved the placement of clean gravel at the top of each refuse platform with interconnecting gas vent pipes within them. Apart from these vents, no specific measures were implemented to prevent gas migration off-site, however in certain areas where the existing PVC liner is not damaged, gas movement will potentially be hindered.

Figure 8.3a illustrates locations of the existing gas vent stacks and monitoring points following the initial restoration of the landfill.

Proposed Gas Control Measures

As significant volumes of landfill gas are being generated, control measures are required. The priorities for landfill gas control at SLSL, as recommended in the Feasibility Study are as follows:

- detailed inspection of existing gas vent pipes, and repair or replace any which are damaged or blocked;
- establish the effectiveness of existing membrane liners and rock face coatings in controlling off-site gas migration;
- design and installation of additional perimeter gas migration control if necessary. This can be accomplished by extending the venting trench around the boundary of the site;

- design and installation of a venting trench and membrane barrier to prevent gas migration from the southern boundary;

- install landfill gas protection measures for buildings and other structures on site as part of the afteruse development;

- place a new capping gravel layer at the southern end of the eastern landfill boundary, designed to link in with perimeter gas control measures; and

- construct, at appropriate intervals, gas wells through the trench into underlying natural strata and which are linked in with the venting trench.

Leachate Generation and Control

Leachate Generation

In work undertaken to date, nine drill holes have been installed within the landfill and beyond the southern boundary of the site, and four surface water monitoring stations have been established upslope and downslope of the site, and along the stream to the south-west of the landfill. The Feasibility Study estimated that leachate production ranges widely from about $70m^3$/day to $200m^3$/day. The average leachate arisings after the completion of the restoration works under the North-west New Territories Landfills Restoration Contract has been estimated to be in the order of $100m^3$/day, based upon the maximum infiltration rate which is likely to specified for the capping materials of the landfill.

Existing Leachate Control Measures

The site was engineered as a partially lined containment landfill, with leachate collection systems being located in two separate areas at the southeast and southwest portions of the site where the filtration tanks and soakaway pits are also situated. The standards of engineering applied at that time are however unlikely to be to those that would be applied today and therefore the performance of the liner must be presumed to be doubtful. Leachate may therefore be entering the culvert under the wastes and also contaminating the groundwater beneath the site.

Contaminated groundwater has been observed discharging from a 750 mm pipe which was constructed to direct groundwater discharge onto the beach at the south of the site. In addition leachate is spilling from the filtration tanks into the stream at the south-western corner of the site.

Proposed Leachate Control Measures

The Feasibility Study proposed the following leachate control measures to be included in the restoration of SLSL:

- rehabilitation of leachate collection tanks;

- routing of leachate discharging from the tanks to a single leachate holding facility;

- interception of contaminated groundwater underlying the site and diversion to the leachate facility;

- construction of works to pump the leachate from SLSL to the leachate treatment facility at PPVL; and
- routine monitoring of flow and quality of leachate into and out of the leachate holding facility.

The exact nature of the restoration works, which will include the landfill gas and leachate control measures, will be subject to the design of the restoration contractor selected by EPD to undertake the works. It is understood that the restoration works have been targeted for completion in 1998. The restoration works will be required to meet the highest of standards in accordance with a Performance Specification covering the design, construction and aftercare of the works.

8.3.2 *Pillar Point Valley Landfill*

Landfill History

PPVL is an operational landfill, covering an area of approximately 53 hectares, which has been in operation since 1983. The capacity of the landfill is estimated to be 13 million tonnes and the landfilling will be completed in mid-1997.

PPVL accepts a range of industrial, domestic and construction wastes at a rate of about 2000 tonnes/day. It is estimated that the biodegradable waste content is approximately 40% of the total wastes deposited.

Geology and Hydrogeology

Details on the underlying geology and hydrogeology of PPVL were obtained from the Feasibility Study.

The landfill area and its surrounds are underlain by granitic bedrock which, in places is intruded by quartz-phyllite dykes. In many areas, the surface granitic deposit is completely decomposed granite comprising silty coarse sand. The valley floor comprises superficial deposits of clay, silt, sand and gravel. Soils are predominantly silty sand and gravel, down to a proven maximum depth of approximately 4.5m.

A stream which originally flowed through the centre of the valley was diverted prior to landfilling. Some contaminated surface water is pumped from the eastern catchwater channel into the leachate collection works.

Groundwater flow is considered to be controlled by topography and is predominantly southwards, discharging into the sea off Pillar Point. Shallow groundwater in the area can be considered as an extension to the surface water system.

Landfill Gas Generation and Control

Landfill Gas Generation

Two models were used in the Feasibility Study to predict landfill gas yields based on data from the analyses of the waste composition. The Oxford University model predicted a production rate of 19,000m^3/hr in 1995 while the

Hofstetter Model predicted a rate of 3,500m^3/hr. Gas pumping trials from two locations yielded approximately 230 and 225m^3/hr.

Existing Gas Control Measures

The containment engineering at the site for leachate and groundwater control comprising of the spraying of bitumen-coated concrete on the side walls and the installation of basal PVC and HDPE liners, which more recently have extended some way up the sidewall, could be regarded, in part, to be gas control measures. However, gas extraction wells, gas vents or gas barriers have not been installed.

A number of drillholes have been installed by CED within the wastes to monitor landfill gas pressure and composition. In addition a combination of three drillholes and three probes have been placed around the southern boundary of the site to monitor offsite gas migration and groundwater quality. *Figure 8.3b* shows the locations of the existing drillholes.

The monitoring of the probes and drillholes at the southern boundary has revealed only trace concentrations of methane gas but there is some evidence of elevated carbon dioxide concentrations and depleted oxygen levels.

Proposed Landfill Gas Control Measures

The Feasibility Study recommended the following priorities for landfill gas control:

- the installation of an impermeable capping layer consisting of a flexible membrane liner and associated drainage and soil layers;
- measures to ensure the continued protection of existing and future buildings and structures to the south of the landfill;
- installation venting wells within the waste to reduce high gas pressures and encourage controlled venting of landfill gas;
- establish effectiveness of existing membrane liner and bitumen-coated sprayed concrete rock face in controlling offsite migration through the installation of gas monitoring probes around the site boundary;
- installation, if necessary, of additional perimeter landfill gas migration control measures, comprising of either an active pumped system or a combination of passive gas barriers;
- design and install gas protection measures for final cap, restoration and afteruse.

Leachate Generation and Control

Leachate Generation

The Feasibility Study estimated the average leachate flows to be about 130m^3/day. The average rate of leachate arisings after the completion of the restoration works under the Pillar Point Valley Landfill Restoration Contract has been estimated to be in the order of 120m^3/day, based upon the likely maximum permitted infiltration rates on the capping materials for the landfill under the Restoration Contract.

Existing Leachate Control Measures

The PPVL has been designed and operated as an engineered containment site with separate leachate and groundwater collection systems. The base of the site has a rudimentary composite liner comprising of a 30m width of 0.6mm PVC membrane overlain by 600mm of compacted completely decomposed granite.

A 300mm granular drainage layer has been placed over the liner to feed leachate to collection drains set in the compacted decomposed granite.

The valley sides have been sealed with bitumen-coated sprayed concrete. A drainage layer has been placed against the valley walls to direct leachate to collection drains.

In the more recently engineered parts of the landfill a 2.0mm thick HDPE liner has been used to seal the base and lower slopes of the landfill.

Leachate and groundwaters are collected in separate systems but the collected groundwater has been diverted to the leachate collection sewer which has led to an approximately threefold increase in leachate volumes and a dilution of leachate strength. This contaminated water is then fed to the Pillar Point Sewage Treatment Works (PPSTW) for primary treatment before passing into marine waters.

Proposed Leachate Control Measures

The Feasibility Study proposed that a leachate treatment plant is constructed, the design of which would be based on the results of a one year monitoring programme. The Study also proposed that the landfill should be capped and an effective drainage system be installed.

The restoration works have been targeted for completion in 1999. The exact nature of the works will again be subject to the design of the restoration contractor selected by EPD to undertake the works.

8.4 *THE PROPOSED DEVELOPMENT*

8.4.1 *General*

The proposed layout for the RTT is shown in *Figure 2.1a*. The main components of the RTT include:

- Road container entrance;
- container lorry park;
- entrance for container freight station and bulk handling berths;
- internal and external goods vehicle parking;
- operational container berths;
- container stacking areas;
- break bulk area for container packing and unpacking;
- CFS warehouse;
- terminal service road; and
- Government buildings.

A detailed description of the RTT is provided in *Section 2*.

8.4.2 *Proximity of the Development to the Landfill*

The relative locations of the SLSL, the PPVL and the RTT are shown in *Figure 8.1a*. The RTT is located approximately 290m beyond the estimated waste boundary of PPVL and 350m beyond the estimated waste boundary of SLSL. As such the RTT does not fall within EPD's recommended 250m consultation for landfill gas hazards investigation. However, under certain circumstances landfill gas and leachate hazards can impact upon developments at distances greater than 250m and EPD have requested that these hazards are assessed for the RTT. The landfill boundaries and 250m consultation zone around SLSL and PPVL are shown in *Figures 8.4a and 8.4b* respectively.

8.4.3 *Utility Services*

General

After the completion of the RTT and various works occurring in the vicinity, there are likely to be various utility conduits which could act as pathways for landfill gas to travel between the landfills and the RTT site. For the purposes of landfill gas risk assessment, such conduits are divided into two categories, as follows:

- **Open void conduits** such as: foul-water/soil pipes, culverts, cable trunking, ventilation ducting, inspection chambers and manholes, soakaways and drains, air conditioning cooling water supply, service tunnels, land drainage pipes, box-outs and substructure cavities.

- **In-filled conduits** such as: electricity supply cables, gas supply pipes, fresh water supply mains, salt water flushing mains, TV cables, computer/ communications system cables, process pipework, hydrants/fire systems, landscape irrigation pipework, street lighting cables, and lightning protection/earth rods.

These two broad categories of pathway require different assessment considerations, as the potential modes of gas transport may differ between them.

ERM are continuing to seek information from the utility companies on the utility services which may link the RTT with the SLSL or PPVL. Some information has been made available through the consultant's work on the North-west New Territories Landfills - Contract Arrangements Study.

Siu Lang Shui

The utility services which pass close to the SLSL alongside the Lung Mun Road include:

- Water Services Department - 700mm watermain;
- Hongkong Telecom - telephone duct;
- China Light & Power - 11kv cable, 132kv cable, P.L. cables, L.T. cables.

The connections, if any, of these services with the RTT are not as yet determined.

Pillar Point Valley Landfill

No information is available, as yet, on the utility services which may connect PPVL with the RTT.

8.5 *MONITORING DATA REVIEW*

8.5.1 *Siu Lang Shui Landfill*

General

Monitoring commenced at SLSL in June 1993 as part of the Feasibility Study. Initial monitoring occurred between June and November 1993. A further monitoring period known as the "Pre-Tender Monitoring"began in December 1994 and continued until August 1995. Additional monitoring, from October 1995 to June 1996, was carried out under the ongoing North-west New Territories Landfills - Contract Arrangements Study and these data have also been reviewed. Monitoring data up to June 1996 have been reviewed in this assessment.

Landfill Gas Monitoring

Monitoring Facilities

In work undertaken to date at SLSL landfill, seventeen drillholes have been installed around the periphery of the landfill. Gas monitoring standpipes have also been installed through the capping layer into the landfilled wastes. DP220, DP221, DP223 and DP224 are located off-site along the southern boundary and are of most interest in this Study. Monitoring of the drillholes DH201, DH203 and DH204, also located at the southern boundary, began in December 1994.

Monitoring Schedules

In the Pre-Tender Monitoring and in the ongoing Further Environmental Monitoring all the landfill gas monitoring points have been monitored using portable instruments on a monthly basis. In addition one landfill gas sample has been taken from each site each month for confirmatory laboratory analysis. The frequency of the laboratory analyses have now been reduced to quarterly. The following measurements have been recorded during the monitoring:

i) Field - temperature;
atmospheric pressure
relative pressure
methane concentration
oxygen concentration
carbon dioxide concentration

ii) Laboratory - methane concentration
oxygen concentration
carbon dioxide concentration
hydrogen concentration
carbon monoxide concentration
nitrogen concentration

Monitoring Results

The monitoring results for the Pre-Tender Monitoring and the Further Environmental Monitoring are provided in *Annex B*. The monitoring undertaken during the Pre-Tender Monitoring and the Further Environmental Monitoring has found no methane in the off-site monitoring probes DP220, DH201, DP221 and only very low levels in DH203A and DP223 located at the southern boundary of the landfill. The only off-site drillholes where significant methane concentrations have been detected are drillholes DH204 and DP224 located at the south-eastern corner of the landfill boundary. The maximum concentrations found at these two drillholes throughout the monitoring period are 7.9% v/v in DH204 in December 1995 and 12.8% v/v in DP224 in June 1995. Elevated concentrations of carbon dioxide were observed in all of these off-site probes, except DP220 with the highest concentrations being found in each probe ranging from 10.5% v/v in probe DH201 to 25.1% v/v in probe DP223. Only a trace concentration of 0.1% carbon dioxide was found in probe DP220 in December 1994 and May 1996.

High concentrations of methane and carbon dioxide have been observed in the on-site monitoring probes DH207, DP217, DP219, DP212A, DH209, DH208 and DH205 which are located in the northern half of the site. The highest concentration of methane found was 64.3% v/v in probe DP217 in December 1994. The highest concentration of carbon dioxide recorded was 36.4% in probe DH208 in August 1995. Carbon dioxide concentrations have also remained consistently high around 30% v/v in DH207.

The probes located in the southern part of the landfill recorded much lower methane and carbon dioxide concentrations. The carbon dioxide concentrations in each of these probes have consistently been found to be moderately high. For example the carbon dioxide concentrations for probes DP214 and DP215 have remained around 10% v/v in the latest monitoring.

These results indicate that the northern part of the landfill is the most active in terms of landfill gas generation and that the southern part of the landfill is relatively inactive.

Leachate Monitoring

Monitoring Facilities

In work undertaken during the IEIA, leachate at SLSL was monitored via two drillholes, labelled DH205 (began in May 1993) and DH207 (testing began in June 1993), two tanks, labelled L206 and L207, and the sump, labelled sump (testing from all began in July 1993). Surface sampling was undertaken at six stations, L201, L202, L203, L204, L205, which were located on the eastern bank of the stream in the south-western corner of the site, and the Pipe discharge point on the beach to the south of the site.

On the recommendations of the Feasibility Study Working Paper 3 : *Leachate Management*, monitoring was extended to nine drill holes within the landfill and beyond the southern boundary of the site, labelled DH201, DH203, DH204, DH205, A251, A252, A253, A254 and A255 (testing from all began in December 1994). Four surface water monitoring stations were established upslope and downslope of the site, and along the stream to the south-west of the landfill, labelled SW201 to SW204, inclusive (testing from each began in December 1994). The monitoring points are shown in *Figure 8.3a*.

DH205, A254 and A255 are located within the landfilled wastes and therefore any water samples taken are assumed to be leachate samples. These drillholes have been monitored together with surface leachate monitoring points L206 and L207, located at the leachate holding tanks at the south-western and south-eastern corners of the landfill respectively, during the Pre-Tender Monitoring.

In the Further Environmental Monitoring sampling was continued, but with a reduction in the sampling frequencies and the extent of the determinants analysed.

Monitoring Schedules

Leachate levels and flows are being monitored on a monthly basis during the Pre-Tender Monitoring and Further Environmental Monitoring at SLSL.

During the Pre-Tender Monitoring the leachate monitoring points L206 and L207 (leachate holding tanks located at the south-western and south-eastern corners of the site respectively) at SLSL have been sampled and analysed in accordance with an extensive analyses suite on a monthly basis. The drillholes located within the landfills have been sampled and analysed in accordance with the same analyses suite on a quarterly basis.

The monitoring frequencies for the Further Environmental Monitoring were reduced after the initial three month period when the same monitoring analyses suites and frequencies as the Pre-Tender Monitoring were carried out. In the Further Environmental Monitoring liquid levels continued to monitored on a monthly basis and samples taken on a monthly or quarterly basis dependent on the monitoring point. However, a smaller analyses suite was used.

Monitoring Results

Leachate levels within SLSL have varied as follows:-

Monitoring Point	***Observed Levels (below drillhole top)***
DH205	18.25-26.50m
A254	13.41-18.10m
A255	31.50-33.92m

The leachate depths are measured from the top of the drillhole to the leachate. The leachate quality within the site has been found to vary greatly by location in the IEIA, the Pre-Tender Monitoring and in the Further Environmental Monitoring.

Leachate Quality

A summary of leachate quality analytical data from SLSL is presented in *Table 8.5a* below. The analytical results for the SLSL have been obtained from the Further Environmental Monitoring (October 1995 - June 1996).

Table 8.5a *Leachate and Groundwater Quality*

Location	COD/mg/l	NH3-N/mg/l
DH205	14,000-17,000	7,100-8,200
A254	2,500-3,200	2,300-2,700
A255	5,600	4,600
DH201	26-940	5-1300
DH204	210-1900	480-3200
A251	410-1400	600-860
L207	280-1,100	490-1,500
L206	480-860	520-1,100

Leachate Volumes

With respect to leachate volumes, a best estimate for average leachate arisings after completion of the restoration work under the North-west New Territories Landfills Contract at SLSL is $75m^3$/day, based upon the likely maximum permitted infiltration rate for the capping materials for the landfill under the Restoration Contract.

Groundwater Contamination

In the Pre-Tender and Further Environmental Monitoring high levels of leachate contamination, as shown in the Table above, have been found in groundwater drillholes in DH201 located at the south-western boundary, DH204 located at the eastern boundary and A251 located at the northern boundary.

Surface Water Contamination

SW201 is located upstream of the landfill and shows no evidence of contamination by leachate. However, at SW204 located in the stream at the south-western corner of the site high levels of COD (23-430mg/l) and NH3-N (15-59mg/l) have been recorded during the Pre-Tender Monitoring and Further Environmental Monitoring.

8.5.2 *Pillar Point Valley Landfill*

Landfill Gas Monitoring

Monitoring Facilities

Landfill gas was monitored during the Pre-Tender Monitoring in four drillholes, of which, DH106, A151 and A152 are on-site and DH103 is off-site. Drillholes DH106 and A151 are located at the southern boundary of the site, as shown in *Figure 8.5b*.

Monitoring Schedule

The landfill gas monitoring drillholes were monitored on a monthly basis throughout the Pre-Tender Monitoring Period. In addition an enhanced weekly and daily monitoring programme was undertaken at selected locations in order to identify any effects which weather may have on landfill gas emissions.

Monitoring Results

In the off-site drillhole DH103 methane was only detected once in January 1995 when a low concentration of 4% LEL was recorded. Carbon dioxide concentrations varied between 1.3 and 5.2% v/v.

The monitoring of the on-site drillholes recorded high concentrations of methane and carbon dioxide, with methane concentrations being generally in the range of 55-65% v/v and carbon dioxide concentrations ranging from 25-40% v/v. The methane and carbon dioxide concentrations suddenly lowered in drillhole DH106 in May 1995 to 19.9% v/v methane and 13% v/v carbon dioxide. These concentrations fell further in August 1995 to 2.1% v/v methane and 3.1% v/v carbon dioxide. Daily monitoring undertaken in July and August 1995 at drillhole DH106 gave a range of concentrations of methane from 0.09% to 10.8% v/v and carbon dioxide from 0.1% to 7.4% v/v.

Leachate Monitoring

Leachate Monitoring Facilities

Groundwater/leachate has been monitored in each of the drillholes DH106, A151 and A152 and DH103. In addition groundwater/leachate has been monitored from groundwater/leachate manhole monitoring points GWMH and Sewer MH respectively.

Leachate Monitoring Schedules

A number of samples were taken over the nine month monitoring period. The results of this monitoring are described below and presented in *Annex B*.

Flow rates at the PPVL sewer manhole were monitored on a daily basis during the wet season.

Monitoring Results

Liquid Levels

Leachate/groundwater level monitoring results showed minor seasonal fluctuations at monitoring wells DH103 and A152, although levels varied by less than 1.3m. Leachate levels at drillhole A151 showed a marked seasonal increase of 6.3m between July and September 1995. Monitoring well DH106 was generally dry, except for the wet season months of May and June 1995.

Leachate Flow

In the Final Report of the Feasibility Study the leachate arisings at PPVL were estimated to be in the order of an average of 130m^3/day which would be about half the wet season daily flow. If the infiltration rate of 80mm/year, as is likely to be specified in the Pillar Point Valley Landfill Restoration Contract Specification, is applied to the landfill area, which covers 53 ha, then an average daily flow of around 120m^3/day will be generated. This average flow does not include leachate arisings through the lowering of leachate levels to meet any performance requirement which may be specified in the PPVL Restoration Contract.

Leachate/Groundwater Quality

A summary of leachate quality analytical data for PPVL from the Pre-Tender Monitoring (December 1994 - August 1995) is provided in *Table 8.5b* below.

Table 8.5b *Leachate and Groundwater Quality*

Location	COD/mg/l	NH3-N/mg/l
A151	2300-7000	490-980
A152	860-1500	990-1600
Sewer MH	660-860	540-920
DH103	13-28	<0.1-<0.3
GWMH	390-480	600-610

The groundwater drillhole downstream of the landfill shows no evidence of pollution by leachate. The Feasibility Study gave the possible explanation that contaminated groundwater passes into the groundwater collection pipeline and seeps into the stream before reaching the groundwater monitoring drillhole.

Upstream and downstream measurements of the catchwater channels show that there are elevated levels of chloride, conductivity, organic and ammonia in the downstream samples.

8.6 QUALITATIVE ASSESSMENT OF RISK TO THE RTT FROM LANDFILL GAS AND LEACHATE ARISING FROM THE SLSL AND PPVL

8.6.1 *Landfill Gas and Leachate Hazards - Assessment Criteria and Methodology*

The risk due to landfill gas and leachate may be evaluated based upon the following three criteria:

- the rate of gas and leachate generation by the source landfill;
- the nature of and length of potential pathways through which gas and leachate can migrate, such as geological strata, utility services and leachate flow for landfill gas and groundwater and surface water flow for leachate; and
- the level of vulnerability of the target to landfill gas and leachate.

A high rate of gas generation, a short or highly permeable pathway, or a highly vulnerable target can cause the gas risk to be assessed as high. Targets which include enclosed spaces where gas can accumulate, or where there are potential sources of ignition, are considered to be vulnerable. Leachate flow may occur to areas beneath or near to targets, and landfill gas may be generated or released from the leachate depending upon decomposition and pressure conditions.

In general, landfill gas is considered to be a potential danger if the distance between the source and the target is 250 m or less, although landfill gas can migrate much further than this given certain conditions. As stated in *Environmental Guidelines for Planning in Hong Kong (EPD, Planning Department, 1991)*, any developments close to landfills should have controls and precautions determined in consultation with EPD.

A similar assessment procedure may be applied to evaluate the potential hazards from leachate. A high rate of leachate generation, a strongly contaminated leachate, a short or highly permeable pathway, or a highly vulnerable target can cause the leachate risk to be assessed as high. Targets may include building foundations, surface waters, drainage systems, sewers and water treatment systems. Leachate flow may occur in groundwater or surface waters and can have adverse effects on concrete, cause corrosion of steel and give rise to offensive odours.

8.6.2 Siu Lang Shui Landfill

Source

SLSL contains 1.2 million tonnes of waste and is actively generating landfill gas at an estimated rate of approximately $200m^3$/hour. Landfill gas monitoring in the northern part of the site, where the landfilled wastes are deepest, has found high methane and carbon dioxide concentrations of up to 65% and 37% respectively. The landfill gas concentrations of methane and carbon dioxide have been found to be much lower in the southern areas of the site where waste depths are much shallower. Landfill gas is allowed to vent to atmosphere through the capping medium and a system of passive gas vents which will prevent the build up gas pressures within the site which could lead to an increased potential for lateral gas migration into the surrounding strata. The partial lining may also assist in preventing any lateral landfill gas migration.

Little or no methane was found in five of the seven monitoring drillholes located off-site during the Pre-Tender and Further Environmental Monitoring. However, elevated carbon dioxide concentrations as high as 10% in all the southern boundary off-site drillholess and reaching 25% in drillhole DP223 were observed. These elevated concentrations may have arisen through the oxidation of methane as it migrates within the geological strata.

Leachate generation has been estimated between 70 and $200m^3$/day. The monitoring has revealed that the highest concentrations of leachate are found in the northern part of the site in the vicinity of drillhole DH205 where COD concentrations ranged from 14,000 to 17,000mg/l and NH3-N concentrations varied between 7,100 and 8,200mg/l. Evidence of groundwater contamination has been found in the drillholes DH201 and DH204, with NH3-N concentrations ranging from 5-1300mg/l and 480-3200mg/l respectively, located off-site in the area of the southern boundary.

The restoration works which will be undertaken under the Restoration of the North-west new Territories Contract, which are likely to comprise of the works outlined in *Section* 8.3.2, will greatly reduce the potential for off-site landfill gas and leachate migration. These works are scheduled for completion in early 1998 which will coincide with the construction works of Phase I and be ahead of the operation of the RTT which is due to commence in mid 1998.

Pathway

The geology between SLSL and the RTT provides a potential pathway for migration of landfill gas through fractures, joints and intergranular movement. However, the RTT development is located at an elevation well below the basal level of the waste within the landfill thereby significantly reducing the geological cross-sectional area through which landfill gas could migrate. In addition, there is a high water table which further limits the cross-sectional area available for gas migration. If these natural barriers are considered together with the distance between the SLSL and the RTT of 350m it can be concluded that this an extremely unlikely pathway.

The risk, if any, posed to the RTT from the SLSL lies in the passage of landfill gas through the geological strata into the utility services which pass along the Lung Mun Road and may connect with the RTT development. However, the tortuous nature of this pathway and the long distances between the SLSL and the RTT mean that the risks to the RTT from this pathway are considered to be low. Additional confidence can be obtained from the review of the monitoring data which shows that little methane gas migration is migrating into the strata surrounding the landfill.

The direction of groundwater flow is down the valley towards the coastline and not in the direction of the RTT. It is therefore concluded that there will be no landfill gas impacts on the RTT from the transport of leachate within groundwater, no adverse affects on the foundations of the RTT from leachate and no odour problems associated with leachate seepage and migration at the RTT.

Targets

The RTT is considered to present only a low risk target. The limited number of buildings and the absence of below ground structures within Phase I of the RTT mean that there is little risk of landfill gas ingress. The design of Phase II has not yet commenced and therefore it is not yet known whether below ground structures will be required within the buildings, in particular the container freight station, of Phase II. Standard connection systems for the utilities which may contain some natural ventilation and standard concrete foundations and rafting for buildings will give further protection to the RTT against possible landfill gas ingress.

Preliminary Qualitative Risk Assessment

A preliminary qualitative risk assessment for the RTT is presented in *Table 8.6.a.*

Table 8.6a *Source - Pathway - Target Analysis for Landfill Gas Risks to the RTT from SLSL*

A. Source	B. Pathway	C. Target	Assessment of Risk
Landfill gas (SLSL) *(minor source)*	Geological strata. Fractured bedrock. Distance 350m. Limited thickness of unsaturated strata due to position of groundwater table. *(long/indirect pathway)*	RTT development. Ground level buildings. *(Low sensitivity target)*	V Low
Landfill gas *(minor source)*	Utilities via geological strata. *(long/indirect pathway)*	RTT development *(Low sensitivity target)*	V Low
Landfill leachate *(minor source)*	Geological strata. Groundwater flow not in direction of the RTT. *(long/indirect pathway)*	RTT development *(Medium/low sensitivity target)*	V Low/None

8.6.3 *Pillar Point Valley Landfill*

Source

PPVL will contain 13 million tonnes of waste upon completion in 1997 and may not yet have reached its peak production of landfill gas. The modelling of landfill gas generation by different consultants has predicted widely varying rates, but it is likely that the site is generating landfill gas at a rate in excess of 1,000m^3/hour. Landfill gas monitoring in drillholes within the landfill, has found high methane and carbon dioxide concentrations of up to 65% and 40% respectively. Landfill gas is currently allowed to vent to atmosphere through the capping medium where placed, but no passive or active landfill gas control system has been installed. The partial lining of the walls of the landfill may assist in preventing any lateral landfill gas migration.

Monitoring of the off-site monitoring drillhole DH103 found little or no methane during the Pre-Tender Monitoring. However, slightly elevated carbon dioxide concentrations as high as 5.2% v/v were recorded. These elevated concentrations may have arisen through the oxidation of methane as it migrates through the geological strata in the presence of oxygen.

Leachate generation has been estimated to be at an average rate of 130m^3/day throughout the year, although the volumes would be significantly higher during the wet season. The monitoring has revealed that the highest concentrations of leachate are found in the northern part of the site in the vicinity of drillhole A151 where COD concentrations ranged from 2,300 to 7,000mg/l and NH3-N concentrations varied between 490- 980mg/l. Samples taken from sampling point GWMH show contamination of groundwater by leachate with NH3-N concentrations being recorded as high as 610mg/l. However, drillhole DH103 located downstream of the site shows no evidence of contamination of groundwater. It is likely that the partial engineering and the leachate collection system and the groundwater collection system are combining to prevent more widespread groundwater contamination from occurring beyond the site. It is therefore concluded that there will be no landfill gas impacts on the RTT from the transport of leachate within groundwater, no adverse affects on the foundations of the RTT from leachate and no odour problems associated with leachate seepage and migration at the RTT.

The restoration works which will be undertaken under the Pillar Point Valley Restoration Contract, which are likely to comprise of the works outlined in *Section 8.3.3*, will greatly reduce the potential for off-site landfill gas and leachate migration. These works are scheduled for completion in 1999 which will be after the date of the commencement of the operation of Phase I of the RTT which is scheduled for mid 1998.

Pathway

The site's geology provides a potential pathway for migration of landfill gas through fractures, joints and intergranular movement. However, the RTT development is located at an elevation well below the basal level of the waste within the landfill thereby significantly reducing the geological cross-sectional area through which landfill gas could migrate. In addition, there is a high water table which further limits the cross-sectional area available for gas migration. If these natural barriers are considered together with the distance between the PPVL and the RTT of 290m it can be concluded that this a very unlikely pathway.

The risk, if any, posed to the RTT from the SLSL lies in the passage of landfill gas through the geological strata into the utility services which pass along the Lung Mun Road and may connect with the RTT development. However, the complicated nature of this pathway and the long distances between the PPVL and Lung Mun Road and the PPVL and the RTT mean that the risks to the RTT from this pathway are low. Additional confidence can be obtained from the review of the monitoring data which shows that only extremely low concentrations of methane gas have been recorded in DH103 which is located between PPVL and the RTT.

The natural flow of groundwater from PPVL is down the valley towards the coastline in the general direction of the RTT. However, the groundwater monitoring results from drillhole DH103 show that leachate contamination has not occurred down the hydraulic gradient form the landfill. It is therefore extremely unlikely that landfill gas will be transported to the RTT via this pathway

Targets

The RTT is considered to present only a low risk target for the reasons described in *Section 8.6.2* above.

Preliminary Qualitative Risk Assessment

A preliminary qualitative risk assessment for the RTT from PPVL is presented in *Table 8.6b* below.

Table 8.6b *Source - Pathway - Target Analysis for Landfill Gas Risks to the RTT from PPVL*

A. Source	B. Pathway	C. Target	Assessment of Risk
Landfill gas (PPVL) *(minor source)*	Geological strata. Fractured bedrock. Distance 290m. Limited thickness of strata can act as pathway due to high groundwater table *(long/indirect pathway)*	RTT development Ground floor buildings. *(Low sensitivity target)*	V Low
Landfill gas *(minor source)*	Utilities via geological strata. Lung Mun Road considerable distance from landfill. No landfill gas migration in direction of RTT detected. *(long/indirect pathway)*	RTT development *(Low sensitivity target)*	V Low
Landfill leachate *(minor source)*	Geological strata. No groundwater contamination observed down hydraulic gradient from PPVL. *(long/indirect pathway)*	RTT development *(Low sensitivity target)*	V Low/None

8.7 *MITIGATION MEASURES*

8.7.1 *Construction Phase*

It is unlikely that any mitigation measures will be required due to the low levels of risks (as discussed above) and the open nature of the RTT construction site. This will be confirmed upon receipt of the additional information which has been requested with respect to the utility services.

8.7.2 *Operational Phase*

Due to the distance between the RTT site and both the PPVL and SLSL, mitigation is considered necessary only if a utility related pathway exits directly between the vicinity of the landfill and the RTT site. If a potential utility pathways is identified, from any additional information along the utility service(s) in the area obtained, monitoring of conduit air spaces at a number of points of the RTT site should be undertaken using appropriately calibrated portable gas detection equipment. If methane or elevated levels of carbon dioxide are detected then the protection measures discussed below should be considered.

Protection measures applied to service conduits should not generally be considered in isolation, as it is important that an integrated approach is adopted for the protection of the building (or development). However, due to the distance of the landfills from the RTT site, the focus here will be on service conduits. The following protection features can be used for the protection of service conduits or the protection of buildings from gas entry via service conduits:

- barriers;
- vents; and
- location of the service outside the (potentially) gas-contaminated ground.

Gas barriers are most readily applied to service trenches at a point between the source of the gas and building (or development) itself; preferably as close as is practical to the building. The barrier should be engineered to have a permeability at least three orders of magnitude lower than the service trench backfill. This may be achieved using either clay (or clay rich soil) or soil-bentonite mixtures.

Gas vents may be used to serve two purposes: to provide additional protection to open conduits such as sewers; or to reduce accumulation of gas on the landfill side of a cut-off barrier. In the former case, a simple stack built into an inspection chamber venting to atmosphere at least 3 m above ground level would be adequate. In the latter case, typical practice would be to lay a high permeability gas drainage layer adjacent to the cut-off barrier and vent to atmosphere through stacks.

In some cases it is possible to route service entries into a building above ground level, thereby effectively providing an 'atmospheric break-leg' and eliminating the risk of gas entry to the building interior. This practice is routinely adopted for Town Gas entry pipes and may be extended to cover electricity supply and other types of cable.

8.8 *CONCLUSIONS*

The RTT's site geology could provide a potential pathway for migration of landfill gas. However, due to the distance between the RTT and both the SLSL (350 m) and the PPVL (290 m) when considered with the high water table and relative elevation of the base of the waste, makes this an extremely unlikely gas migration pathway.

The groundwater regime at SLSL is such that leachate flows away from the RTT thereby preventing any leachate impacts upon the RTT. It is also extremely unlikely that there would be any impacts upon the RTT from leachate generated at PPVL because of the effective operation of the existing leachate management controls at the landfill. The restoration works and associated management and maintenance controls will be improved with the implementation of the Pillar Point Valley Landfill Restoration Contract which is scheduled for completion in 1999.

It is therefore considered unlikely that any mitigation measures will be required for the construction phase due to the distance and open nature of the RTT construction site.

For the operational phase, due to the distance between the RTT and both landfills, mitigation measures would only be considered necessary in cases where a utility related pathway exists directly between one of the landfills and the RTT site. The risks of landfill gas migration to the RTT from either SLSL or PPVL are assessed to be very low. The only potential pathway for landfill gas to impact upon the construction or operation of the RTT is through the migration of landfill gas within a utility service connection from the vicinity of SLSL or PPVL to the RTT. Due to the large separation distance between the proposed RTT and both landfill sites, "above ground pathways" will not pose air quality impacts on the RTT.

A review of additional utilities information will be conducted when it becomes available and may recommend some short term monitoring of landfill gas. Mitigation measures are unlikely to be recommended unless landfill gas migration is found to be occurring within the utility services.

9 VISUAL

9.1 INTRODUCTION

The proposed RTT shown in *Figure 2.1a*, will be constructed on reclaimed land at Pillar Point (Mong Hau Shek) in front of the Pillar Point Sewage Treatment Works, and to the west of the existing factories and shipyards. The site will be accessed from the upgraded Lung Mun Road. To the west it is proposed that a Special Industries Area will be constructed.

The Tuen Mun Area 38 EIA included no consideration of the visual impact of the RTT construction or operation. Therefore the Visual Impact Assessment (VIA) as part of the EIA of the RTT was to identify the most affected views and recommend mitigation measures which should be incorporated into the detailed design and construction stages of the project. The aim will be for implementation of the project to take place with potential visual impacts minimised.

9.2 ENVIRONMENTAL STANDARDS AND LEGISLATION, AND ASSESSMENT METHODOLOGY

9.2.1 *Environmental Standards and Legislation*

In Hong Kong, there are currently no specific elements of legislation which govern visual impact or offer guidelines on visual assessment methodology. The Government has, however, published the following policy and guidance which is relevant to visual issues:

The 1990 Government White Paper on "Pollution in Hong Kong - A Time to Act" offers general policy objectives on avoiding environmental problems by considering all environmental impacts in the early stages of the development process. The Hong Kong Environmental Protection Department's (EPD) Advice Note 2/92 offers guidelines on the environmental impact process for major private sector projects. This recognises visual impact as an issue of concern.

The "Environmental Guidelines for Planning in Hong Kong" (containing extracts from the Hong Kong Planning Standards and Guidelines) make no specific reference to visual impacts in their "Guidelines on environmental matters which should be considered in planning and development activities in Hong Kong".

Chapter 10: Conservation of the Hong Kong Planning Standards and Guidelines (HKPSG) states the objective of retaining significant landscapes. Statutory land use zoning categories afford a varying degree of protection to such landscapes. It also refers to the need to assess environmental impacts of developments, but does not specify a methodology.

The Environment Impact Assessment Bill, introduced in draft form in January 1996, will (if passed) make environmental impact assessment part of the statutory development process. It includes a definition that an environmental impact is a change that a proposed development may cause on the environment affecting the well-being of people, flora, fauna and ecosystems. Specific reference is made to visual impact. The Bill, however, does not recommend minimum standards to assess environmental impacts.

These general statements offer little specific guidance on standards for evaluation or methodologies for assessing visual impacts. Therefore, an assessment methodology has been developed based on current best practice in the United Kingdom developed jointly by the Institute of Environmental Assessment and The Landscape Institute. For this Study, it has been specifically adapted to Hong Kong's particular context and environmental planning objectives for urban and rural landscapes as well as the requirements of the Brief.

9.2.2 *Assessment Methodology*

The methodology developed for this VIA comprises four stages: a baseline study, impact assessment, a mitigation measures study, and the assessment of residual landscape and visual impacts.

Baseline Study

The overall visual envelope (zone of visual influence) is identified. The existing visual resources within the visual envelope are described and assessed to establish the baseline condition. Sensitive viewpoints are identified. The characteristics of the proposed RTT which would affect the baseline condition and sensitive viewpoints are described.

Impact Assessment

An assessment is undertaken of the likely changes to the baseline condition, as well as impacts on the sensitive viewpoints arising from construction and operation of the RTT. The most affected views are identified, with an indication of the impacts of the RTT if no mitigation measures were implemented, illustrated by photomontage shown in *Figure 9.2a*.

Mitigation Measures Study

This evaluation identifies design features which should be incorporated into the proposed development to reduce the extent of the predicted changes to the baseline condition as well as the most affected views.

Assessment of the Residual Landscape and Visual Impacts

This assessment describes the visual impacts of the RTT, if all mitigation measures are implemented. The assessment of visual impact is based on a viewpoint analysis approach and relies on a balance between objective and subjective professional opinion.

9.2.3 *Definition of Technical Terms*

For the purpose of this study, the following technical terms are defined as follows:

Visual impact is a change to the appearance of the landscape and its subsequent effect on sensitive viewpoints.

Sensitive Viewpoints are considered to have varying degrees of "sensitivity" to changes in the view based on the land use at each viewpoint. The Environmental Guidelines for Planning in Hong Kong define sensitive users as "land uses which, by virtue of the nature of the activities thereon, are susceptible to the influence of residuals or physical changes generated by polluting uses". It should be noted that, unlike the "harder" environmental impacts, visual impact does not usually result in direct physical changes to the users of an area, as would possible damage to health from air or noise pollution.

Highly Sensitive Viewpoints are views from high rise or low rise residential developments and buildings which are considered highly sensitive as the users (the residents) would be particularly aware of any visual changes. Residents are likely to care about the views from their homes as this is where they are likely to spend their leisure time. In addition, residents are likely to have a financial interest in the property (either ownership or rental) and a change in the appearance of the surroundings could have a significant financial implication on property values leading to public objections.

Moderately Sensitive Viewpoints are views from commercial developments, schools, public open spaces including beaches and scenic transport corridors which are considered moderately sensitive. In the case of schools and offices, while users may be at these viewpoints regularly, they are primarily there for another reason i.e. for study or work. In the case of open spaces, beaches and certain transport corridors, these are likely to be visited for shorter periods of time and there would be an element of control or choice in their use. A change in the view from these land uses would have a less significant impact.

Low Sensitivity Viewpoints are views from industrial areas and most transport corridors which are considered to have low sensitivity. In industrial areas, user expectations of visual quality are low; the users are there primarily for another reason i.e. to work. Users of certain transport corridors are subject to changes in a view for a relative short period of time. A change in the view would therefore have an insignificant effect on the overall quality of life from such view points.

9.3 *BASELINE STUDY*

9.3.1 *Study Area*

The Study Area for the EIA encompasses the headlands of Siu Lang Shui and Pillar Point, and to the east of the proposed site; Butterfly Beach and the residential areas to the southwest of Tuen Mun shown in *Figure 9.3a*.

The new residential development of Tung Chung on Lantau Island, being constructed adjacent to the new airport development, and the North Lantau Expressway and Airport Railway, are also included within the visual envelope shown in *Figure 9.3b*.

9.3.2 *Existing Visual Resources*

The eastern section of the Study Area, includes the upper floors of the highrise residential blocks of Melody Garden and Richland Garden to the southwest of Tuen Mun. All have associated commercial and school developments. The area has an urban character, and is set against the backdrop of Castle Peak. The urban area is defined to the south by the coastline. The residential blocks command open views of the sea and the existing view is shown in *Figure 9.3c*. The residential development of Pearl Island does not fall within the Study Area as the RTT will not be visible from this location.

To the west of the Tuen Mun urban area, at the foot of Castle Peak, lies Butterfly Beach and Butterfly Beach Park. This is a popular recreation facility and is highly accessible to the residents of Tuen Mun and is shown in *Figure 9.3c*.

At the western end of Butterfly Beach, at the headland adjacent to the proposed site, the sea has been reclaimed to house several factories, shipyards, godowns, and a sewage treatment works. This reclamation juts out beyond the natural coastline so that the large scale buildings, cranes and shipping activity are highly visible from Butterfly Beach and the southwestern residential areas of Tuen Mun.

To the north of the Study Area the landform rises steeply as a series of ridges and small valleys to a summit at 240m above sea level. Within the valleys several borrow areas have been completed and reinstated with vegetation. The hills are covered with a variety of vegetation, including low and tall scrub, grassland, and plantation woodland. Large portions of the hillside show signs of man-made cuts, restabilised using concrete, and large areas of bare rock have been exposed and is shown in *Figure 9.3c*.

The Tuen Mun Outline Zoning Plan (OZP) identifies the hillsides to the north as Green Belt. The aim of a Green Belt zoning is to define the limit of development on the fringes of the existing and proposed urban areas, with the aim of conserving natural features and, where possible, enhancing its landscape and amenity value. This area of Green Belt contributes substantially to the amenity of the coast of the western New Territories.

The western part of the study area includes the cement works jutting out from the coast at Siu Lang Shui. From here the chimneys of Castle Peak Power Station can be clearly seen and is shown in *Figure 9.3d*.

The Chek Lap Kok Airport site on the northern side of Lantau Island, and the future residential development of Tung Chung, presently under construction; lie to the south of the study area across the sea channel shown in *Figure 9.3e*.

9.3.3 Sensitive Viewpoints

As stated in *Section 9.2*, the "sensitivity" of each viewpoint is based on the land use at each location. In addition to this general classification of sensitivity, also of importance are :

- the distance between the viewpoint and the development,
- the number of people at each of the viewpoints,
- the number of times people will look at the view while at this viewpoint,
- what the viewer will be doing at the time (for example, sleeping, morning exercises),
- light, air and general weather conditions will affect the view (hazy conditions, which prevail in Hong Kong during the summer months, reduce contrasts within the visual environment),
- the size of the development in relation to the overall view (the impact will be less significant if part of a wide or panoramic view),

- the overall quality of the existing view; this will be influenced by the extent and type of existing man-made development.

Having established the sensitivity of the viewpoints to the new development (a factual exercise), the overall visual impact can be assessed. This is based on objective professional experience, with consideration of the following:

- Visual obstruction; the extent to which the development will block a view.

- Visual intrusion; the incompatibility of the development within the existing view. This is created by the introduction of contrasting and incongruous forms, textures and colours.

- Visual quality; a judgement of the effect of the development on the existing visual quality of the area.

The following sensitive viewpoints have been identified within the visual envelope:

Highly Sensitive Viewpoints

- Residents of Melody Garden (upper floors only);
- Residents of Richland Garden (upper floors only);
- Residents of the Residential Developments of Tung Chung on North Lantau.

Moderately Sensitive Viewpoints

- Users of Butterfly Beach;

Low Sensitivity Receivers

- Workers at the Pillar Point factories and shipyards;
- Workers at the proposed Special Industries Area;
- Motorists on Lung Mun Road;
- Passengers on the Tuen Mun ferry;
- Boats using the channel.
- Passengers on the North Lantau Expressway and Airport Railway.

9.3.4 *Project Description*

The proposed RTT will be constructed mainly on reclamation at 5mPD, and on existing land at its connection with Lung Mun Road, between the sewage treatment works and the godowns of Pillar Point. From Pillar Point the reclamation will extend westwards to the cement works at Siu Lang Shui. The reclamation extends into the sea a distance of 950 meters. The reclamation will be surrounded by sea walls and breakwaters shown in *Figure 2.1a*.

The completed project will include ancillary structures such as small scale buildings, cranes and lighting masts at heights of up to 40mPD. During operation the area will be used for storing shipping containers. In general the RTT will cover a large surface area, but will be relatively low in height. At night time the area will be lit by powerful floodlights at a height of 35 meters above the reclamation level of 5mPD. The light source will be a sodium lamp emitting a yellow light. Reflectors will be fitted to the lights to eliminate any horizontal phasing, and the lights from the high towers will be directed towards the south to southwest (out to sea).

9.4 *Assessment of Visual Impacts*

This section summarises the broad impacts of the RTT and the key visual impacts. As it is assumed that mitigation measures will be adopted in whole or part, the residual impacts are considered in more detail in *Section 9.6* of this Report.

9.4.1 *Construction Phase*

Construction activity will fall into two stages; reclamation of the site platform, and construction of the terminal area. The total construction period is 3 years. Construction activity tends to be visually untidy and cluttered, and will be visible from all sensitive viewpoints. However, the level of impact will be reduced as the construction of the reclamation and the terminal will cause very little disturbance to existing landforms. Construction operations will be at grade and will result in the removal of the existing vegetation along Lung Mun Road.

From the viewpoint of the highly rated sensitive receivers of Melody Garden and Richland Garden the RTT construction will only be visible from the upper floors. The construction activity will be almost 2 kilometers away from the residential blocks and will form a minor component of the sensitive receivers' overall view out towards Lantau Island.

Viewed from Lantau Island, the light from floodlit night time work will be visible. The impact of construction during daytime working hours will be of no significance due to the distance from the site.

To the users of Butterfly Beach, the construction activity will be moderately visible, however this impact will be reduced as the site is partly concealed from the beach by the natural curve of the headland and by the existing factory buildings at Pillar Point.

Work will be highly visible for the workers of the factories and shipyards at Pillar Point, due to their proximity to the construction works and because of the introduction of such a large man-made element into their surroundings. However, the existing character of this area of coastline is already very industrial, thereby reducing the comparative impact.

Due to the removal of the existing vegetation along Lung Mun Road, the construction works and the construction traffic coming and going from the site, will be highly visible to motorists using this road, although the impact will be low.

Commuters using the Tun Mun ferry, and boats in the channel, will be able to view the full extent of the construction against the sea, creating a contrast of high visual impact.

In summary, the predicted changes to the baseline condition and subsequent effects on views from sensitive viewpoints are as follows:

- Construction work rated highly visible can be seen from the intensively used recreation facility of Butterfly Beach, and otherwise from the low sensitivity viewpoints of the ferries and marine traffic;

- A small stretch of existing coastline will be directly lost through RTT reclamation;

- Existing trees and shrubs within the existing RTT reclamation site will be removed. It should be noted that this reclamation is relatively new and the vegetation young. This area only comprises 5% of the whole RTT site with the remaining 95% being on future reclamation; and

- Construction during hours of darkness using low floodlights, extends the visual impact to sensitive receivers further afield.

9.4.2 *Operation Phase*

Once construction of the RTT is complete and it is opened and operational, the main visual impacts will relate to its finished appearance, and to the activity generated by operations and is shown in *Figure 9.4a*.

Viewed from the sea from the south and east, the main impacts will relate to the appearance of the sea walls, and to the visibility of the cranes and stacks of containers. The design and scale of the buildings within the site will also have an impact visually. Although the RTT covers a large area, it is relatively low in height; this means that the visual impact is greatly reduced when viewed from a distance. This case applies to the sensitive viewpoints of the upper floors of Melody Garden, Richland Garden, and Butterfly Beach. From these viewpoints, the visual impact is further reduced as the RTT forms only a small component of their overall view, and because the existing character of this piece of coastline is already quite industrial, including the factories and shipyards of Pillar Point, and the sewage treatment works beyond.

The proximity of the RTT to Lung Mun Road, and the removal of the existing roadside vegetation, will mean that the treatment of this edge of the site will be critical to the degree of visual impact experienced by motorists using this road.

When completed, the RTT will operate 24 hours a day. At night time, the visual impact of the high mast floodlights will be moderate from all of the sensitive viewpoints, and will extend the visual envelope to receivers on the north coast of Lantau. The lighting masts up to 40mPD in height will constitute the biggest change to the existing view. However the light towers will generally be directed towards the south to southwest along the lines of the container stacks (out to sea), and reflectors fitted to the lights will eliminate any glare that would be perceived by the sensitive receivers. The visual impact of the lights is further reduced by the sensitive receivers' comparative distance from the source.

In summary, following the construction phase, the subsequent effects on views from sensitive viewpoints are as follows:

- The stacked containers and tall cranes are rated highly visible;
- The sea walls and breakwaters likewise are rated highly visible; and
- The high mast floodlights will be highly visible throughout the night.

9.5 *MITIGATION MEASURES*

A number of design features should be included into the detailed design of the proposed scheme to mitigate the predicted changes to the baseline condition and the subsequent impacts on sensitive viewpoints.

9.5.1 *Construction Phase*

- The site boundary along Lung Mun Road should be enclosed by hoardings to reduce the impact of construction activity on sensitive receivers;
- Heights of storage materials and stock piles should be maintained at low levels and should not exceed the surcharge levels of the reclamation filling currently specified as + 13mPD; and
- Where possible, planting to screen the permanent works should be undertaken during the construction stage, to assist in mitigating construction impacts.

9.5.2 *Operation Phase*

The mitigation measures proposed for implementation during the operation phase, aim to mitigate the following visual impacts;

- Soften the appearance of the sea walls;
- Partially screen the activity within the RTT;
- Reduce the surface glare of the terminal's hard surface area;

Appearance of the Sea Walls

Due to the severe wave climate during typhoons, the southern sea wall and the outer face of the breakwater will be armoured with precast concrete accropode units. In time marine growth will auotmatically soften the appearance of the outer face of the breakwaters. The sea walls to the east of the RTT will be the energy absorbing rip rap type, constructed using natural stone which will better integrate them with the naturally rocky coastline shown in *Figure 9.5a*.

Soften and Screen the RTT using Trees and Screen Planting

Screen planting will be incorporated wherever possible to soften the appearance of the sea walls and partially screen the cranes, containers, and buildings of the RTT. This will improve the distant views of the RTT from the south and east to a certain extent, but will be most effective in screening views from the closer sensitive receivers of Lung Mun Road, the Pillar Point factories and shipyards, and the future Special Industries Area. Plant material that is well adapted to the extreme site conditions experienced on coastal sites will be used. This is shown in *Figure 9.5a*.

Appearance of the RTT

The surface of the RTT platform will be finished in bitumen which is a non reflective, dark coloured material. This is important for the reduction of the surface glare and hence the visibility of the hard surface area. Planting will also be incorporated within the site to soften its appearance. Proposed planting will take sightline restrictions into account.

9.6 *Assessment of Residual Visual Impacts*

If the mitigation measures described in *Section 9.5* are adopted, the following residual visual impacts are anticipated.

9.6.1 *Residual Visual Impacts During Construction*

During the reclamation and construction period of 3 years, the works will be visible from the moderately and low sensitive receivers in close proximity to the site. However there are no highly sensitive receivers within 2 kilometers of the site. Taking into account the distance of the more sensitive receivers from the site; visual impact is predicted to be low during the construction period. As the site projects a long way out from the natural coastline into the sea, effective mitigation measures are not possible to the south, west and east.

9.6.2 *Residual Visual Impact During Operation*

The change to the baseline condition of the visual resource after completion is considered to be moderate. The level of impact will vary from the sensitive viewpoints and would be dependant on the criteria outlined in *Section 9.2.3*.

Based on this criteria, the sensitive receivers most affected by the proposed RTT would be the upper floor residents of Melody Garden and Richland Garden. For these people the RTT will appear as a low lying, linear, man-made feature, of which the most significant impact will be that of the floodlights at night-time. However when considered in relation to their distance from the RTT, with the factories in the foreground, and in relation to their overall view; the visual impact can be considered to be of low significance. This would also apply to the users of Butterfly Beach, in whose case the impact would be further reduced, as they are only in the area for short periods of time and at their own choice.

The sensitive viewpoints affected to a lesser extent, would be those of the people using ferries, and from ships. However this impact is considered to be of low significance as the surrounding area is generally quite industrial with Castle Peak Power Station to the west and Tuen Mun to the east, and these people will only experience this impact for a short period of time.

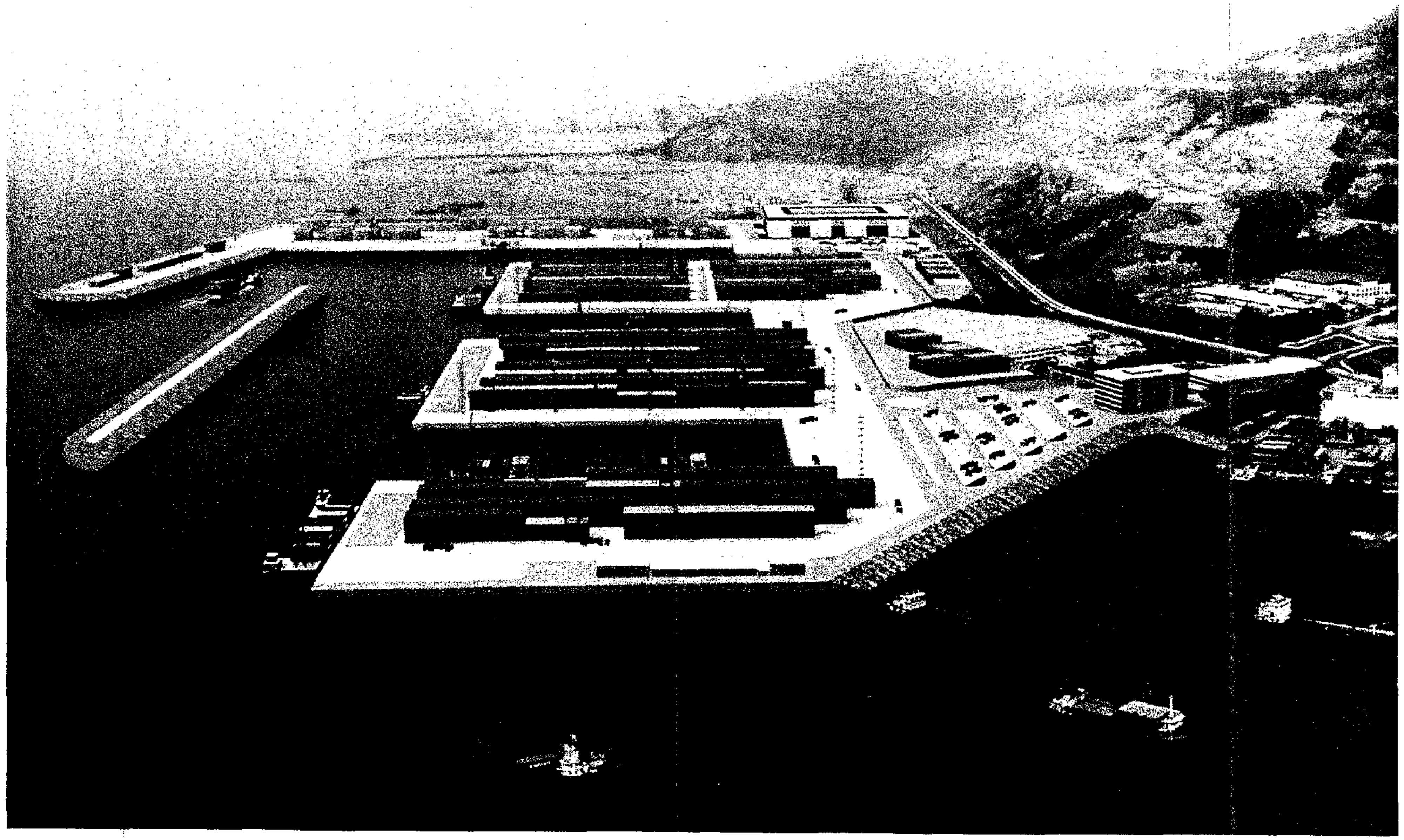
Sensitive viewpoints also affected to a lesser extent will be those of the Pillar Point factory workers, the Special Industries Area workers, and motorists on Lung Mun Road. All of these sensitive receivers come within close proximity of the site, however the overall impact on them is considered to be low, as the workers would be there for a purpose other than to observe the view, and their working environment would already be considered to be of low visual quality; while the duration of the view for motorists is considered to be insignificant.

The sensitive viewpoints least affected would be the residential developments of Tung Chung, the North Lantau Expressway, and the Airport Railway on north Lantau. From these viewpoints the RTT would only be visible at night when floodlit. When viewed from such a distance and in the context of the wider view, alongside the lights of Tuen Mun, this impact is considered to be minimal.

9.7 CONCLUSIONS

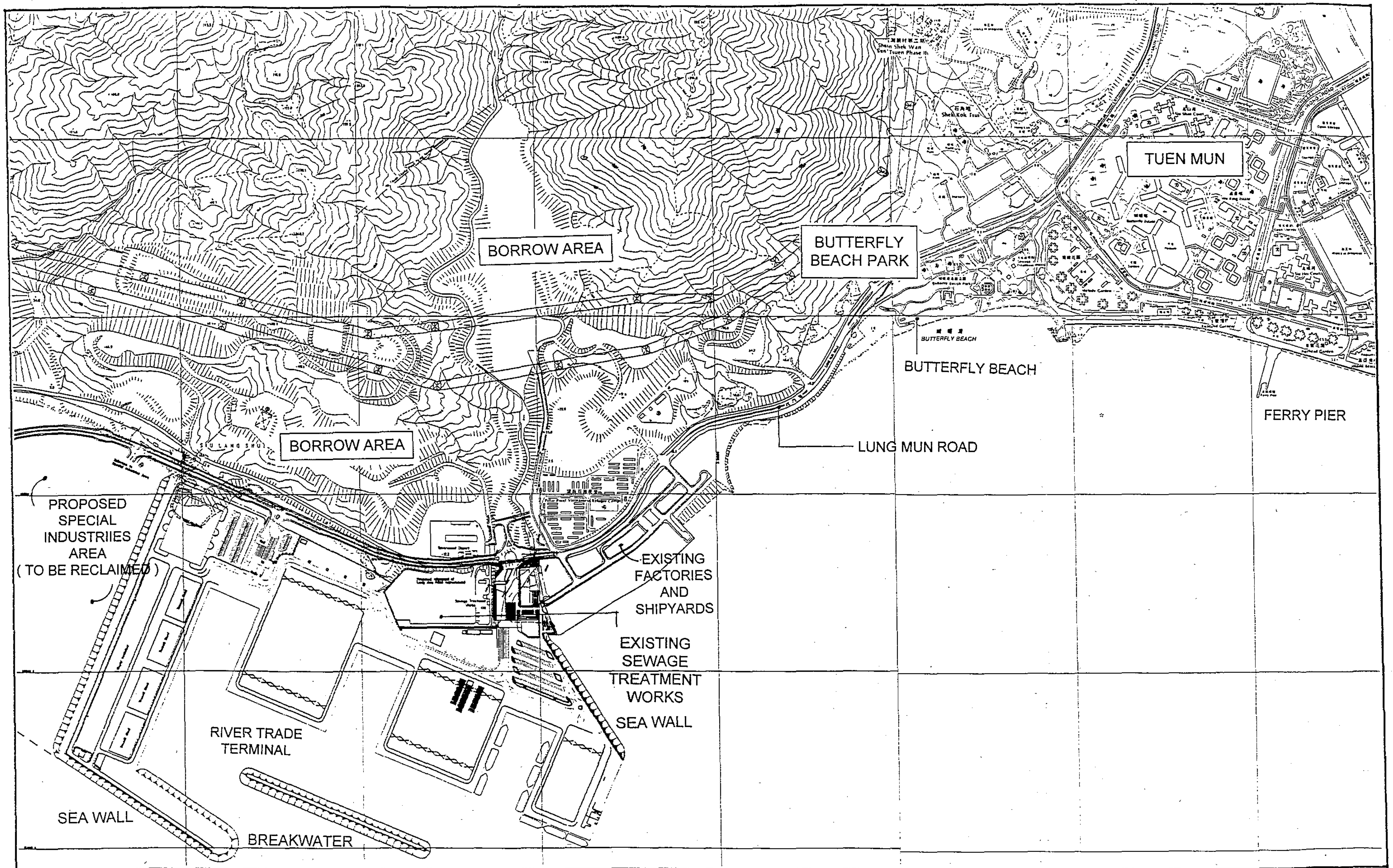
The VIA has identified the potentially affected views and recommended suitable mitigation measures to be incorporated into the detailed design and construction stages of the project. The VIA has lead to the following conclusions:

- The change to the baseline condition of the visual resource is moderate at night, to low during the day;
- Due to the distance of the highly sensitive viewpoints from the source of visual impact; the impact is deemed to be moderate at night time and low during the day, affecting upper floors only;
- The proposed development should incorporate design features recommended in *Section 9.5*;
- The detailed design of the terminal platform, sea walls and breakwaters should take particular account of their appearance; and
- Control of the construction practices, is required to minimise visual impacts.



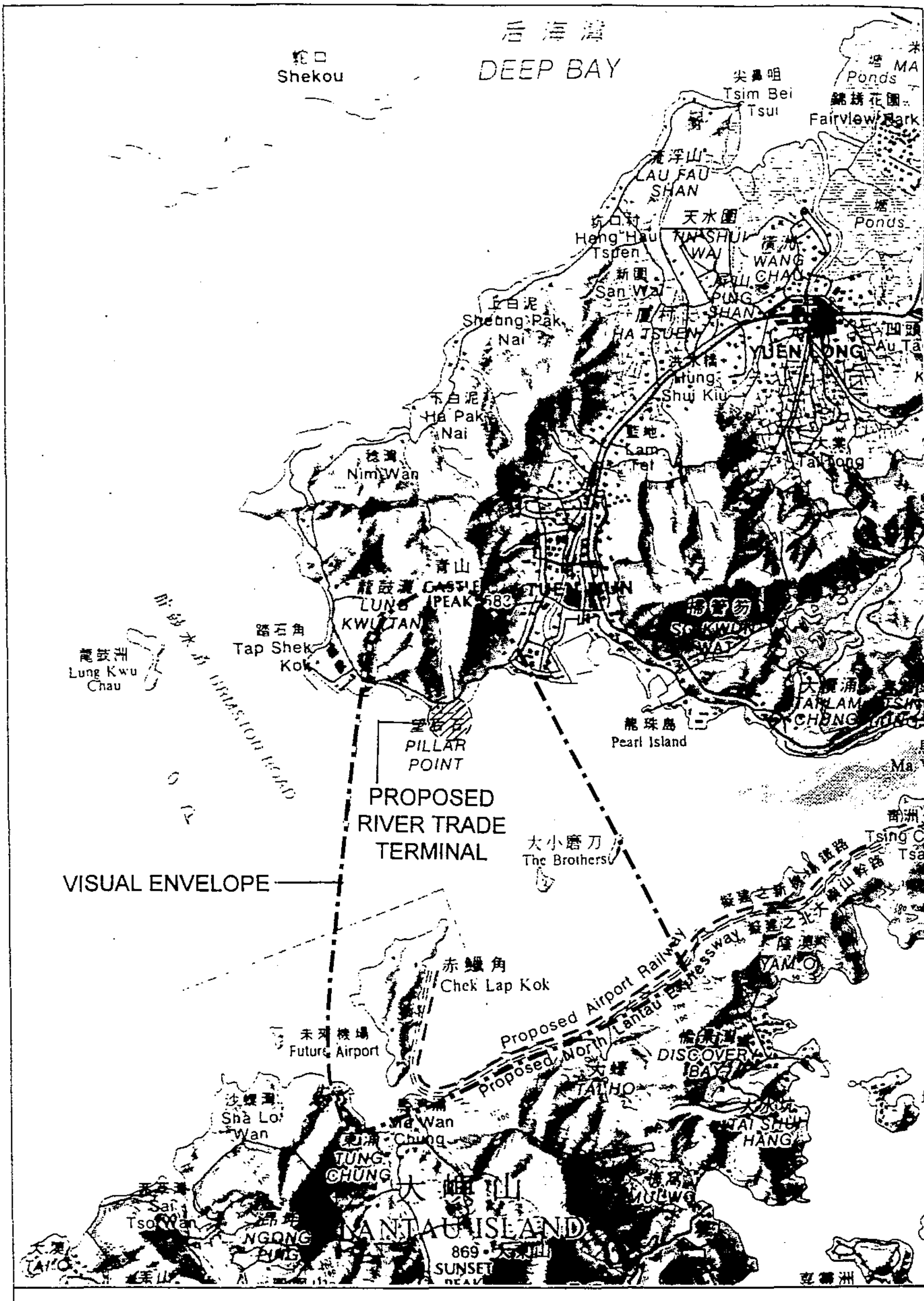
PHOTOMONTAGE OF R.T.T. LOOKING WEST

FIGURE 9.2a



PROPOSED RIVER TRADE TERMINAL

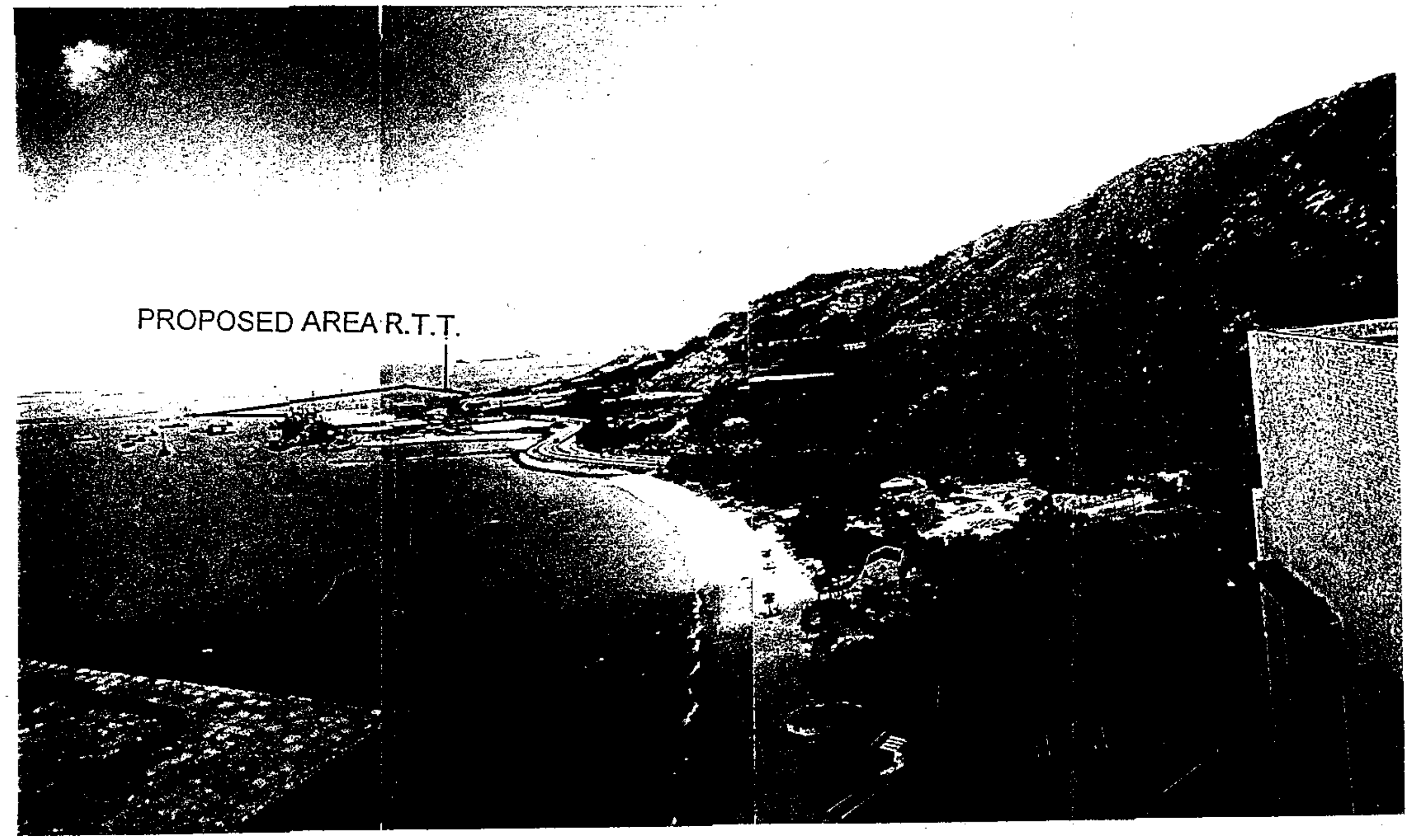
FIGURE 9.3a



VISUAL ENVELOPE

FIGURE 9.3b

VIEW OF HILLS TO NORTH FROM EXISTING SEWAGE TREATMENT WORKS



VIEW FROM TOP FLOOR OF MELODY GARDEN WITH BUTTERFLY BEACH IN FOREGROUND

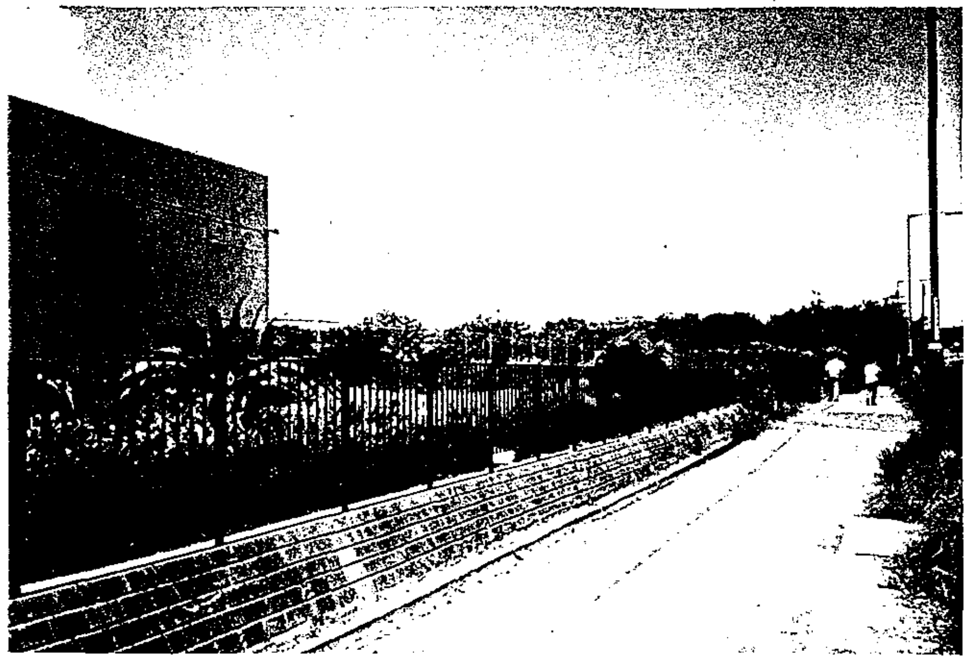
FIGURE 9.3c

AREA TO BE RECLAIMED

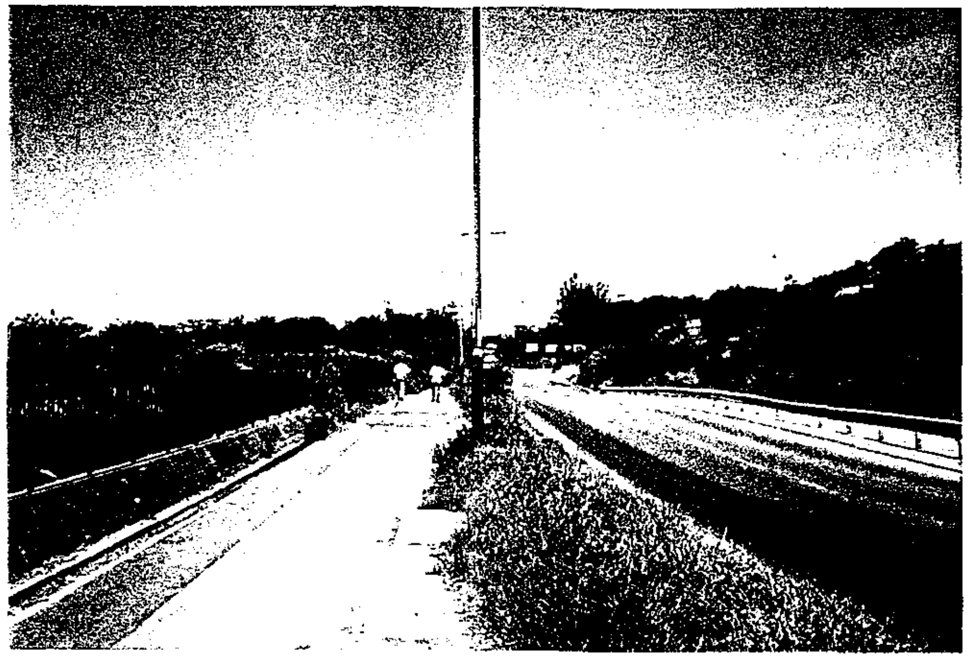
EXISTING COASTLINE (LOW QUALITY) TO BE RECLAIMED

VIEW WEST TOWARDS CASTLE PEAK POWER STATION,
FROM SIU LANG SHUI.
THE WESTERN BOUNDARY OF THE R.T.T. IS MARKED
BY THE YELLOW FENCE

FIGURE 9.3d

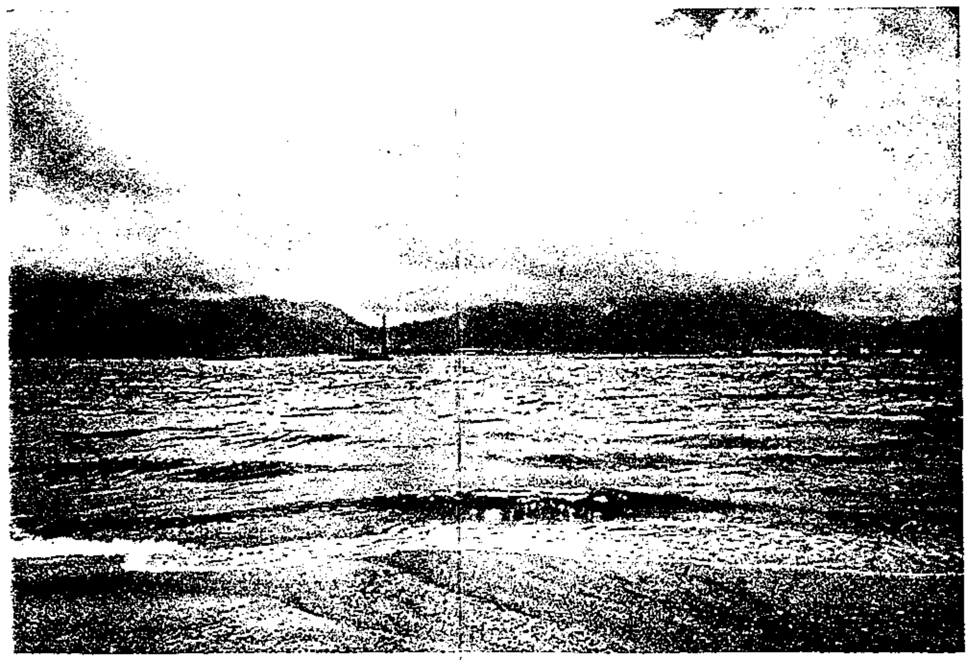


ENTRANCE POINT TO R.T.T. FROM
LUNG MUN ROAD



VIEW LOOKING WEST ALONG LUNG MUN ROAD

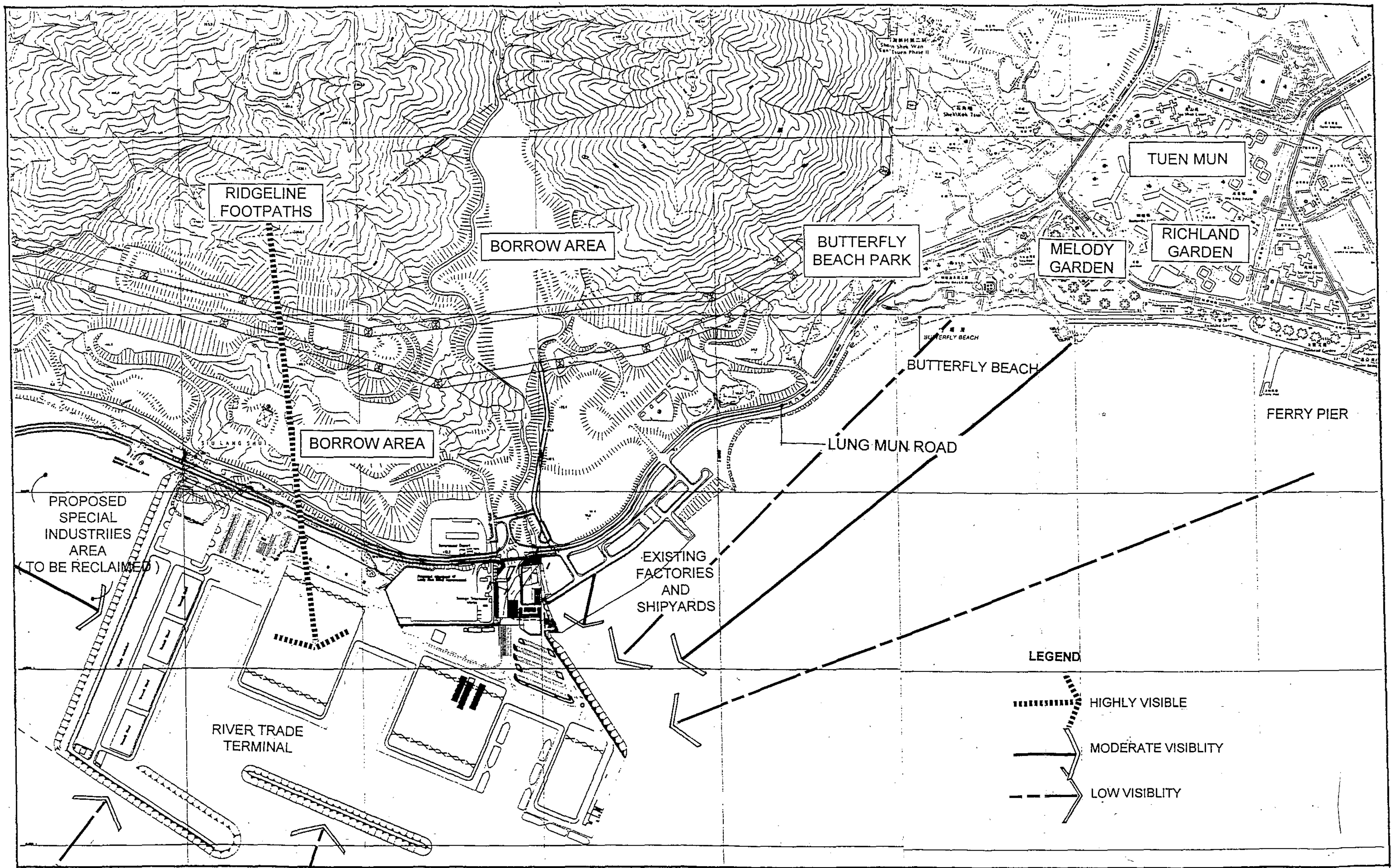
VIEW LOOKING EAST ALONG LUNG MUN ROAD
TOWARDS FACTORIES .EXISTING VEGETATION
TO BE REMOVED



DISTANT VIEW TOWARDS CHEK LAP KOK AIRPORT
AND TUNG CHUNG ON NORTH LANTAU

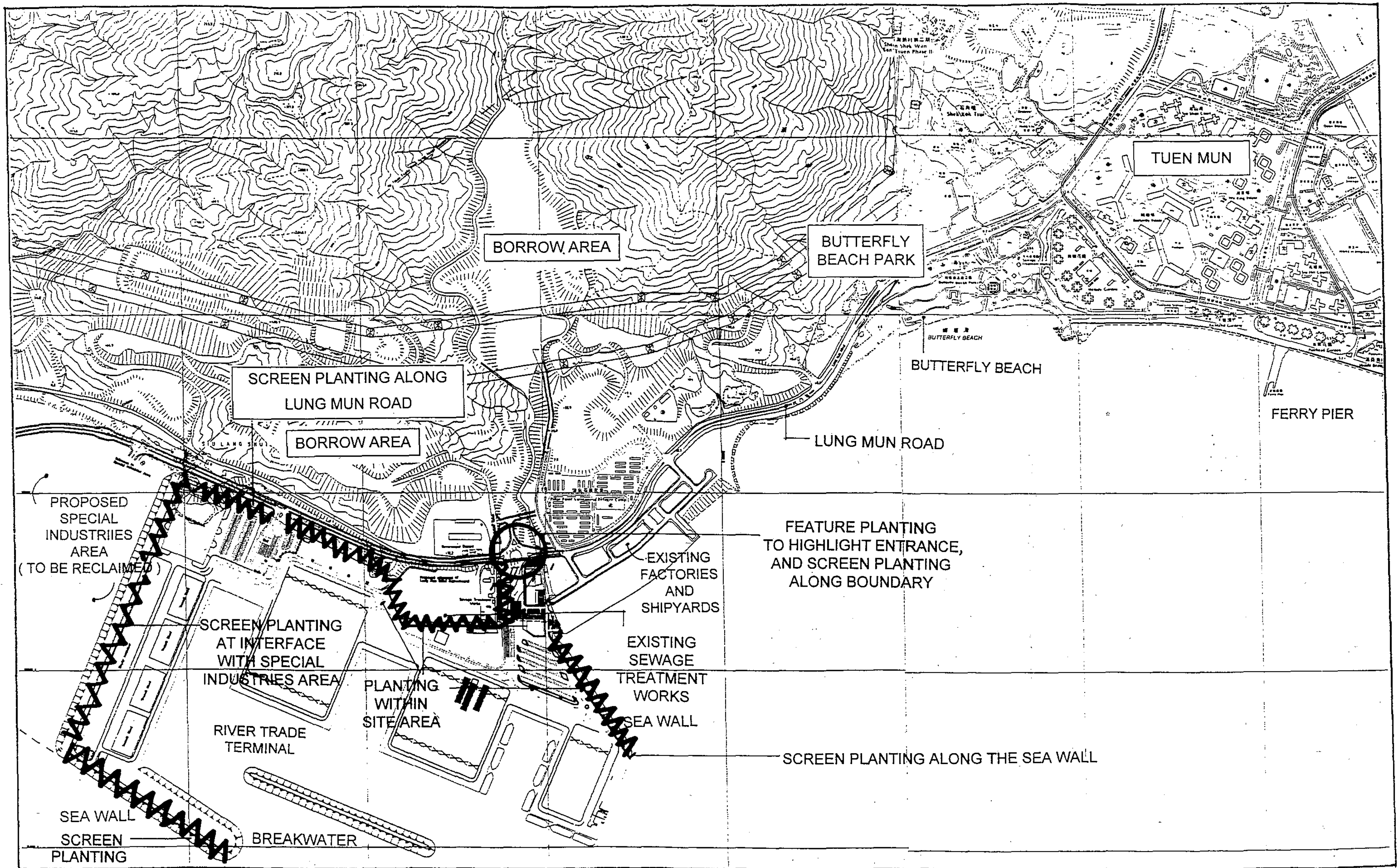
PROPOSED TREATMENT OF SEAWALLS TO
MITIGATE VISUAL IMPACT **TO THE EAST OF THE R.T.T.**

FIGURE 9.3e



VISUAL IMPACT

FIGURE 9.4a



PROPOSED MITIGATION MEASURES

FIGURE 9.5a

10 OVERALL CONCLUSIONS

As described in *Section 1*, this EIA of the RTT does not assess the overall environmental feasibility or acceptability of the RTT development at Tuen Mun as this has previously been established and endorsed by Government and the ACE in the Tuen Mun Area 38 EIA. This EIA aims to appraise environmental consequences associated with differences between the RTT conceptual and RTT detailed design, and also identifies any mitigation recommendations required to ensure the environmental acceptability of any detailed design changes. Additionally, this EIA aimed to identify any environmental benefits and improvements arising from the detailed design. The issues assessed are as follows:

10.1 WATER QUALITY

10.1.1 *Construction Phase*

In this study, water quality impact of the RTT construction was therefore comparatively assessed with reference to the modelling results reported in the previously endorsed Tuen Mun Area 38 EIA. The results indicated that although the water sensitive receivers comprising gazetted Tuen Mun beaches, waters of Deep Bay and cooling water intakes for the Castle Peak Power Station were not adversely impacted, adjacent waters will be protected by the implementation of dredging and reclamation mitigation controls to minimise these potential impacts. The assessment also concluded that one month baseline monitoring should be undertaken before any construction works and that thereafter impact monitoring of water quality to be undertaken throughout the RTT construction period. In accordance with EPD protocols, the water quality monitoring will identify any indications of a deterioration of water quality, via a proactive approach, in order that there may be direct feedback into the RTT construction methodology to ensure that possible adverse impacts do not eventuate. Therefore, with appropriate mitigation the residual water quality impacts during the construction phase will comply with the statutory WQOs. Marine sediment arisings and contamination status have been identified and appropriate recommendations made to prevent water quality impacts from dredging and disposal.

10.1.2 *Operation Phase*

The assessment indicates that the operation of the RTT will not impact on water quality as RTT operations will primarily comprise the handling of containers. In terms of potential water quality impact sources, however, there will be a land and marine fuel filling station, temporary and permanent workshops and a solid waste management site, although the detailed design of these facilities have included water pollution control measures. Thus these facilities will not impact on marine water quality and will fully comply with the required EPD Water Pollution Control Ordinance discharge licence. In addition, in the light of the EPD's general policy "to prohibit any form of discharge in embayments/enclosed water bodies" the detailed stormwater drainage design has located stormwater drainage outfalls to avoid any direct discharge to the RTT basin waters, which will be beneficial in terms of water quality.

Reprovisioned Outfall

The RTT construction includes the construction of a long replacement outfall for the existing Pillar Point outfall. This replacement outfall will be approximately twice the existing outfall length at around 2,070 m and will discharge into the faster moving (>1m/s) waters of the main Urmstom Road channel at approximately -15 mPD which is deeper than the existing outfall discharge depth as well as providing a specified effluent dilution factor of 1:85.

The detailed design of the reprovisioned outfall is very similar to the conceptual reprovisioned outfall proposed and modelled in the Tuen Mun Area 38 EIA. The only changes comprise a diffuser configuration of the detailed design to minimise damage to the diffusers from marine traffic which results in the relocation of the closest outfall discharge point relative to the shore to approximately 300 m further out to sea. Additionally, a minor revision has been made to the detailed design reprovisioned outfall orientation intended to avoid the need for underwater blasting. This detailed design change will minimise construction impacts, in particular to marine mammals, including the Chinese White Dolphin (*Sousa chinesis*).

The previously accepted Tuen Mun Area 38 EIA comprised extensive water quality modelling of the reprovisioned Pillar Point outfall which confirmed the acceptability of the reprovisioned outfall. Comparative assessment undertaken as part of the EIA of the RTT indicated that the minor detailed design differences with regard to diffuser configuration still achieves the required 1:85 effluent dilution factor and the diffuser location will also lead to discharge further from the existing Tuen Mun shoreline. The detailed design is therefore in accordance with the endorsed findings of the Tuen Mun Area 38 EIA with regard to reprovisioned outfall acceptability. Overall the assessment undertaken concludes that the reprovisioned outfall will lead to an improvement over the existing shorter outfall condition as the outfall will be in compliance with WQOs at WSRs and will no longer be responsible for bacterial pollution of the adjacent gazetted Tuen Mun bathing beaches.

No water quality will be required for the RTT operational phase, however, the operation stage of the reprovisioned outfall will be monitored as part of the forthcoming EPD *Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall* Study which is scheduled to commence in late 1996.

10.1.3 Overall Consideration

Based on the assessment it is concluded that RTT will not lead to exceedance of statutory water quality standards, either during RTT construction or operation.

10.2 AIR QUALITY

10.2.1 Construction Phase

Fugitive dust was expected to be the key pollutant during construction of the RTT and an EPD approved dust dispersion model (FDM) was employed to predict the impact upon the ASR located in the adjacent industrial site (Area 40 Industrial Area).

As marine plant will be employed for the reclamation and the scale of works is small, dust impacts exceeding the criteria were not predicted at the ASR or the site boundary. Dust suppression measures and EM&A of dust emissions have been recommended, as good site practice, to reduce the dust emission from the site during RTT construction.

10.2.2 *Operational Phase*

This quantitative RTT assessment indicates that freight carried by barge is a better mode of transportation than road transportation in terms of air quality. The proposed RTT arrangement will reduce road traffic by carrying freight by water and the function of the RTT in consolidating the container loads of approximately 10 small PRD river trade vessels on to one large barge will reduce the numbers of marine vessels trafficking the water east of the RTT to Kwai Chung by approximately 10%. The amount of nitrogen oxides generated would be reduced by 160 tonnes per annum; while the amount of carbon monoxide and particulate matter would be reduced by 130 and 23 tonnes per annum, respectively. As the pollutant generated from both the marine and land traffic are expected to be low, the air quality of the ASR will satisfy the AQO and further mitigation measures are therefore not required.

10.3 NOISE

10.3.1 *Construction Phase*

The construction noise assessment showed that construction activities from the proposed RTT will be within all applicable daytime and evening noise criteria. Nighttime construction activities can be undertaken provided suitable mitigation measures are incorporated. These measures include reducing the amount of equipment in use, especially restricting concreting activities. It was also recommended that environmental noise monitoring and audit also should be carried out at nighttime during the construction phase of the RTT. The monitoring station was recommended to be located at either San Shek Wan or Melody Garden.

It should be noted that a CNP must be obtained from EPD before carrying out any construction works during the evening and nighttime (1900-2300 and 2300-0700 hours, respectively). Details and the extent of the construction activities as well as any mitigation measures for the compliance with the NCO, are needed to be provided in the application of the CNP.

Although the construction noise assessment predicted noise emissions from percussive piling to be within the NCO criteria, a CNP must be obtained from the EPD prior to the undertaking of the percussive piling, and it will specify the permitted time period for the actual piling operation. However, it should be noted that the percussive piling is prohibited outside normal working hours (0700-1900 hours).

10.3.2 *Operational Phase*

Accepting that provided that the total sound power of the cargo handling equipment of the RTT will be limited to 132 dB(A), noise levels at NSRs to the northwest and northeast of the site will comply with the HKPSG criteria.

The RTT will substantially reduce the actual number of container trucks using the roads in the area for the cargo handling by transporting freight by water. The traffic generated by the RTT operation will mainly use the Foothills Bypass which was taken on board by a separate EIA study, and therefore not increase traffic noise exposure of the nearby NSRs.

10.4 *WASTE MANAGEMENT*

10.4.1 *Construction Phase*

With the exception of marine sediments to be dredged it is likely that only small quantities of excavated materials and construction chemical and general waste will be generated by the construction of the RTT. However, mitigation measures relating to good practice have been recommended to ensure that adverse impacts are prevented and that the opportunities for waste minimisation and recycling are taken.

10.4.2 *Operation Phase*

The level of general refuse produced by the RTT operation is not expected to be unduly high, but all feasible measures should be taken to avoid and recycle wastes. Chemical waste arisings from maintenance activities will be limited to plant and equipment maintenance.

It is recommended that *ad hoc* auditing of each waste stream should be carried out periodically by the RTT contractor or operator, as appropriate, during the construction and operation of the RTT. The audit should determine if wastes are being managed in accordance with approved procedures and the site waste management plan and if waste reduction targets are being achieved and could be improved. The audits should look at all aspects of waste management including waste generation, storage, recycling, treatment, transport, and disposal.

Presuming that the recommendations put forward in this report are conscientiously acted upon, no waste related regulatory non-compliances should occur as a result of the storage, handling, collection, transport, and disposal of wastes arising from the construction and operation of the RTT.

10.5 *ECOLOGY*

10.5.1 *Construction/Operation Phase*

Benthic Environment

The results indicated that no unacceptable residual impacts are expected to arise from either the construction or operation of the RTT. Benthic organisms present at the site are typical of that found at other soft bottom environments in Hong Kong.

Commercial Fisheries

The results show that unacceptable impacts to commercial fisheries are avoided during the construction or operation of the RTT. The loss to fisheries production, has been estimated by consideration of data from the ongoing AFD - *Study of*

Fisheries Resources and Fishing Operations in Hong Kong Waters to be 1.18 g m^{-2} which represents an instantaneous productivity of the RTT area and is relatively low compared with fisheries located in eastern waters.

Chinese White Dolphin (Sousa chinensis)

Sousa have been sighted in the general vicinity of the RTT site during the ongoing AFD Dolphin Survey, however they tend to be concentrated further west of the RTT site and south of the busy Urmston Road waterway. Nevertheless, based on a precautionary principle, it is assumed that construction impacts of the RTT might affect *Sousa* in the area and therefore construction stage mitigation measures have been recommended to protect *Sousa* including the use of a 500 m "exclusion zone" closely monitored by a trained observer. This 500 m area in any direction from the construction activity should be visually monitored by a trained observer before the commencement of each marine based construction activity. If *Sousa* are sighted in the "exclusion zone", work should be delayed until such time as the *Sousa* have left the area. A minor revision has been made to the detailed design of the reprovisioned Pillar Point outfall in order to prevent any need for underwater blasting which will be beneficial in terms of *Sousa*. Finally, marine based piling has been avoided for the construction phase to minimise adverse impacts to *Sousa*.

In terms of operational impacts to *Sousa* the RTT itself will provide a positive impact by reducing the marine traffic in areas comprising *Sousa* habitat. *Sousa* may increase their use of the waters surrounding the reprovisioned outfall, due to the predicted increase in abundance of prey species resulting from the outfall. It should be noted, however, that the reprovisioned outfall will replace the existing outfall and that no additional impacts are expected. The operational impacts and the need for any additional measures will be closely monitored as part of the forthcoming EPD study entitled *Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall Study* which is scheduled to commence in late 1996.

Terrestrial Ecology

The Tuen Mun Area 38 EIA terrestrial ecological field review indicated that the RTT area consists of non-pristine areas greatly affected by human and industrial activity. Within the RTT site area, no terrestrial fauna or flora were identified as rare or endangered. RTT field visits confirmed the Tuen Mun Area 38 EIA findings and concluded that the terrestrial ecology has been altered materially from its natural state and thus the conservation significance in the context of Hong Kong as a whole was considered low due to degradation as a result of the adjacent industrial land uses, including a cement works, power station and a steel mill.

10.6 LANDFILL GAS

10.6.1 Construction/Operation Phase

The RTT's site geology could provide a potential pathway for migration of landfill gas. However, due to the distance between the RTT and both the SLSL (350 m) and the PPVL (290 m) when considered with the high water table and relative elevation of the base of the waste, makes this an extremely unlikely gas migration pathway.

It is therefore considered unlikely that any mitigation measures will be required for the construction phase due to the distance and open nature of the RTT construction site. This will be confirmed upon receipt of additional information which has been requested on utility services.

For the operational phase, due to the distance between the RTT and both landfills, mitigation measures would only be considered necessary in cases where a utility related pathway exists directly between one of the landfills and the RTT site. If such utility pathways are identified, from any additional information along the utility service(s) in the area obtained, monitoring of conduit air spaces at a number of points of the RTT site should be undertaken using appropriately calibrated portable gas detection equipment.

A review of additional utilities information will be conducted when it becomes available and may recommend some short term monitoring of landfill gas. Mitigation measures are unlikely to be recommended unless landfill gas migration is found to be occurring within the utility services.

10.7 *VISUAL*

10.7.1 *Construction Phase*

The predicted changes to the baseline condition and subsequent effects on views from sensitive viewpoints are as follows:

- Construction work rated highly visible can be seen from the intensively used recreation facility of Butterfly Beach, and otherwise from the low sensitivity viewpoints of the ferries and marine traffic;

- A small stretch of existing coastline will be directly lost through RTT reclamation;

- Existing trees and shrubs within the existing RTT reclamation site will be removed. It should be noted that this reclamation is relatively new and the vegetation young. This area only comprises 5% of the whole RTT site with the remaining 95% being on future reclamation; and

- Construction during hours of darkness using low floodlights, extends the visual impact to sensitive receivers further afield.

There are no highly sensitive receivers within 2 km of the site. Taking into account the distance of the more sensitive receivers from the site; visual impact is predicted to be low during the construction period.

10.7.2 *Operation Phase*

Following the construction phase, the subsequent effects on views from sensitive viewpoints are as follows:

- The stacked containers and tall cranes are rated highly visible;
- The sea walls and breakwaters likewise are rated highly visible; and
- The high mast floodlights will be highly visible throughout the night.

The sensitive receivers most affected by the proposed RTT would be the residents of the upper floors of Melody Garden and Richland Garden. For these people the RTT will appear as a low lying, linear, man-made feature, of which the most significant impact will be that of the floodlights at night-time. However when considered in relation to their distance from the RTT, with the factories in the foreground, and in relation to their overall view; the visual impact can be considered to be of low significance.

10.8 *OVERALL CONCLUSIONS*

The River Trade Terminal Company Limited, the project proponent, has committed to implement all mitigation measures detailed in this EIA for the RTT and thus it may be concluded that the environmental impacts from either RTT construction or operation will be kept within established standards and guidelines.

Annex A

Summary of Sediment Quality Report

...er Tr... ...nal
Area 38, Tuen Mun
Contamination Class of Marine Deposits

Sample depth below seabed (m)	Vibrocore (MS/-)																				
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22
0.0-0.1	A	A		A	A	A	A	A	A	A	C(Cu), B(Ni)	C(Cr,Cu) C(Ni)	C(Cu)	B(Cu)	A	B(Cu)	B(Cu)	B(Cu)	B(Cu)	A	A
0.9-1.0	A	A		A	A	A	B(Cu)	A	A	A	C(Cu), B(Cr,Ni)	A	A	A	C(Cu)	C(Cu), B(Cr,Ni)	C(Cu) B(Cr)	C(Cu)	A	A	A
1.2-1.3																					
1.4-1.5																					
1.5-1.6																					
1.8-1.9																					
1.9-2.0	A	A		A	A	A	A	A	A	C(Cu) B(Cr,Zn)	A	A	A	A	A	C(Cu), B(Cr)	A	A	A	A	A
2.2-2.3																					
2.7-2.8																					
2.9-3.0	A	A		A	A	A	A	A	A	B(Cu)	A	A	A	A	A	A	C(Cu)	A	A	A	A
3.2-3.3																					
3.7-3.8																					
3.9-4.0			REFUSAL																		
4.2-4.3																					
4.4-4.5																					
4.7-4.8														A							
4.8-4.9																					
4.9-5.0																					
5.7-5.8	A			A	A					A	A	A	A		A	A	A	A	A	A	A
6.0-6.1		A					A	A	A												
6.6-6.7																					
7.2-7.3																					
8.0-8.1								A													
8.2-8.3																					
8.5-8.6																					
8.7-8.8												A									
8.9-9.0		A							A	A	A					B(Pb)	A	A	A		A
9.0-9.1																					
9.7-9.8																		A			
9.9-10.0																					
10.3-10.4									A												
10.5-10.6																					
10.7-10.8											A						A		A		
11.7-11.8										A						A					
12.0-12.1		A																			B(Pb)
14.2-14.3																					A
14.7-14.8																					
14.9-15.0																					
16.2-16.3																					
16.9-17.0																					
17.7-17.8																					

Note:
Class A: Uncontaminated
Class B: Moderately Contaminated
Class C: Seriously Contaminated

River Trade Terminal
Area 38, Tuen Mun
Contamination Class of Marine Deposits

Sample depth below seabed (m)	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	41A	42
0.0-0.1		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	C(Pb)	A	A	C(Cd,Zn)	A
0.9-1.0		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
1.2-1.3																	A				
1.4-1.5																					
1.5-1.6																					
1.8-1.9																					
1.9-2.0		A	A	A	A	A	A	A	A	A	A	A	A	A	A	A		A	A	A	
2.2-2.3																					
2.7-2.8																					
2.9-3.0		A	A	A	A	A	A	A	A	A	A	A	A	A	A				A	A	
3.2-3.3																					
3.7-3.8																					
3.9-4.0																					
4.2-4.3																					
4.4-4.5	NO RECOVERY												A								
4.7-4.8																					
4.8-4.9																					
4.9-5.0																				A	
5.7-5.8		A	A	A	A	A	A	A	A	A	A	A		A	C(Pb)						
6.0-6.1		A																			
6.6-6.7																					
7.2-7.3															A						
8.0-8.1																					
8.2-8.3																					
8.5-8.6																					
8.7-8.8																					
8.9-9.0		A	A	A						A											
9.0-9.1																					
9.7-9.8										A											
9.9-10.0																					
10.3-10.4																					
10.5-10.6				A																	
10.7-10.8																					
11.7-11.8		A	A																		
12.0-12.1		A																			
14.2-14.3																					
14.7-14.8																					
14.9-15.0		A																			
16.2-16.3																					
16.9-17.0																					
17.7-17.8		A																			

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River Trade Terminal
Area 38, Tuen Mun
Contamination Class of Marine Deposits

Sample depth below seabed (m)	43	44	45	46	47	48	49	50	51	52	53	54	55	56	57	58	59	60	61	62	63
0.0-0.1	A	A	A	A	A	B(Hg)	A	A	A	A	A	A	A	A		A	A	A	A	A	A
0.9-1.0	A	A	A	A	B(Cu)	C(Cu)	C(Cu)	A	A	A	C(Pb)	B(Cr)	A	A		A	A	A	A	A	A
1.2-1.3												B(Cr), C(Ni,Pb)									
1.4-1.5								A													
1.5-1.6	A																				
1.8-1.9		A																			
1.9-2.0			A	A	A	C(Hg)	A		A	A	A		A	A		A	A	A	A	A	A
2.2-2.3										A											
2.7-2.8			A	A	A						A										
2.9-3.0						A	A		A				A	A	NO RECOVERY	A	A	A	A	A	A
3.2-3.3																					
3.7-3.8							A														
3.9-4.0																				A	
4.2-4.3									A												
4.4-4.5																					
4.7-4.8						A													A		
4.8-4.9																					A
4.9-5.0																					
5.7-5.8													B(Cr)			A	A	A			
6.0-6.1														A							
6.6-6.7																					
7.2-7.3																					
8.0-8.1																					
8.2-8.3																					
8.5-8.6																					
8.7-8.8																					
8.9-9.0														A				A			
9.0-9.1																					
9.7-9.8																		A			
9.9-10.0																					
10.3-10.4																					
10.5-10.6																					
10.7-10.8																					
11.7-11.8														A							
12.0-12.1																					
14.2-14.3																					
14.7-14.8																					
14.9-15.0																					
16.2-16.3																					
16.9-17.0																					
17.7-17.8																					

Note:
Class A: Uncontaminated
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Class C: Seriously Contaminated

River Trade Terminal
Area 38, Tuen Mun
Contamination Class of Marine Deposits

Sample depth below seabed (m)	64	65	66	67	68	69	70	71	72	73	74	75	76	77	78	79	80	81	82	83	84
0.0-0.1	A	A	A	C(Cu)	B(Cu)	A	A	B(Cr)	A	A	A	A	A	A	A	A	A	A	A	A	A
0.9-1.0	A	A	A	A	A	A	A	C(Hg)	B(Cu)	B(Cu)	A	C(Cu)	A	A	A	A	A	A	A	A	A
1.2-1.3																					
1.4-1.5																					
1.5-1.6																					
1.8-1.9																					
1.9-2.0	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
2.2-2.3																					
2.7-2.8				A																	
2.9-3.0	A	A	A		A	A	A	A	A	A	A	B(Pb)	A	A	A	A	A	A	A	A	A
3.2-3.3					A																
3.7-3.8																					
3.9-4.0																					
4.2-4.3																					
4.4-4.5																					
4.7-4.8																					
4.8-4.9																					
4.9-5.0																					
5.7-5.8			A			A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
6.0-6.1	A	B(Pb)																			
6.6-6.7		A																			
7.2-7.3																					
8.0-8.1																					
8.2-8.3										B(Pb)											
8.5-8.6			A																		
8.7-8.8												A	A	A							
8.9-9.0	A										A				A	A			A	A	A
9.0-9.1																			A		
9.7-9.8																A					
9.9-10.0											A										
10.3-10.4																					
10.5-10.6																					
10.7-10.8																				A	
11.7-11.8																					A
12.0-12.1																					
14.2-14.3																					
14.7-14.8																					
14.9-15.0																					
16.2-16.3																					
16.9-17.0																					
17.7-17.8																					

Note:
Class A: Uncontaminated
Class B: Moderately Contaminated
Class C: Seriously Contaminated

River Trade Terminal
Area 38, Tuen Mun
Contamination Class of Marine Deposits

Sample depth below seabed (m)	85	86	87	88	89
0.0-0.1	A	A	A	A	A
0.9-1.0	A	A	A	A	A
1.2-1.3					
1.4-1.5					
1.5-1.6					
1.8-1.9					
1.9-2.0	A	A	A	A	A
2.2-2.3					
2.7-2.8					
2.9-3.0	A	A	A	A	A
3.2-3.3					
3.7-3.8					
3.9-4.0					
4.2-4.3					
4.4-4.5					
4.7-4.8					
4.8-4.9					
4.9-5.0					
5.7-5.8	A	A	A	A	A
6.0-6.1					
6.6-6.7					
7.2-7.3					
8.0-8.1					
8.2-8.3					
8.5-8.6					
8.7-8.8					
8.9-9.0	A	A	A	A	A
9.0-9.1					
9.7-9.8					
9.9-10.0					
10.3-10.4					
10.5-10.6					
10.7-10.8					
11.7-11.8	A	A	A	A	A
12.0-12.1					
14.2-14.3					
14.7-14.8		A			
14.9-15.0	A		A	A	A
16.2-16.3				A	
16.9-17.0	A				
17.7-17.8			A		A

Note:
Class A: Uncontaminated
Class B: Moderately Contaminated
Class C: Seriously Contaminated

Annex B

Monitoring Results for the Pre-Tender Monitoring and the Further Environmental Monitoring for the PPVL and SLSL

Leachate, Ground Water & Surface Water Monitoring Results
for
Siu Lang Shui Landfill

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui

Sample Location : DH201

Top Level of Well : 8.36 mPD

Bottom Level of Well : -1.40 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	8.72	7.2	7.18	7.2	7.12	7.17	7.13	3.71	2.59	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	7.6	--	--	7.32	--	--	7.08	--	
4	Temperature (°C)	--	25.3	--	--	25.2	--	--	27.3	--	
5	Total Organic Carbon (TOC) (mg/L)	--	240	--	--	120	--	--	11	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	640	--	--	440	--	--	19	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	48	--	--	27	--	--	<5	--	
*8	Ammonical Nitrogen (mg-N/L)	--	740	--	--	520	--	--	13	--	
*9	TKN (mg-N/L)	--	780	--	--	530	--	--	13	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	< 0.3	--	--	<0.3	--	--	3.1	--	
11	Orthophosphate (mg-P/L)	--	0.9	--	--	0.55	--	--	<0.2	--	
*12	Sodium (mg/L)	--	580	--	--	480	--	--	39	--	
*13	Potassium (mg/L)	--	200	--	--	150	--	--	10	--	
*14	Calcium (mg/L)	--	40	--	--	19	--	--	47	--	
*15	Magnesium (mg/L)	--	23	--	--	28	--	--	6.9	--	
*16	Chloride (mg/L)	--	550	--	--	420	--	--	34	--	
*17	Sulphate (mg/L)	--	7.6	--	--	<5	--	--	24	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	3700	--	--	2500	--	--	180	--	
*19	Iron (mg/L)	--	17	--	--	18	--	--	<0.6	--	
*20	Manganese (mg/L)	--	1.5	--	--	1.5	--	--	0.7	--	
*21	Zinc (mg/L)	--	0.16	--	--	0.11	--	--	0.03	--	
*22	Copper (mg/L)	--	0.11	--	--	0.05	--	--	0.1	--	
*23	Nickel (mg/L)	--	0.05	--	--	0.03	--	--	<0.03	--	
*24	Chromium (mg/L)	--	0.4	--	--	0.11	--	--	0.1	--	
*25	Lead (mg/L)	--	0.45	--	--	0.3	--	--	0.1	--	
*26	Cadmium (mg/L)	--	< 0.01	--	--	<0.01	--	--	<0.01	--	
*27	Suspended Solids (mg/L)	--	1300	--	--	1200	--	--	14	--	
28	Settleable Solids (mg/L)	--	1100	--	--	890	--	--	13	--	
29	Oil & Grease (mg/L)	--	< 10	--	--	<10	--	--	<10	--	
30	Boron (mg/L)	--	2	--	--	1	--	--	0.1	--	
*31	Barium (mg/L)	--	1.1	--	--	<1	--	--	1	--	
32	Mecury (ug/L)	--	1	--	--	<1	--	--	<1	--	
33	Ag (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
34	Cyanide (mg/L)	--	< 1	--	--	<0.01	--	--	<0.01	--	
35	Phenol (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
36	Sulphide (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
37	Total Surfactants (mg/L)	--	1	--	--	0.6	--	--	0.4	--	
38	E.Coli (No./100mL)	--	700	--	--	4	--	--	400	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui | Sample Location : DH203

Top Level of Well : 8.51 mPD | Bottom Level of Well : 1.54 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	No Water	No Water	No water	No Water	No water	No water	No water	No water	No water	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	--	--	--	--	--	--	--	--	
4	Temperature (°C)	--	--	--	--	--	--	--	--	--	
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--	--	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	--	--	--	--	--	--	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	--	--	--	--	--	--	--	--	
*8	Ammonical Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
*9	TKN (mg-N/L)	--	--	--	--	--	--	--	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--	--	--	--	
*12	Sodium (mg/L)	--	--	--	--	--	--	--	--	--	
*13	Potassium (mg/L)	--	--	--	--	--	--	--	--	--	
*14	Calcium (mg/L)	--	--	--	--	--	--	--	--	--	
*15	Magnesium (mg/L)	--	--	--	--	--	--	--	--	--	
*16	Chloride (mg/L)	--	--	--	--	--	--	--	--	--	
*17	Sulphate (mg/L)	--	--	--	--	--	--	--	--	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	--	--	--	--	--	--	--	--	
*19	Iron (mg/L)	--	--	--	--	--	--	--	--	--	
*20	Manganese (mg/L)	--	--	--	--	--	--	--	--	--	
*21	Zinc (mg/L)	--	--	--	--	--	--	--	--	--	
*22	Copper (mg/L)	--	--	--	--	--	--	--	--	--	
*23	Nickel (mg/L)	--	--	--	--	--	--	--	--	--	
*24	Chromium (mg/L)	--	--	--	--	--	--	--	--	--	
*25	Lead (mg/L)	--	--	--	--	--	--	--	--	--	
*26	Cadmium (mg/L)	--	--	--	--	--	--	--	--	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulphide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui | Sample Location : DH204

Top Level of Well : 8.76 mPD | Bottom Level of Well : −1.20 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	2.88	3.14	3.42	3.48	3.44	3.20	3.69	2.35	6.84	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	8.0	--	--	7.93	--	--	6.30	--	
4	Temperature (°C)	--	24.5	--	--	23.2	--	--	28.1	--	
5	Total Organic Carbon (TOC) (mg/L)	--	210	--	--	500	--	--	11	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	700	--	--	1600	--	--	93	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	91	--	--	210	--	--	19	--	
*8	Ammonical Nitrogen (mg-N/L)	--	1000	--	--	2900	--	--	22	--	
*9	TKN (mg-N/L)	--	1100	--	--	3000	--	--	24	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	< 0.3	--	--	<0.3	--	--	22	--	
11	Orthophosphate (mg-P/L)	--	6.4	--	--	18	--	--	2.2	--	
*12	Sodium (mg/L)	--	390	--	--	1700	--	--	46	--	
*13	Potassium (mg/L)	--	190	--	--	620	--	--	17	--	
*14	Calcium (mg/L)	--	31	--	--	27	--	--	69	--	
*15	Magnesium (mg/L)	--	9.3	--	--	17	--	--	6.9	--	
*16	Chloride (mg/L)	--	540	--	--	1600	--	--	36	--	
*17	Sulphate (mg/L)	--	22	--	--	22	--	--	100	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	4600	--	--	12000	--	--	140	--	
*19	Iron (mg/L)	--	25	--	--	26	--	--	<0.6	--	
*20	Manganese (mg/L)	--	1.3	--	--	1	--	--	0.8	--	
*21	Zinc (mg/L)	--	0.51	--	--	0.49	--	--	<0.03	--	
*22	Copper (mg/L)	--	0.67	--	--	0.3	--	--	0.1	--	
*23	Nickel (mg/L)	--	0.05	--	--	0.1	--	--	<0.03	--	
*24	Chromium (mg/L)	--	0.8	--	--	1.4	--	--	0.1	--	
*25	Lead (mg/L)	--	0.62	--	--	0.4	--	--	0.084	--	
*26	Cadmium (mg/L)	--	< 0.01	--	--	<0.01	--	--	<0.01	--	
*27	Suspended Solids (mg/L)	--	860	--	--	1100	--	--	1400	--	
28	Settleable Solids (mg/L)	--	690	--	--	890	--	--	1300	--	
29	Oil & Grease (mg/L)	--	< 10	--	--	<10	--	--	<10	--	
30	Boron (mg/L)	--	1.5	--	--	4.5	--	--	<0.1	--	
*31	Barium (mg/L)	--	< 1	--	--	<1	--	--	1	--	
32	Mecury (ug/L)	--	1	--	--	5.9	--	--	<1	--	
33	Ag (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
34	Cyanide (mg/L)	--	< 1	--	--	0.02	--	--	<0.01	--	
35	Phenol (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
36	Sulphide (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
37	Total Surfactants (mg/L)	--	1	--	--	1.6	--	--	3.3	--	
38	E.Coli (No./100mL)	--	320	--	--	4	--	--	240	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui

Sample Location : DH205

Top Level of Well : 37.19 mPD

Bottom Level of Well : 5.16 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	25.85	18.25	25.85	26.01	26.23	26.27	26.31	26.15	25.92	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	8.4	--	--	8.02	--	--	7.98	--	
4	Temperature (°C)	--	40.1	--	--	40.2	--	--	41.1	--	
5	Total Organic Carbon (TOC) (mg/L)	--	16000	--	--	7600	--	--	6600	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	18000	--	--	20000	--	--	17000	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	8600	--	--	11000	--	--	7900	--	
*8	Ammonical Nitrogen (mg-N/L)	--	7900	--	--	8600	--	--	7900	--	
*9	TKN (mg-N/L)	--	8700	--	--	8800	--	--	8600	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	< 0.3	--	--	<0.3	--	--	<0.3	--	
11	Orthophosphate (mg-P/L)	--	48	--	--	30	--	--	44	--	
*12	Sodium (mg/L)	--	4600	--	--	6500	--	--	4300	--	
*13	Potassium (mg/L)	--	1600	--	--	2300	--	--	1400	--	
*14	Calcium (mg/L)	--	12	--	--	17	--	--	5.8	--	
*15	Magnesium (mg/L)	--	13	--	--	5.8	--	--	12	--	
*16	Chloride (mg/L)	--	4600	--	--	4800	--	--	5500	--	
*17	Sulphate (mg/L)	--	18	--	--	22	--	--	54	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	35000	--	--	36000	--	--	33000	--	
*19	Iron (mg/L)	--	16	--	--	12	--	--	9.9	--	
*20	Manganese (mg/L)	--	0.2	--	--	0.1	--	--	0.2	--	
*21	Zinc (mg/L)	--	78	--	--	<0.03	--	--	50	--	
*22	Copper (mg/L)	--	1.8	--	--	1.5	--	--	1.7	--	
*23	Nickel (mg/L)	--	0.4	--	--	0.3	--	--	0.7	--	
*24	Chromium (mg/L)	--	7.6	--	--	4.5	--	--	9.8	--	
*25	Lead (mg/L)	--	0.8	--	--	1	--	--	2.2	--	
*26	Cadmium (mg/L)	--	0.01	--	--	<0.01	--	--	<0.01	--	
*27	Suspended Solids (mg/L)	--	450	--	--	610	--	--	460	--	
28	Settleable Solids (mg/L)	--	330	--	--	410	--	--	410	--	
29	Oil & Grease (mg/L)	--	< 10	--	--	10	--	--	19	--	
30	Boron (mg/L)	--	17	--	--	18	--	--	14	--	
*31	Barium (mg/L)	--	2.5	--	--	1.1	--	--	2	--	
32	Mecury (ug/L)	--	2.1	--	--	16	--	--	33	--	
33	Ag (mg/L)	--	0.1	--	--	<0.1	--	--	0.1	--	
34	Cyanide (mg/L)	--	4.6	--	--	0.08	--	--	0.03	--	
35	Phenol (mg/L)	--	1.3	--	--	0.7	--	--	1.4	--	
36	Sulphide (mg/L)	--	32	--	--	39	--	--	8.6	--	
37	Total Surfactants (mg/L)	--	15	--	--	7.1	--	--	9.1	--	
38	E.Coli (No./100mL)	--	< 1	--	--	<1	--	--	<1	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui · Sample Location : A251

Top Level of Well : 24.57 mPD · Bottom Level of Well : 4.57 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	13.54	13.73	13.95	14.11	14.24	14.52	14.69	14.70	13.98	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	7.4	--	--	7.02	--	--	7.12	--	
4	Temperature (°C)	--	29.3	--	--	29.6	--	--	30.7	--	
5	Total Organic Carbon (TOC) (mg/L)	--	250	--	--	95	--	--	200	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	1400	--	--	410	--	--	620	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	24	--	--	20	--	--	18	--	
*8	Ammonical Nitrogen (mg-N/L)	--	800	--	--	600	--	--	750	--	
*9	TKN (mg-N/L)	--	810	--	--	640	--	--	820	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	< 0.3	--	--	<0.3	--	--	<0.3	--	
11	Orthophosphate (mg-P/L)	--	1.4	--	--	1.5	--	--	2.4	--	
*12	Sodium (mg/L)	--	560	--	--	370	--	--	480	--	
*13	Potassium (mg/L)	--	180	--	--	130	--	--	150	--	
*14	Calcium (mg/L)	--	150	--	--	120	--	--	26	--	
*15	Magnesium (mg/L)	--	32	--	--	27	--	--	31	--	
*16	Chloride (mg/L)	--	500	--	--	430	--	--	600	--	
*17	Sulphate (mg/L)	--	6.1	--	--	<5	--	--	25	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	3800	--	--	3000	--	--	3600	--	
*19	Iron (mg/L)	--	190	--	--	25	--	--	13	--	
*20	Manganese (mg/L)	--	4	--	--	0.5	--	--	0.4	--	
*21	Zinc (mg/L)	--	6.6	--	--	0.35	--	--	0.14	--	
*22	Copper (mg/L)	--	2.2	--	--	0.1	--	--	0.1	--	
*23	Nickel (mg/L)	--	0.27	--	--	0.04	--	--	0.1	--	
*24	Chromium (mg/L)	--	2.7	--	--	0.2	--	--	0.8	--	
*25	Lead (mg/L)	--	1.9	--	--	0.2	--	--	0.1	--	
*26	Cadmium (mg/L)	--	0.03	--	--	<0.01	--	--	<0.01	--	
*27	Suspended Solids (mg/L)	--	3000	--	--	670	--	--	360	--	
28	Settleable Solids (mg/L)	--	2500	--	--	480	--	--	300	--	
29	Oil & Grease (mg/L)	--	17	--	--	<10	--	--	<10	--	
30	Boron (mg/L)	--	2.4	--	--	1.6	--	--	2.1	--	
*31	Barium (mg/L)	--	4	--	--	1	--	--	1	--	
32	Mecury (ug/L)	--	1	--	--	<1	--	--	<1	--	
33	Ag (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
34	Cyanide (mg/L)	--	< 1	--	--	<0.01	--	--	<0.01	--	
35	Phenol (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
36	Sulphide (mg/L)	--	2	--	--	1.6	--	--	<0.1	--	
37	Total Surfactants (mg/L)	--	0.8	--	--	0.6	--	--	1.8	--	
38	E.Coli (No./100mL)	--	160	--	--	<1	--	--	100	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui — Sample Location : A252

Top Level of Well : 35.60 mPD — Bottom Level of Well : 15.60 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	19.33	No water	19.35	19.46	No water	No water	No water	No water	19.09	
2	Water Flow Rate (L/s)			--	--	--	--	--	--	--	
*3	pH	--	--	--	--	--	--	--	--	--	
4	Temperature (°C)	--	--	--	--	--	--	--	--	--	
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--	--	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	--	--	--	--	--	--	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	--	--	--	--	--	--	--	--	
*8	Ammonical Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
*9	TKN (mg-N/L)	--	--	--	--	--	--	--	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--	--	--	--	
*12	Sodium (mg/L)	--	--	--	--	--	--	--	--	--	
*13	Potassium (mg/L)	--	--	--	--	--	--	--	--	--	
*14	Calcium (mg/L)	--	--	--	--	--	--	--	--	--	
*15	Magnesium (mg/L)	--	--	--	--	--	--	--	--	--	
*16	Chloride (mg/L)	--	--	--	--	--	--	--	--	--	
*17	Sulphate (mg/L)	--	--	--	--	--	--	--	--	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	--	--	--	--	--	--	--	--	
*19	Iron (mg/L)	--	--	--	--	--	--	--	--	--	
*20	Manganese (mg/L)	--	--	--	--	--	--	--	--	--	
*21	Zinc (mg/L)	--	--	--	--	--	--	--	--	--	
*22	Copper (mg/L)	--	--	--	--	--	--	--	--	--	
*23	Nickel (mg/L)	--	--	--	--	--	--	--	--	--	
*24	Chromium (mg/L)	--	--	--	--	--	--	--	--	--	
*25	Lead (mg/L)	--	--	--	--	--	--	--	--	--	
*26	Cadmium (mg/L)	--	--	--	--	--	--	--	--	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulphide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui

Sample Location : A253

Top Level of Well : 25.93 mPD

Bottom Level of Well : 15.93 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	No water	No water	No water	No water	No water	No water	No water	No water	No water	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	--	--	--	--	--	--	--	--	
4	Temperature (°C)	--	--	--	--	--	--	--	--	--	
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--	--	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	--	--	--	--	--	--	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	--	--	--	--	--	--	--	--	
*8	Ammonical Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
*9	TKN (mg-N/L)	--	--	--	--	--	--	--	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--	--	--	--	
*12	Sodium (mg/L)	--	--	--	--	--	--	--	--	--	
*13	Potassium (mg/L)	--	--	--	--	--	--	--	--	--	
*14	Calcium (mg/L)	--	--	--	--	--	--	--	--	--	
*15	Magnesium (mg/L)	--	--	--	--	--	--	--	--	--	
*16	Chloride (mg/L)	--	--	--	--	--	--	--	--	--	
*17	Sulphate (mg/L)	--	--	--	--	--	--	--	--	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	--	--	--	--	--	--	--	--	
*19	Iron (mg/L)	--	--	--	--	--	--	--	--	--	
*20	Manganese (mg/L)	--	--	--	--	--	--	--	--	--	
*21	Zinc (mg/L)	--	--	--	--	--	--	--	--	--	
*22	Copper (mg/L)	--	--	--	--	--	--	--	--	--	
*23	Nickel (mg/L)	--	--	--	--	--	--	--	--	--	
*24	Chromium (mg/L)	--	--	--	--	--	--	--	--	--	
*25	Lead (mg/L)	--	--	--	--	--	--	--	--	--	
*26	Cadmium (mg/L)	--	--	--	--	--	--	--	--	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulphide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui

Sample Location : A254

Top Level of Well : 39.81 mPD

Bottom Level of Well : 14.81 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	17.35	13.41	17.67	17.67	17.67	17.82	17.75	16.12	16.15	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	8.0	--	--	7.64	--	--	7.72	--	
4	Temperature (°C)	--	38.8	--	--	39.3	--	--	39.8	--	
5	Total Organic Carbon (TOC) (mg/L)	--	1300	--	--	1100	--	--	1200	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	4700	--	--	4200	--	--	6000	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	210	--	--	330	--	--	340	--	
*8	Ammonical Nitrogen (mg-N/L)	--	2600	--	--	2900	--	--	2900	--	
*9	TKN (mg-N/L)	--	2800	--	--	3000	--	--	3100	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	< 0.3	--	--	<0.3	--	--	0.01	--	
11	Orthophosphate (mg-P/L)	--	13	--	--	13.8	--	--	18	--	
*12	Sodium (mg/L)	--	1500	--	--	2200	--	--	200	--	
*13	Potassium (mg/L)	--	850	--	--	1100	--	--	920	--	
*14	Calcium (mg/L)	--	43	--	--	51	--	--	6.3	--	
*15	Magnesium (mg/L)	--	19	--	--	20.7	--	--	22	--	
*16	Chloride (mg/L)	--	1600	--	--	1800	--	--	2400	--	
*17	Sulphate (mg/L)	--	< 5	--	--	<5	--	--	120	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	13000	--	--	13000	--	--	14000	--	
*19	Iron (mg/L)	--	200	--	--	78	--	--	24	--	
*20	Manganese (mg/L)	--	3.1	--	--	1.2	--	--	3.3	--	
*21	Zinc (mg/L)	--	5.1	--	--	1.95	--	--	0.53	--	
*22	Copper (mg/L)	--	1.2	--	--	0.3	--	--	0.2	--	
*23	Nickel (mg/L)	--	0.3	--	--	2.1	--	--	0.4	--	
*24	Chromium (mg/L)	--	11	--	--	3.3	--	--	5.9	--	
*25	Lead (mg/L)	--	1.7	--	--	0.6	--	--	0.4	--	
*26	Cadmium (mg/L)	--	0.01	--	--	<0.01	--	--	<0.01	--	
*27	Suspended Solids (mg/L)	--	5900	--	--	1800	--	--	1000	--	
28	Settleable Solids (mg/L)	--	5200	--	--	1100	--	--	13	--	
29	Oil & Grease (mg/L)	--	130	--	--	45	--	--	20	--	
30	Boron (mg/L)	--	3.4	--	--	3	--	--	3	--	
*31	Barium (mg/L)	--	4.4	--	--	1.5	--	--	1	--	
32	Mecury (ug/L)	--	1	--	--	5.7	--	--	11	--	
33	Ag (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
34	Cyanide (mg/L)	--	< 1	--	--	0.03	--	--	0.01	--	
35	Phenol (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
36	Sulphide (mg/L)	--	< 0.1	--	--	<0.1	--	--	3.2	--	
37	Total Surfactants (mg/L)	--	4.9	--	--	3	--	--	6.6	--	
38	E.Coli (No./100mL)	--	< 1	--	--	<1	--	--	<1	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui | Sample Location : A255

Top Level of Well : 45.70 mPD | Bottom Level of Well : 10.70 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	32.68	32.82	33.8	33.92	No water	33.81	33.14	No water	32.4	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	8.0	--	--	--	--	--	--	--	
4	Temperature (°C)	--	33	--	--	--	--	--	--	--	
5	Total Organic Carbon (TOC) (mg/L)	--	6000	--	--	--	--	--	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	6900	--	--	--	--	--	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	6200	--	--	--	--	--	--	--	
*8	Ammonical Nitrogen (mg-N/L)	--	4300	--	--	--	--	--	--	--	
*9	TKN (mg-N/L)	--	4300	--	--	--	--	--	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	< 0.3	--	--	--	--	--	--	--	
11	Orthophosphate (mg-P/L)	--	22	--	--	--	--	--	--	--	
*12	Sodium (mg/L)	--	3000	--	--	--	--	--	--	--	
*13	Potassium (mg/L)	--	1200	--	--	--	--	--	--	--	
*14	Calcium (mg/L)	--	39	--	--	--	--	--	--	--	
*15	Magnesium (mg/L)	--	20	--	--	--	--	--	--	--	
*16	Chloride (mg/L)	--	3100	--	--	--	--	--	--	--	
*17	Sulphate (mg/L)	--	< 5	--	--	--	--	--	--	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	19000	--	--	--	--	--	--	--	
*19	Iron (mg/L)	--	430	--	--	--	--	--	--	--	
*20	Manganese (mg/L)	--	7	--	--	--	--	--	--	--	
*21	Zinc (mg/L)	--	5	--	--	--	--	--	--	--	
*22	Copper (mg/L)	--	1.4	--	--	--	--	--	--	--	
*23	Nickel (mg/L)	--	0.4	--	--	--	--	--	--	--	
*24	Chromium (mg/L)	--	8	--	--	--	--	--	--	--	
*25	Lead (mg/L)	--	1.5	--	--	--	--	--	--	--	
*26	Cadmium (mg/L)	--	0.02	--	--	--	--	--	--	--	
*27	Suspended Solids (mg/L)	--	6800	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	6200	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	42	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	14	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	4	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	1.1	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	0.1	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	< 1	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	< 0.1	--	--	--	--	--	--	--	
36	Sulphide (mg/L)	--	9.6	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	7.8	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	< 1	--	--	--	--	--	--	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH–WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui

Sample Location : L206

Number	Analyical Parameters	12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	8.6	8.5	8.4	8.3	7.81	7.62	8.35	8.53	7.21	
4	Temperature (°C)	23.4	21.8	19.5	21.4	23.2	26.8	27.9	29.5	28.7	
5	Total Organic Carbon (TOC) (mg/L)	150	210	250	340	260	300	250	110	100	
*6	Chemical Oxygen Demand (COD) (mg/L)	450	550	600	700	1500	950	910	340	310	
*7	5–day Biochemical Oxygen Demand (BOD_5) (mg/L)	49	49	39	48	150	79	86	43	21	
*8	Ammonical Nitrogen (mg–N/L)	490	620	730	810	2300	1100	800	270	410	
*9	TKN (mg–N/L)	500	620	740	810	2400	1200	870	290	420	
*10	Total Oxidized Nitrogen (mg–N/L)	< 0.3	< 0.3	<0.3	<0.3	<0.3	0.03	72	9.8	8.7	
11	Orthophosphate (mg–P/L)	1.6	2.3	0.06	4.3	14	6.1	4.3	1.7	1.5	
*12	Sodium (mg/L)	300	390	470	600	1300	720	700	310	260	
*13	Potassium (mg/L)	150	200	230	280	590	380	830	180	360	
*14	Calcium (mg/L)	51	14	19	21	25	34	25	8	30	
*15	Magnesium (mg/L)	20	8.4	9.5	11	15	12	12	4.2	9	
*16	Chloride (mg/L)	380	420	450	600	1300	750	710	270	240	
*17	Sulphate (mg/L)	110	89	72	59	<5	8	47	32	< 5	
*18	Alkalinity (as $CaCO_3$) (mg/L)	190	2700	3300	4000	9900	5500	3800	1500	1500	
*19	Iron (mg/L)	2.2	2	2	2.5	3.9	3.5	3.4	1.6	2.8	
*20	Manganese (mg/L)	0.04	0.1	0.05	0.08	0.1	0.1	0.1	0.1	0.2	
*21	Zinc (mg/L)	0.38	0.15	0.29	0.37	0.23	0.14	0.38	0.48	0.34	
*22	Copper (mg/L)	0.05	0.04	0.03	0.02	0.02	<0.02	<0.02	0.1	< 0.02	
*23	Nickel (mg/L)	0.03	0.06	0.04	0.05	0.1	0.1	0.1	0.1	< 0.03	
*24	Chromium (mg/L)	0.7	0.6	2	0.9	1.3	1.2	1	0.5	0.2	
*25	Lead (mg/L)	< 0.04	< 0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.1	
*26	Cadmium (mg/L)	< 0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.01	
*27	Suspended Solids (mg/L)	25	44	13	8	8	<5	9	15	6	
28	Settleable Solids (mg/L)	< 5	41	6	<5	<5	<5	<5	10	< 5	
29	Oil & Grease (mg/L)	< 10	< 10	<10	<10	<10	<10	<10	<10	< 10	
30	Boron (mg/L)	1.1	1.1	1.4	1.9	3.6	2.2	2.3	1	1.4	
*31	Barium (mg/L)	< 1	< 1	<1	<1	<1	<1	<1	1	< 1	
32	Mecury (ug/L)	1	1	1	2.6	4.2	2.8	5.8	1.4	1.5	
33	Ag (mg/L)	< 0.1	< 0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	0.1	
34	Cyanide (mg/L)	<1	< 1	<1	<1	<0.01	<0.01	0.03	<0.01	< 0.01	
35	Phenol (mg/L)	< 0.1	< 0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	< 0.1	
36	Sulphide (mg/L)	1	< 0.1	1.8	2.6	3.2	2.4	0.4	<0.1	< 0.1	
37	Total Surfactants (mg/L)	0.07	1	0.9	1.3	1.3	1.4	1.3	1.3	4.8	
38	E.Coli (No./100mL)	260	< 1	<1	2	4	3	96000	150	530	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non–accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui

Sample Location : L207

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	-- ***	0.001	0.00067	0.003	0.012	0.005	0.0023	0.015	0.114	
*3	pH	8.0	7.6	7.4	7.6	7.60	7.45	7.56	7.08	7.35	
4	Temperature (°C)	27.4	26.8	18.5	25.6	25.5	27.3	27.1	28.9	28.4	
5	Total Organic Carbon (TOC) (mg/L)	500	330	500	480	430	450	490	70	280	
*6	Chemical Oxygen Demand (COD) (mg/L)	1100	1100	1100	940	950	980	980	250	710	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	64	76	64	69	66	68	64	16	45	
*8	Ammonical Nitrogen (mg-N/L)	1500	1400	1500	1400	1200	1300	1200	230	920	
*9	TKN (mg-N/L)	1500	1500	1500	1400	1300	1400	1400	240	940	
*10	Total Oxidized Nitrogen (mg-N/L)	0.9	0.8	<0.3	0.7	2.7	0.48	0.42	0.66	< 0.3	
11	Orthophosphate (mg-P/L)	5.9	5.5	5.5	5.4	5.2	4.3	5.6	1	2.8	
*12	Sodium (mg/L)	960	940	960	970	1000	850	920	170	610	
*13	Potassium (mg/L)	360	340	330	330	380	340	320	70	240	
*14	Calcium (mg/L)	100	46	46	50	54	59	40	100	70	
*15	Magnesium (mg/L)	41	26	24	25	27	25	25	12	26	
*16	Chloride (mg/L)	1000	890	980	880	790	900	820	160	590	
*17	Sulphate (mg/L)	7.9	< 5	<5	<5	7.9	<5	<5	29	5.5	
*18	Alkalinity (as $CaCO_3$) (mg/L)	630	6800	6600	6500	6000	6100	6200	1300	4300	
*19	Iron (mg/L)	6.1	5.3	5.6	6.1	6.5	5.4	6	3	5.9	
*20	Manganese (mg/L)	0.1	0.07	0.07	0.09	0.1	0.09	0.1	0.2	0.2	
*21	Zinc (mg/L)	0.11	0.07	0.09	0.07	0.13	0.12	0.07	0.07	0.15	
*22	Copper (mg/L)	< 0.02	0.03	0.05	<0.02	0.02	<0.02	<0.02	0.1	< 0.02	
*23	Nickel (mg/L)	0.1	0.08	0.08	0.08	0.07	0.1	0.1	<0.03	0.1	
*24	Chromium (mg/L)	2.3	1.4	3.3	1.5	0.8	1.4	1.2	0.2	0.7	
*25	Lead (mg/L)	< 0.04	0.01	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.1	
*26	Cadmium (mg/L)	< 0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.01	
*27	Suspended Solids (mg/L)	8	< 5	10	<5	6	<5	16	20	10	
28	Settleable Solids (mg/L)	< 5	< 5	<5	<5	<5	<5	22	18	6	
29	Oil & Grease (mg/L)	< 10	< 10	<10	<10	<10	<10	<10	<10	< 10	
30	Boron (mg/L)	4.2	2.4	3.3	3.5	3.4	3.3	3.2	1.2	2.4	
*31	Barium (mg/L)	2	1.1	<1	<1	<1	<1	<1	1	1	
32	Mecury (ug/L)	1	1	1	1.9	1.3	2.9	3	<1	2.7	
33	Ag (mg/L)	< 0.1	< 0.1	<0.1	<0.1	<0.1	0.2	<0.1	<0.1	0.1	
34	Cyanide (mg/L)	< 1	< 1	<1	<1	<0.01	<0.01	0.02	<0.01	< 0.01	
35	Phenol (mg/L)	< 0.1	< 0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	< 0.1	
36	Sulphide (mg/L)	2	< 0.1	3.6	2.4	<0.1	2.2	<0.1	<0.1	< 0.1	
37	Total Surfactants (mg/L)	0.8	1.4	1.1	1.4	0.9	1.1	14	0.9	5.1	
38	E.Coli (No./100mL)	< 1	< 1	<1	2	<1	10	102	30	6	

* : These testing parameters are accredited under Hong Kong Laboratory Accredited Scheme (HOKLAS).

For those non-accredited parameters, HKPC shall follow the same QA/QC procedures in the analysis work as required by HOKLAS.

** : The water depth measured from the top of borehole to water surface in the bore hole.

*** : The flowrate for L207 srarted to be measured from January.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui **Sample Location : SW201**

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	11.9	17.92	12.67	10.5	19.38	17	19	150	65.14	
*3	pH	7.2	7.1	7.5	7.5	7.40	7.26	8.39	7.77	7.45	
4	Temperature (°C)	17.5	16.4	13.5	19.0	18.9	27.9	29.6	28.1	28.1	
5	Total Organic Carbon (TOC) (mg/L)	< 0.3	< 0.3	1	2	1	1	4	2	< 1	
*6	Chemical Oxygen Demand (COD) (mg/L)	< 7	< 7	<7	<7	<7	18	<7	<7	7.1	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	<5	<5	<5	<5	<3	<3	<5	<5	< 5	
*8	Ammonical Nitrogen (mg-N/L)	<0.01	<0.01	<0.01	0.03	<0.01	<0.01	0.2	0.14	0.11	
*9	TKN (mg-N/L)	0.17	0.09	0.06	0.06	0.03	0.06	0.25	0.14	0.14	
*10	Total Oxidized Nitrogen (mg-N/L)	< 0.3	< 0.3	<0.3	<0.3	<0.3	0.06	0.37	0.14	< 0.3	
11	Orthophosphate (mg-P/L)	< 0.2	< 0.2	< 0.2	< 0.2	<0.2	<0.2	<0.2	<0.2	< 0.2	
*12	Sodium (mg/L)	9.3	10	8.4	11	9.5	10	12	11	7.2	
*13	Potassium (mg/L)	2.2	3.8	1.6	2.2	2.5	2.6	4	0.7	1.8	
*14	Calcium (mg/L)	4.4	4.4	3.2	4.9	4.9	4.1	6.4	2.6	2	
*15	Magnesium (mg/L)	< 1	< 1	<1	1.1	0.99	1	1.6	<1	< 1	
*16	Chloride (mg/L)	11	11	8.2	10	9	11	13	6.7	7.1	
*17	Sulphate (mg/L)	11	13	6.1	14	12	14	17	15	6.6	
*18	Alkalinity (as $CaCO_3$) (mg/L)	11	10	8	11	12	12	11	7	7	
*19	Iron (mg/L)	< 0.6	< 0.6	< 0.6	< 0.6	<0.6	0.014	<0.6	<0.6	< 0.6	
*20	Mangɛ ıese (mg/L)	< 0.04	< 0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.015	< 0.04	
*21	Zinc (mg/L)	0.08	0.1	0.03	< 0.03	<0.03	<0.03	<0.03	<0.03	0.08	
*22	Copper (mg/L)	< 0.02	< 0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	< 0.02	
*23	Nickel (mg/L)	< 0.03	< 0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	< 0.03	
*24	Chromium (mg/L)	< 0.02	< 0.02	<0.02	< 0.02	<0.02	<0.02	<0.02	0.1	< 0.02	
*25	Lead (mg/L)	< 0.04	< 0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	< 0.04	
*26	Cadmium (mg/L)	< 0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.01	
*27	Suspended Solids (mg/L)	--	9	--	--	8	--	--	14	--	
28	Settleable Solids (mg/L)	--	9	--	--	<5	--	--	8	--	
29	Oil & Grease (mg/L)	--	< 10	--	--	<10	--	--	<10	--	
30	Boron (mg/L)	--	0.15	--	--	0.1	--	--	<0.1	--	
*31	Barium (mg/L)	--	< 1	--	--	<1	--	--	1	--	
32	Mecury (ug/L)	--	1	--	--	<1	--	--	<1	--	
33	Ag (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
34	Cyanide (mg/L)	--	< 1	--	--	<0.01	--	--	<0.01	--	
35	Phenol (mg/L)	--	< 0.1	--	--	0.1	--	--	<0.1	--	
36	Sulphide (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
37	Total Surfactants (mg/L)	--	< 0.4	--	--	<0.4	--	--	4.4	--	
38	E.Coli (No./100mL)	--	87	--	--	1000	--	--	53	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui

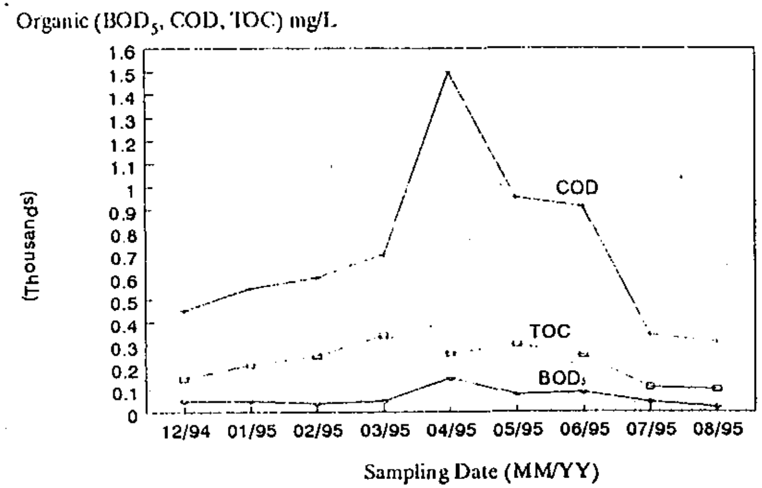
Sample Location : SW204

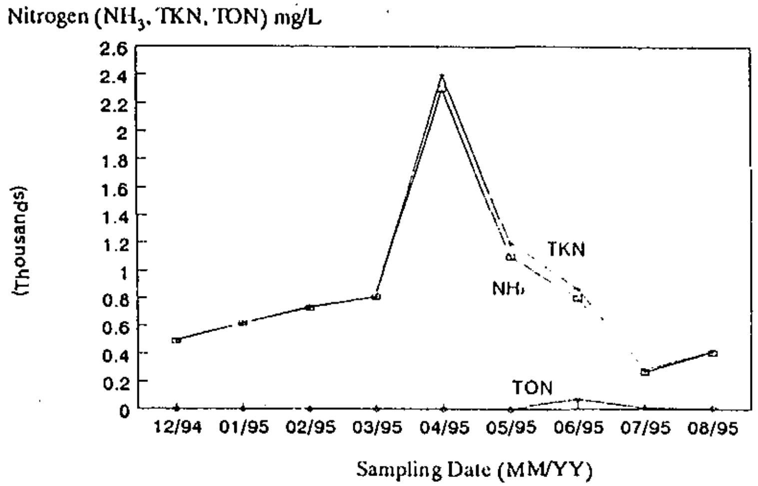
Number	Analyical Parameters	Sampling Date 12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	242	60	No flow	3.9	21.43	14.3	15	190	63.28	
*3	pH	7.8	7.9	8.0	7.8	7.71	7.68	8.23	6.90	7.34	
4	Temperature (°C)	19.1	15	13.6	18.8	18.8	28.1	26.8	27.6	27.6	
5	Total Organic Carbon (TOC) (mg/L)	18	14	18	17	15	6	15	3	3	
*6	Chemical Oxygen Demand (COD) (mg/L)	430	32	38	34	35	120	23	<7	7.5	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	<5	9.5	13	11	9.9	42	19	<5	< 5	
*8	Ammonical Nitrogen (mg-N/L)	36	46	59	51	20	15	25	1.3	9.9	
*9	TKN (mg-N/L)	37	49	62	53	24	15	25	1.5	11	
*10	Total Oxidized Nitrogen (mg-N/L)	3.7	1.6	1.9	2.8	1.7	2.8	6.6	0.1	0.36	
11	Orthophosphate (mg-P/L)	< 0.2	< 0.2	0.18	< 0.2	<0.2	<0.2	<0.2	<0.2	< 0.2	
*12	Sodium (mg/L)	4000	610	88	74	56	1200	31	13	13	
*13	Potassium (mg/L)	190	34	20	18	11	54	10	1.2	4	
*14	Calcium (mg/L)	270	27	10	9.1	18	56	8.4	3.3	2.5	
*15	Magnesium (mg/L)	510	70	7	5.4	6	160	2.5	<1	1	
*16	Chloride (mg/L)	7100	1000	110	79	36	2800	34	7.6	13	
*17	Sulphate (mg/L)	1000	140	20	17	24	390	9.6	23	< 5	
*18	Alkalinity (as $CaCO_3$) (mg/L)	230	238	290	260	130	99	130	14	60	
*19	Iron (mg/L)	< 0.6	0.27	0.13	< 0.6	1.3	1.4	2.1	0.6	0.9	
*20	Manganese (mg/L)	0.06	0.08	0.1	0.09	0.1	0.2	0.3	0.1	0.2	
*21	Zinc (mg/L)	0.05	< 0.03	0.06	< 0.03	0.04	0.03	<0.03	<0.03	0.04	
*22	Copper (mg/L)	0.03	0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	< 0.02	
*23	Nickel (mg/L)	< 0.03	< 0.03	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	< 0.03	
*24	Chromium (mg/L)	0.05	0.02	0.13	0.05	<0.02	<0.02	<0.02	0.1	< 0.02	
*25	Lead (mg/L)	< 0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	< 0.04	
*26	Cadmium (mg/L)	< 0.01	< 0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	< 0.01	
*27	Suspended Solids (mg/L)	--	< 5	--	--	30	--	--	17	--	
28	Settleable Solids (mg/L)	--	< 5	--	--	6	--	--	7	--	
29	Oil & Grease (mg/L)	--	< 10	--	--	<10	--	--	<10	--	
30	Boron (mg/L)	--	0.52	--	--	0.16	--	--	<0.1	--	
*31	Barium (mg/L)	--	< 1	--	--	<1	--	--	1	--	
32	Mecury (ug/L)	--	1	--	--	<1	--	--	<1	--	
33	Ag (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
34	Cyanide (mg/L)	--	< 1	--	--	0.01	--	--	<0.01	--	
35	Phenol (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
36	Sulphide (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
37	Total Surfactants (mg/L)	--	< 0.4	--	--	<0.4	--	--	0.6	--	
38	E.Coli (No./100mL)	--	1600	--	--	4400	--	--	200	--	

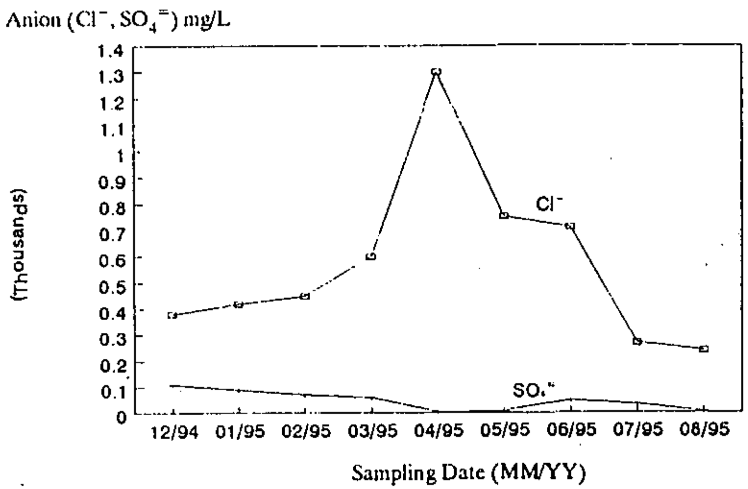
* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

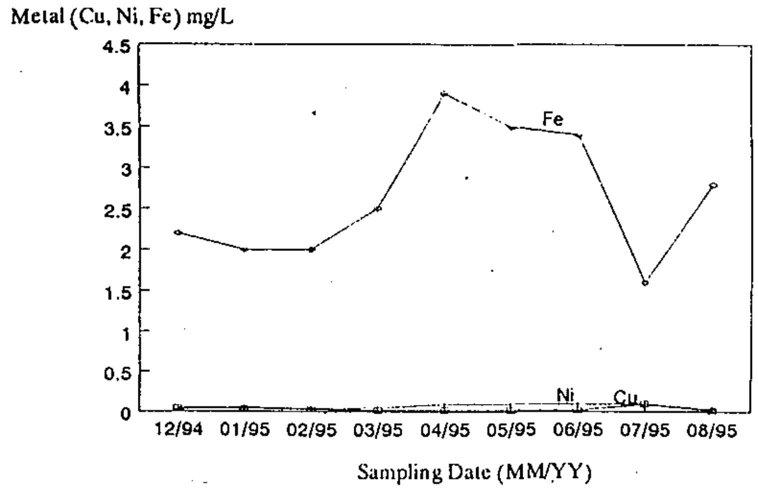
** : The water depth measured from the top of bore hole to water surface in the bore hole.

Location: SLS–L206
Leachate Sampling

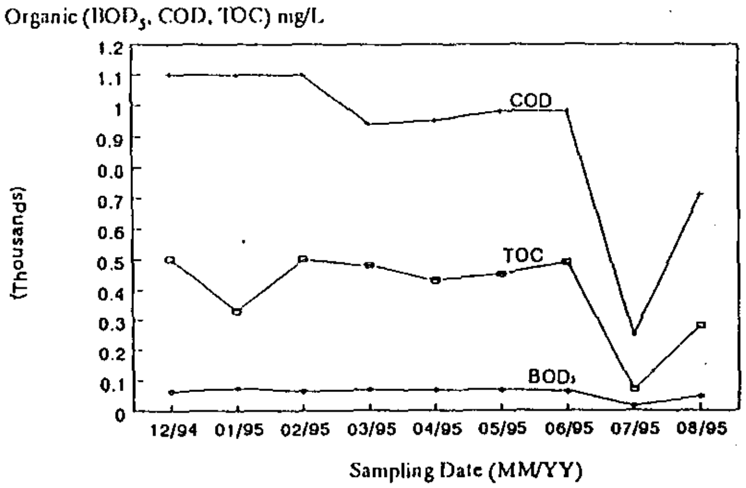


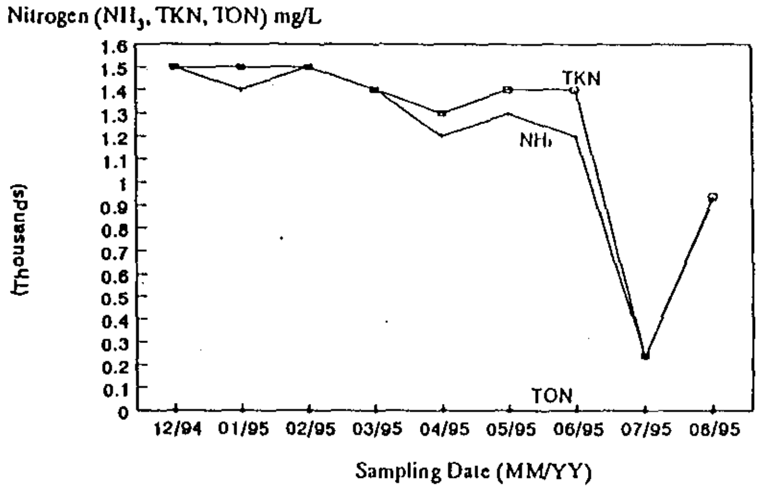


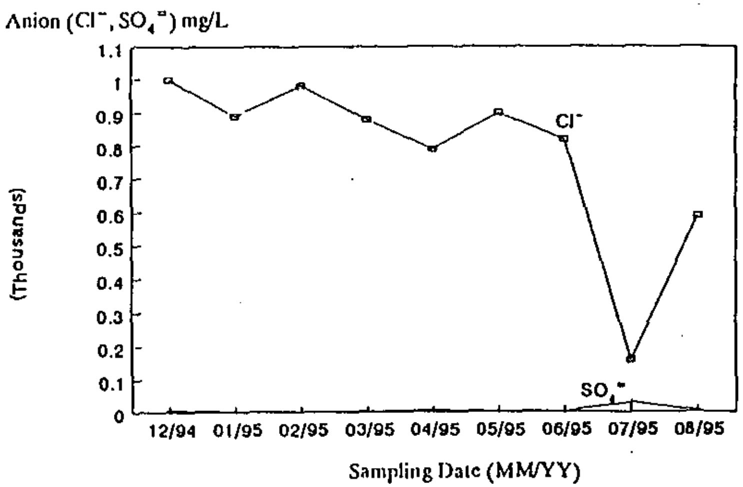


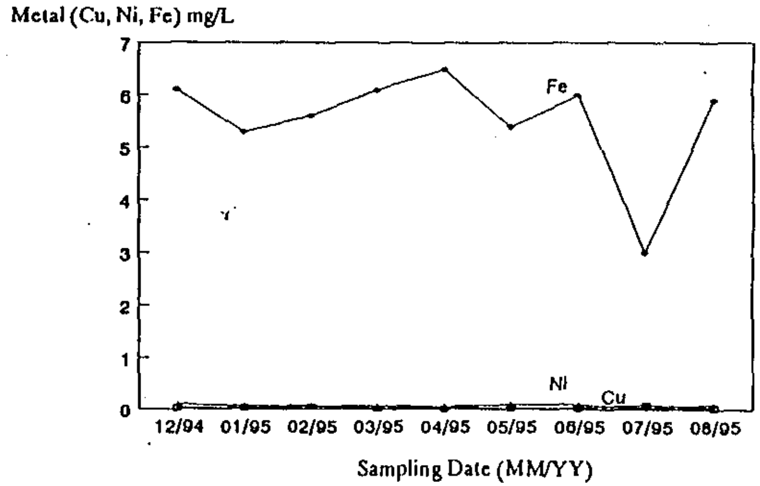


Location: SLS–L207
Leachate Sampling

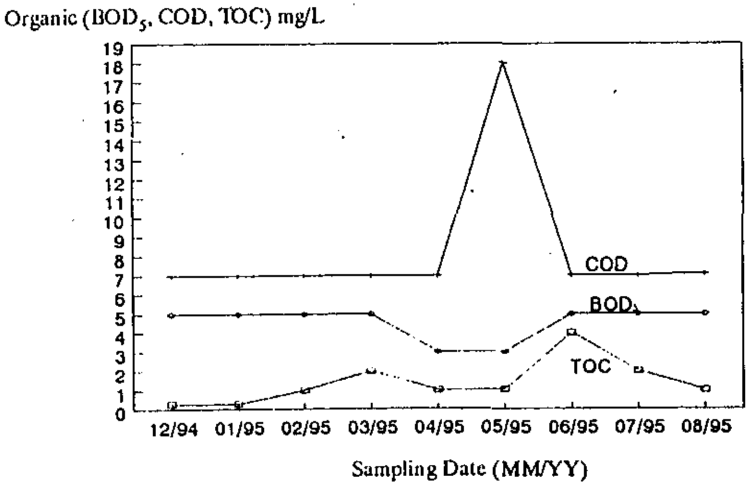


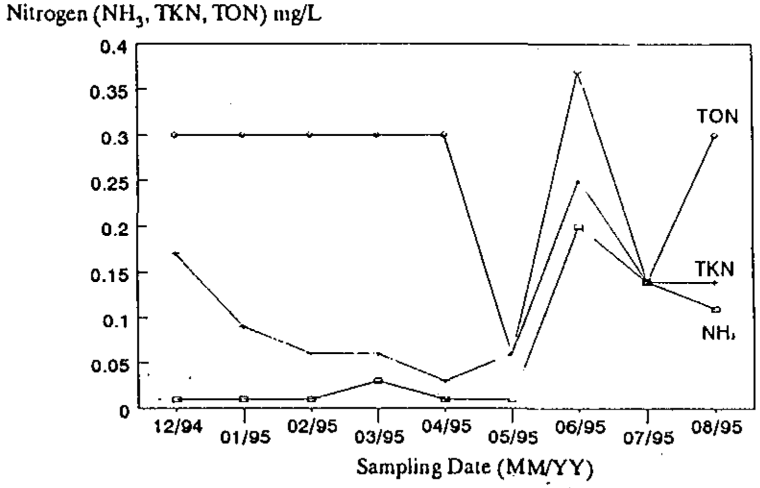


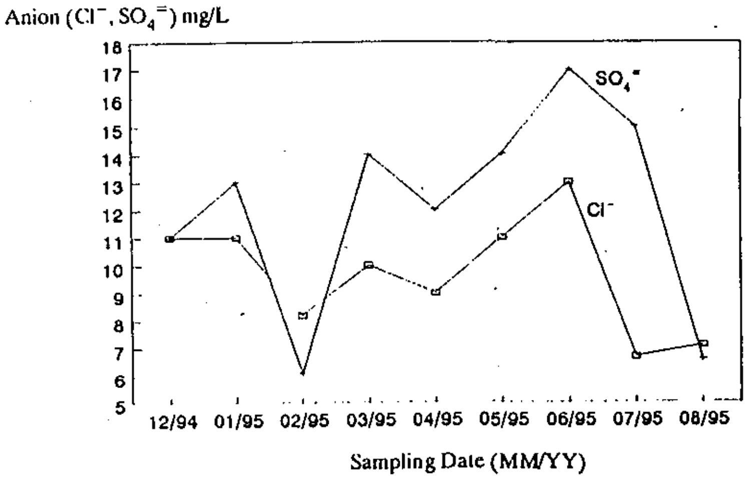


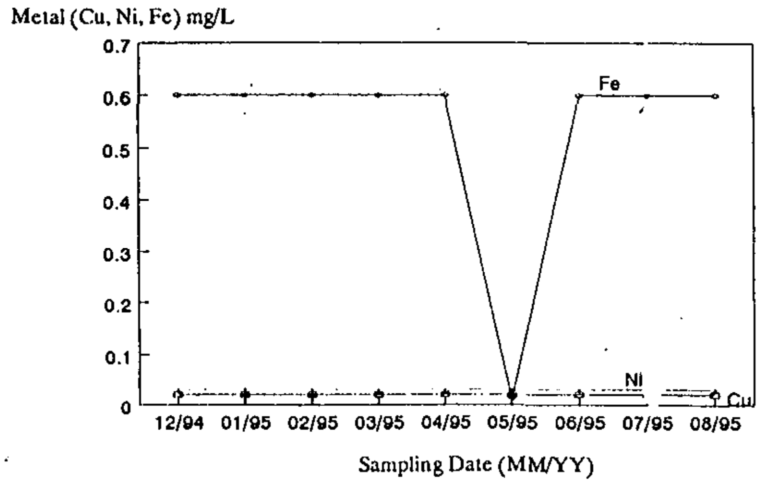


Location: SLS−SW201
Surface Water Sampling

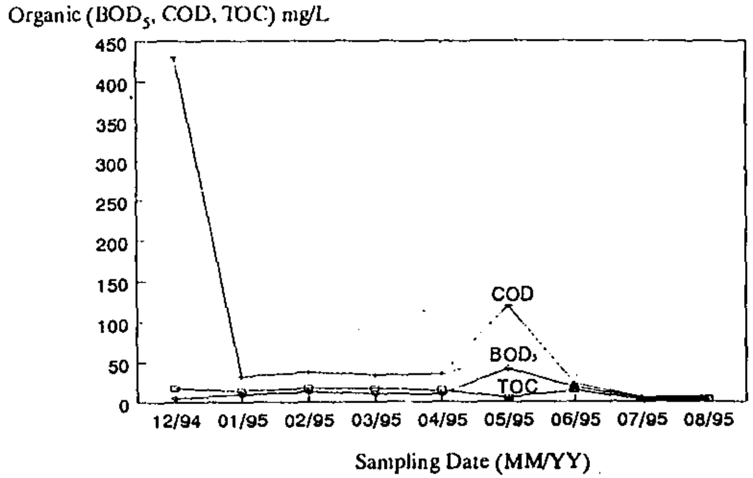


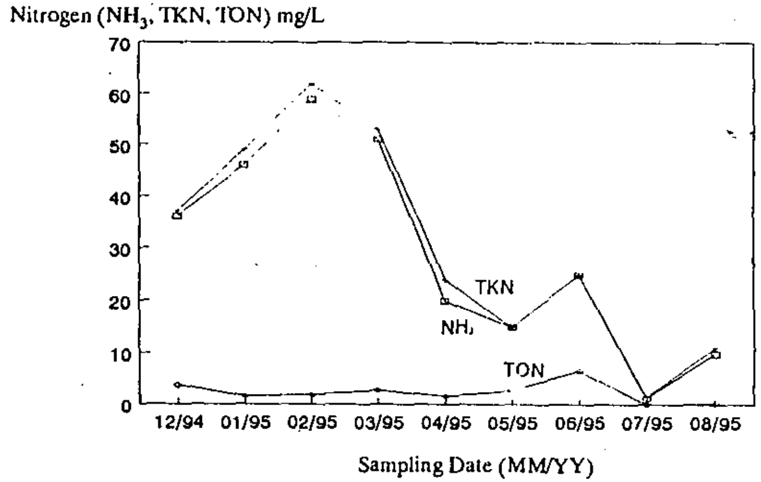


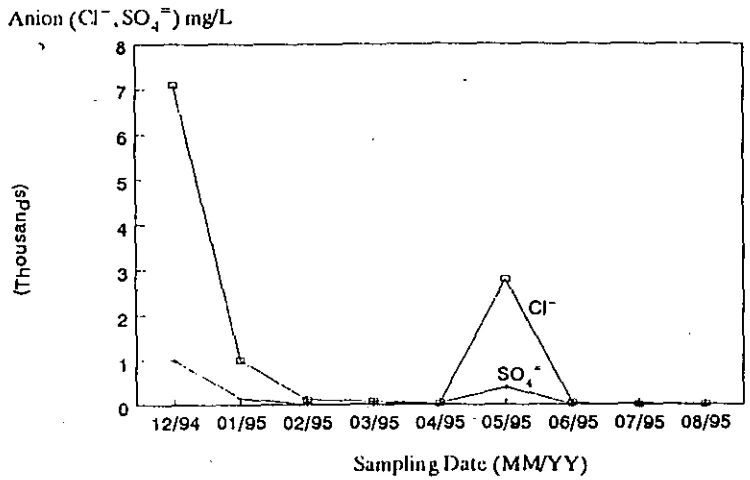


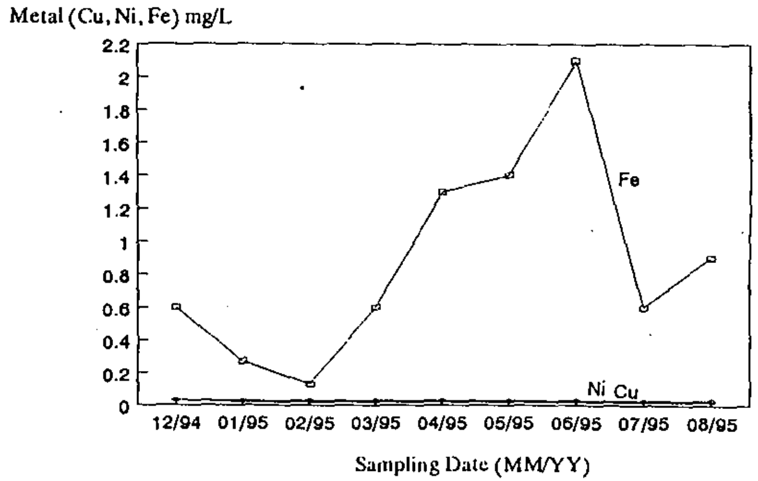


Location: SLS−SW204
Surface Water Sampling









Note : Please note that the sample collected on 12/94 contained sea water.

Leachate, Ground Water & Surface Water Monitoring Results
for
Ma Tso Lung Landfill

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Ma Tso Lung — **Sample Location : DH301**

Top Level of Well : 48.61 mPD — **Bottom Level of Well : 32.86 mPD**

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	6.36	7.03	7.27	7.69	7.3	7.87	7.97	5.95	7.32	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	8.1	--	--	8.03	--	--	7.90	--	
4	Temperature (°C)	--	27.7	--	--	24.8	--	--	29.2	--	
5	Total Organic Carbon (TOC) (mg/L)	--	6200	--	--	3600	--	--	2800	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	13000	--	--	8800	--	--	6900	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	5900	--	--	3500	--	--	2700	--	
*8	Ammonical Nitrogen (mg-N/L)	--	9900	--	--	8900	--	--	8200	--	
*9	TKN (mg-N/L)	--	10000	--	--	9600	--	--	8500	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	< 0.3	--	--	<0.3	--	--	<0.3	--	
11	Orthophosphate (mg-P/L)	--	57	--	--	95	--	--	81	--	
*12	Sodium (mg/L)	--	3200	--	--	3000	--	--	2500	--	
*13	Potassium (mg/L)	--	990	--	--	1100	--	--	750	--	
*14	Calcium (mg/L)	--	17	--	--	13	--	--	86	--	
*15	Magnesium (mg/L)	--	14	--	--	20	--	--	5	--	
*16	Chloride (mg/L)	--	3900	--	--	4900	--	--	5000	--	
*17	Sulphate (mg/L)	--	71	--	--	44	--	--	190	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	36000	--	--	34000	--	--	31000	--	
*19	Iron (mg/L)	--	28	--	--	9	--	--	5.4	--	
*20	Manganese (mg/L)	--	0.15	--	--	0.08	--	--	0.1	--	
*21	Zinc (mg/L)	--	0.77	--	--	0.35	--	--	0.23	--	
*22	Copper (mg/L)	--	0.12	--	--	0.04	--	--	0.1	--	
*23	Nickel (mg/L)	--	0.18	--	--	0.3	--	--	0.4	--	
*24	Chromium (mg/L)	--	40	--	--	9	--	--	13	--	
*25	Lead (mg/L)	--	0.22	--	--	0.16	--	--	0.3	--	
*26	Cadmium (mg/L)	--	< 0.01	--	--	0.02	--	--	<0.01	--	
*27	Suspended Solids (mg/L)	--	840	--	--	720	--	--	180	--	
28	Settleable Solids (mg/L)	--	760	--	--	590	--	--	38	--	
29	Oil & Grease (mg/L)	--	96	--	--	21	--	--	17	--	
30	Boron (mg/L)	--	4.6	--	--	7.2	--	--	7.2	--	
*31	Barium (mg/L)	--	3.5	--	--	<1	--	--	<1	--	
32	Mecury (ug/L)	--	4.0	--	--	20	--	--	35	--	
33	Ag (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
34	Cyanide (mg/L)	--	0.11	--	--	0.05	--	--	0.04	--	
35	Phenol (mg/L)	--	91	--	--	47	--	--	42	--	
36	Sulpide (mg/L)	--	18	--	--	9	--	--	2.8	--	
37	Total Surfactants (mg/L)	--	2.2	--	--	3.9	--	--	6.5	--	
38	E.Coli (No./100mL)	--	< 1	--	--	<1	--	--	15	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Ma Tso Lung — Sample Location : DH302

Top Level of Well : 47.32 mPD — Bottom Level of Well : 27.32 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	7.27	7.5	7.85	8.25	8.33	9.35	8.2	6.53	7.15	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	7.9	--	--	8.00	--	--	8.28	--	
4	Temperature (°C)	--	35.4	--	--	31	--	--	38.2	--	
5	Total Organic Carbon (TOC) (mg/L)	--	1400	--	--	1900	--	--	1800	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	9100	--	--	4700	--	--	2800	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	360	--	--	690	--	--	470	--	
*8	Ammonical Nitrogen (mg-N/L)	--	5400	--	--	7100	--	--	3700	--	
*9	TKN (mg-N/L)	--	5700	--	--	7300	--	--	4200	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	< 0.3	--	--	<0.5	--	--	<0.3	--	
11	Orthophosphate (mg-P/L)	--	64	--	--	80	--	--	47	--	
*12	Sodium (mg/L)	--	1700	--	--	2300	--	--	1200	--	
*13	Potassium (mg/L)	--	790	--	--	1100	--	--	480	--	
*14	Calcium (mg/L)	--	17	--	--	21	--	--	18	--	
*15	Magnesium (mg/L)	--	7.2	--	--	14	--	--	5.5	--	
*16	Chloride (mg/L)	--	2400	--	--	2900	--	--	2200	--	
*17	Sulphate (mg/L)	--	17	--	--	26	--	--	41	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	21000	--	--	26000	--	--	15000	--	
*19	Iron (mg/L)	--	3	--	--	6	--	--	2.5	--	
*20	Manganese (mg/L)	--	0.05	--	--	0.06	--	--	0.1	--	
*21	Zinc (mg/L)	--	0.37	--	--	0.49	--	--	0.23	--	
*22	Copper (mg/L)	--	0.05	--	--	0.08	--	--	0.1	--	
*23	Nickel (mg/L)	--	0.15	--	--	0.21	--	--	0.2	--	
*24	Chromium (mg/L)	--	6	--	--	5.5	--	--	6.3	--	
*25	Lead (mg/L)	--	0.12	--	--	0.22	--	--	0.2	--	
*26	Cadmium (mg/L)	--	< 0.01	--	--	0.01	--	--	<0.01	--	
*27	Suspended Solids (mg/L)	--	75	--	--	210	--	--	84	--	
28	Settleable Solids (mg/L)	--	45	--	--	170	--	--	38	--	
29	Oil & Grease (mg/L)	--	21	--	--	13	--	--	< 10	--	
30	Boron (mg/L)	--	4.7	--	--	7.2	--	--	3.8	--	
*31	Barium (mg/L)	--	< 1	--	--	<1	--	--	1	--	
32	Mecury (ug/L)	--	2.8	--	--	26	--	--	17	--	
33	Ag (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
34	Cyanide (mg/L)	--	<1	--	--	0.03	--	--	0.02	--	
35	Phenol (mg/L)	--	< 0.1	--	--	0.5	--	--	<0.1	--	
36	Sulpide (mg/L)	--	2.4	--	--	2.9	--	--	1.2	--	
37	Total Surfactants (mg/L)	--	4.7	--	--	4	--	--	1.1	--	
38	E.Coli (No./100mL)	--	< 1	--	--	30	--	--	<1	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Ma Tso Lung　　　　Sample Location : DH303

Top Level of Well : 41.94 mPD　　　　Bottom Level of Well : 27.05 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	5.67	10.23	10.8	11.05	10.85	11.00	11.05	6.28	10.28	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	7.8	--	--	7.86	--	--	7.69	--	
4	Temperature (°C)	--	25.5	--	--	25.3	--	--	27.4	--	
5	Total Organic Carbon (TOC) (mg/L)	--	4400	--	--	2700	--	--	1600	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	7600	--	--	8800	--	--	4400	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	3300	--	--	4200	--	--	1900	--	
*8	Ammonical Nitrogen (mg-N/L)	--	5800	--	--	7000	--	--	3700	--	
*9	TKN (mg-N/L)	--	5800	--	--	7300	--	--	4300	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	< 0.3	--	--	<0.3	--	--	<0.3	--	
11	Orthophosphate (mg-P/L)	--	63	--	--	73	--	--	43	--	
*12	Sodium (mg/L)	--	1600	--	--	1900	--	--	1100	--	
*13	Potassium (mg/L)	--	560	--	--	740	--	--	320	--	
*14	Calcium (mg/L)	--	14	--	--	18	--	--	16	--	
*15	Magnesium (mg/L)	--	17	--	--	21	--	--	12	--	
*16	Chlo. de (mg/L)	--	2200	--	--	3200	--	--	1700	--	
*17	Sulphate (mg/L)	--	5.4	--	--	<5	--	--	250	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	21000	--	--	24000	--	--	15000	--	
*19	Iron (mg/L)	--	200	--	--	42	--	--	1	--	
*20	Manganese (mg/L)	--	0.32	--	--	0.22	--	--	0.1	--	
*21	Zinc (mg/L)	--	1.1	--	--	0.64	--	--	0.35	--	
*22	Copper (mg/L)	--	0.36	--	--	0.09	--	--	0.1	--	
*23	Nickel (mg/L)	--	0.28	--	--	0.22	--	--	0.1	--	
*24	Chromium (mg/L)	--	22	--	--	5.5	--	--	1.8	--	
*25	Lead (mg/L)	--	0.26	--	--	0.17	--	--	<0.04	--	
*26	Cadmium (mg/L)	--	< 0.01	--	--	0.01	--	--	<0.01	--	
*27	Suspended Solids (mg/L)	--	2100	--	--	950	--	--	720	--	
28	Settleable Solids (mg/L)	--	2000	--	--	660	--	--	450	--	
29	Oil & Grease (mg/L)	--	56	--	--	11	--	--	< 10	--	
30	Boron (mg/L)	--	8.4	--	--	7.9	--	--	4.2	--	
*31	Barium (mg/L)	--	1.5	--	--	<1	--	--	2	--	
32	Mecury (ug/L)	--	1	--	--	19	--	--	9.1	--	
33	Ag (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
34	Cyanide (mg/L)	--	0.42	--	--	1.9	--	--	0.07	--	
35	Phenol (mg/L)	--	0.3	--	--	2.6	--	--	<0.1	--	
36	Sulpide (mg/L)	--	62	--	--	39	--	--	34	--	
37	Total Surfactants (mg/L)	--	26	--	--	8.1	--	--	46	--	
38	E.Coli (No./100mL)	--	< 1	--	--	380	--	--	80	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Ma Tso Lung

Sample Location : DH304

Top Level of Well : 28.11 mPD

Bottom Level of Well : 8.61 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	3.42	7.21	4.5	5.05	5.57	5.82	6.2	5.38	4.03	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	5.1	--	--	5.46	--	--	4.98	--	
4	Temperature (°C)	--	22.7	--	--	21.4	--	--	25.2	--	
5	Total Organic Carbon (TOC) (mg/L)	--	3	--	--	3	--	--	2	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	9.5	--	--	39	--	--	12	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	<5	--	--	<3	--	--	<5	--	
*8	Ammonical Nitrogen (mg-N/L)	--	5.9	--	--	6.7	--	--	8	--	
*9	TKN (mg-N/L)	--	6.5	--	--	8.4	--	--	9	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	33	--	--	60	--	--	33	--	
11	Orthophosphate (mg-P/L)	--	< 0.2	--	--	<0.2	--	--	<0.2	--	
*12	Sodium (mg/L)	--	110	--	--	70	--	--	92	--	
*13	Potassium (mg/L)	--	3.1	--	--	3.4	--	--	4.0	--	
*14	Calcium (mg/L)	--	7	--	--	7.9	--	--	4.4	--	
*15	Magnesium (mg/L)	--	3.1	--	--	1.6	--	--	2.2	--	
*16	Chloride (mg/L)	--	67	--	--	61	--	--	82	--	
*17	Sulphate (mg/L)	--	<5	--	--	<5	--	--	5	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	20	--	--	25	--	--	12	--	
*19	Iron (mg/L)	--	40	--	--	68	--	--	30	--	
*20	Manganese (mg/L)	--	0.46	--	--	1.0	--	--	0.5	--	
*21	Zinc (mg/L)	--	0.09	--	--	0.28	--	--	0.08	--	
*22	Copper (mg/L)	--	< 0.02	--	--	0.03	--	--	0.1	--	
*23	Nickel (mg/L)	--	< 0.03	--	--	<0.03	--	--	0.1	--	
*24	Chromium (mg/L)	--	0.03	--	--	<0.02	--	--	0.2	--	
*25	Lead (mg/L)	--	0.22	--	--	0.3	--	--	0.1	--	
*26	Cadmium (mg/L)	--	< 0.01	--	--	0.02	--	--	<0.01	--	
*27	Suspended Solids (mg/L)	--	850	--	--	1600	--	--	620	--	
28	Settleable Solids (mg/L)	--	800	--	--	1400	--	--	540	--	
29	Oil & Grease (mg/L)	--	< 10	--	--	<10	--	--	< 10	--	
30	Boron (mg/L)	--	0.1	--	--	<0.1	--	--	<0.1	--	
*31	Barium (mg/L)	--	< 1	--	--	<1	--	--	1	--	
32	Mecury (ug/L)	--	1	--	--	<1	--	--	<1	--	
33	Ag (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
34	Cyanide (mg/L)	--	0.02	--	--	<0.01	--	--	0.04	--	
35	Phenol (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
36	Sulpide (mg/L)	--	< 0.1	--	--	0.2	--	--	<0.1	--	
37	Total Surfactants (mg/L)	--	< 0.4	--	--	0.25	--	--	0.6	--	
38	E.Coli (No./100mL)	--	44	--	--	800	--	--	23	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

Leachate, Ground Water & Surface Water Monitoring Results
for
Pillar Point Valley Landfill

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley

Sample Location : A151

Top Level of Well : 143.13 mPD

Bottom Level of Well : 123.10 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
A	SUITE A FULL ANALYSIS										
1	Water Level (m)**	13.54	14.02	14.02	12.51	12.27	No water	14.6	15.57	--	9.27
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	--
*3	pH	7.8	--	--	--	--	--	--	--	--	7.39
4	Temperature (°C)	32.8	--	--	--	--	--	--	--	--	36.5
5	Total Organic Carbon (TOC) (mg/L)	1200	--	--	--	--	--	--	--	--	540
*6	Chemical Oxygen Demand (COD) (mg/L)	7000	--	--	--	--	--	--	--	--	2300
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	450	--	--	--	--	--	--	--	--	310
*8	Ammonical Nitrogen (mg-N/L)	490	--	--	--	--	--	--	--	--	980
*9	TKN (mg-N/L)	520	--	--	--	--	--	--	--	--	1000
*10	Total Oxidized Nitrogen (mg-N/L)	0.3	--	--	--	--	--	--	--	--	2.7
11	Orthophosphate (mg-P/L)	7.1	--	--	--	--	--	--	--	--	6.4
*12	Sodium (mg/L)	480	--	--	--	--	--	--	--	--	1500
*13	Potassium (mg/L)	250	--	--	--	--	--	--	--	--	630
*14	Calcium (mg/L)	200	--	--	--	--	--	--	--	--	100
*15	Magnesium (mg/L)	34	--	--	--	--	--	--	--	--	72
*16	Chloride (mg/L)	660	--	--	--	--	--	--	--	--	2200
*17	Sulphate (mg/L)	15	--	--	--	--	--	--	--	--	<5
*18	Alkalinity (as $CaCO_3$) (mg/L)	260	--	--	--	--	--	--	--	--	5300
*19	Iron (mg/L)	200	--	--	--	--	--	--	--	--	10
*20	Manganese (mg/L)	6	--	--	--	--	--	--	--	--	0.6
*21	Zinc (mg/L)	12	--	--	--	--	--	--	--	--	1.8
*22	Copper (mg/L)	1.6	--	--	--	--	--	--	--	--	1
*23	Nickel (mg/L)	0.32	--	--	--	--	--	--	--	--	0.1
*24	Chromium (mg/L)	0.46	--	--	--	--	--	--	--	--	0.2
*25	Lead (mg/L)	1.6	--	--	--	--	--	--	--	--	0.2
*26	Cadmium (mg/L)	0.15	--	--	--	--	--	--	--	--	<0.01
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	--
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	--
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	--
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	--
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	--
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	--
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	--
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	--
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	--
36	Sulpide (mg/L)	--	--	--	--	--	--	--	--	--	--
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	--
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	--

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore holes to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley

Sample Location : A152

Top Level of Well : 45.08 mPD

Bottom Level of Well : 25.08 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
A	SUITE A FULL ANALYSIS										
1	Water Level (m)**	12.41	12.28	12.28	13.50	12.94	12.27	12.49	12.21	12.22	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	7.8	--	--	--	--	--	7.68	--	--	
4	Temperature (°C)	28.9	--	--	--	--	--	31.6	--	--	
5	Total Organic Carbon (TOC) (mg/L)	400	--	--	--	--	--	570	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	860	--	--	--	--	--	1500	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	53	--	--	--	--	--	120	--	--	
*8	Ammonical Nitrogen (mg-N/L)	990	--	--	--	--	--	1600	--	--	
*9	TKN (mg-N/L)	1000	--	--	--	--	--	1700	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	<0.3	--	--	--	--	--	<0.3	--	--	
11	Orthophosphate (mg-P/L)	4.7	--	--	--	--	--	8.3	--	--	
*12	Sodium (mg/L)	1000	--	--	--	--	--	1700	--	--	
*13	Potassium (mg/L)	430	--	--	--	--	--	140	--	--	
*14	Calcium (mg/L)	38	--	--	--	--	--	8.1	--	--	
*15	Magnesium (mg/L)	21	--	--	--	--	--	20	--	--	
*16	Chloride (mg/L)	1100	--	--	--	--	--	1900	--	--	
*17	Sulphate (mg/L)	180	--	--	--	--	--	<5	--	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	470	--	--	--	--	--	8400	--	--	
*19	Iron (mg/L)	15	--	--	--	--	--	10	--	--	
*20	Manganese (mg/L)	0.29	--	--	--	--	--	0.2	--	--	
*21	Zinc (mg/L)	0.06	--	--	--	--	--	0.05	--	--	
*22	Copper (mg/L)	0.04	--	--	--	--	--	<0.02	--	--	
*23	Nickel (mg/L)	0.08	--	--	--	--	--	0.2	--	--	
*24	Chromium (mg/L)	0.18	--	--	--	--	--	0.3	--	--	
*25	Lead (mg/L)	0.13	--	--	--	--	--	<0.0.4	--	--	
*26	Cadmium (mg/L)	<0.01	--	--	--	--	--	<0.01	--	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulpide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore holes to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley **Sample Location : Sewer MH**

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	7.8	--	7.7	7.67	--	--	7.57	--	
4	Temperature (°C)	--	30.9	--	30.6	30.3	--	--	32.2	--	
5	Total Organic Carbon (TOC) (mg/L)	--	380	--	--	220	--	--	200	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	860	--	800	790	--	--	660	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	58	--	--	79	--	--	49	--	
*8	Ammonical Nitrogen (mg-N/L)	--	820	--	920	920	--	--	540	--	
*9	TKN (mg-N/L)	--	940	--	--	930	--	--	580	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	< 0.3		--	<0.3	--	--	0.34	--	
11	Orthophosphate (mg-P/L)	--	4.5	--	--	4.5	--	--	2.8	--	
*12	Sodium (mg/L)	--	950	--	1000	1100	--	--	650	--	
*13	Potassium (mg/L)	--	420	--	--	480	--	--	260	--	
*14	Calcium (mg/L)	--	48	--	53	54	--	--	17	--	
*15	Magnesium (mg/L)	--	33	--	27	27	--	--	21	--	
*16	Chloride (mg/L)	--	960	--	840	1100	--	--	680	--	
*17	Sulphate (mg/L)	--	5.2	--	--	<5	--	--	22	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	4900	--	--	4700	--	--	3000	--	
*19	Iron (mg/L)	--	9.1	--	--	11	--	--	7.2	--	
*20	Manganese (mg/L)	--	0.12	--	--	3	--	--	3.1	--	
*21	Zinc (mg/L)	--	0.1	--	--	0.05	--	--	0.07	--	
*22	Copper (mg/L)	--	0.03	--	--	0.02	--	--	0.1	--	
*23	Nickel (mg/L)	--	0.08	--	--	0.07	--	--	0.1	--	
*24	Chromium (mg/L)	--	0.08	--	--	0.06	--	--	0.2	--	
*25	Lead (mg/L)	--	<0.04	--	--	<0.04	--	--	<0.04	--	
*26	Cadmium (mg/L)	--	< 0.01	--	--	<0.01	--	--	<0.01	--	
*27	Suspended Solids (mg/L)	--	24	--	--	39	--	--	56	--	
28	Settleable Solids (mg/L)	--	9	--	--	11	--	--	18	--	
29	Oil & Grease (mg/L)	--	< 10	--	--	<10	--	--	<10	--	
30	Boron (mg/L)	--	2.3	--	--	1.6	--	--	1.2	--	
*31	Barium (mg/L)	--	1	--	--	<1	--	--	1	--	
32	Mecury (ug/L)	--	1	--	--	1	--	--	<1	--	
33	Ag (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
34	Cyanide (mg/L)	--	<1	--	--	<0.01	--	--	<0.01	--	
35	Phenol (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
36	Sulpide (mg/L)	--	< 0.1	--	--	<0.1	--	--	<0.1	--	
37	Total Surfactants (mg/L)	--	2.2	--	--	1.4	--	--	1.2	--	
38	E.Coli (No./100mL)	--	150	--	--	400	--	--	3800	--	

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** : The water depth measured from the top of bore holes to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley   Sample Location : M2

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	8.14	--	--	--	--	--	--	--	--	
4	Temperature (°C)	26.5	--	--	--	--	--	--	--	--	
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--	--	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	1500	--	--	--	--	--	--	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	--	--	--	--	--	--	--	--	
*8	Ammonical Nitrogen (mg-N/L)	1200	--	--	--	--	--	--	--	--	
*9	TKN (mg-N/L)	--	--	--	--	--	--	--	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--	--	--	--	
*12	Sodium (mg/L)	1600	--	--	--	--	--	--	--	--	
*13	Potassium (mg/L)	--	--	--	--	--	--	--	--	--	
*14	Calcium (mg/L)	83	--	--	--	--	--	--	--	--	
*15	Magnesium (mg/L)	34	--	--	--	--	--	--	--	--	
*16	Chloride (mg/L)	1600	--	--	--	--	--	--	--	--	
*17	Sulphate (mg/L)	--	--	--	--	--	--	--	--	--	
*18	Alkalini' · (as $CaCO_3$) (mg/L)	--	--	--	--	--	--	--	--	--	
*19	Iron (mg/L)	--	--	--	--	--	--	--	--	--	
*20	Manganese (mg/L)	--	--	--	--	--	--	--	--	--	
*21	Zinc (mg/L)	--	--	--	--	--	--	--	--	--	
*22	Copper (mg/L)	--	--	--	--	--	--	--	--	--	
*23	Nickel (mg/L)	--	--	--	--	--	--	--	--	--	
*24	Chromium (mg/L)	--	--	--	--	--	--	--	--	--	
*25	Lead (mg/L)	--	--	--	--	--	--	--	--	--	
*26	Cadmium (mg/L)	--	--	--	--	--	--	--	--	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulpide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore holes to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley　　　　Sample Location : M10

Number	Analyical Parameters	Sampling Date 12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	7.77	--	--	--	--	--	--	--	--	
4	Temperature (°C)	27.3	--	--	--	--	--	--	--	--	
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--	--	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	1000	--	--	--	--	--	--	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	--	--	--	--	--	--	--	--	
*8	Ammonical Nitrogen (mg-N/L)	970	--	--	--	--	--	--	--	--	
*9	TKN (mg-N/L)	--	--	--	--	--	--	--	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--	--	--	--	
*12	Sodium (mg/L)	1000	--	--	--	--	--	--	--	--	
*13	Potassium (mg/L)	--	--	--	--	--	--	--	--	--	
*14	Calcium (mg/L)	70	--	--	--	--	--	--	--	--	
*15	Magnesium (mg/L)	35	--	--	--	--	--	--	--	--	
*16	Chloride (mg/L)	1100	--	--	--	--	--	--	--	--	
*17	Sulphate (mg/L)	--	--	--	--	--	--	--	--	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	--	--	--	--	--	--	--	--	
*19	Iron (mg/L)	--	--	--	--	--	--	--	--	--	
*20	Manganese (mg/L)	--	--	--	--	--	--	--	--	--	
*21	Zinc (mg/L)	--	--	--	--	--	--	--	--	--	
*22	Copper (mg/L)	--	--	--	--	--	--	--	--	--	
*23	Nickel (mg/L)	--	--	--	--	--	--	--	--	--	
*24	Chromium (mg/L)	--	--	--	--	--	--	--	--	--	
*25	Lead (mg/L)	--	--	--	--	--	--	--	--	--	
*26	Cadmium (mg/L)	--	--	--	--	--	--	--	--	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulpide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS),
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore holes to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley

Sample Location : M11

Number	Analyical Parameters	Sample date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	7.69	--	--	--	--	--	--	--	--	
4	Temperature (°C)	28.2	--	--	--	--	--	--	--	--	
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--	--	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	1100	--	--	--	--	--	--	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	--	--	--	--	--	--	--	--	
*8	Ammonical Nitrogen (mg-N/L)	900	--	--	--	--	--	--	--	--	
*9	TKN (mg-N/L)	--	--	--	--	--	--	--	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--	--	--	--	
*12	Sodium (mg/L)	1000	--	--	--	--	--	--	--	--	
*13	Potassium (mg/L)	--	--	--	--	--	--	--	--	--	
*14	Calcium (mg/L)	69	--	--	--	--	--	--	--	--	
*15	Magnesium (mg/L)	35	--	--	--	--	--	--	--	--	
*16	Chloride (mg/L)	1100	--	--	--	--	--	--	--	--	
*17	Sulphate (mg/L)	--	--	--	--	--	--	--	--	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	--	--	--	--	--	--	--	--	
*19	Iron (mg/L)	--	--	--	--	--	--	--	--	--	
*20	Manganese (mg/L)	--	--	--	--	--	--	--	--	--	
*21	Zinc (mg/L)	--	--	--	--	--	--	--	--	--	
*22	Copper (mg/L)	--	--	--	--	--	--	--	--	--	
*23	Nickel (mg/L)	--	--	--	--	--	--	--	--	--	
*24	Chromium (mg/L)	--	--	--	--	--	--	--	--	--	
*25	Lead (mg/L)	--	--	--	--	--	--	--	--	--	
*26	Cadmium (mg/L)	--	--	--	--	--	--	--	--	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulpide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

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** : The water depth measured from the top of bore holes to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley

Sample Location : M12

Number	Analyical Parameters	Sample date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	7.5	--	--	--	--	--	--	--	--	
4	Temperature (°C)	28.2	--	--	--	--	--	--	--	--	
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--	--	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	980	--	--	--	--	--	--	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	--	--	--	--	--	--	--	--	
*8	Ammonical Nitrogen (mg-N/L)	840	--	--	--	--	--	--	--	--	
*9	TKN (mg-N/L)	--	--	--	--	--	--	--	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--	--	--	--	
*12	Sodium (mg/L)	1000	--	--	--	--	--	--	--	--	
*13	Potassium (mg/L)	--	--	--	--	--	--	--	--	--	
*14	Calcium (mg/L)	71	--	--	--	--	--	--	--	--	
*15	Magnesium (mg/L)	36	--	--	--	--	--	--	--	--	
*16	Chloride (mg/L)	1100	--	--	--	--	--	--	--	--	
*17	Sulphate (mg/L)	--	--	--	--	--	--	--	--	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	--	--	--	--	--	--	--	--	
*19	Iron (mg/L)	--	--	--	--	--	--	--	--	--	
*20	Manganese (mg/L)	--	--	--	--	--	--	--	--	--	
*21	Zinc (mg/L)	--	--	--	--	--	--	--	--	--	
*22	Copper (mg/L)	--	--	--	--	--	--	--	--	--	
*23	Nickel (mg/L)	--	--	--	--	--	--	--	--	--	
*24	Chromium (mg/L)	--	--	--	--	--	--	--	--	--	
*25	Lead (mg/L)	--	--	--	--	--	--	--	--	--	
*26	Cadmium (mg/L)	--	--	--	--	--	--	--	--	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulpide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

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** : The water depth measured from the top of bore holes to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley

Sample Location : M13

Number	Analyical Parameters	Sampling Date 12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	7.57	--	--	7.62	--	--	--	--	--	
4	Temperature (°C)	27.1	--	--	31	--	--	--	--	--	
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--	--	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	1100	--	--	940	--	--	--	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	--	--	--	--	--	--	--	--	
*8	Ammonical Nitrogen (mg-N/L)	920	--	--	1000	--	--	--	--	--	
*9	TKN (mg-N/L)	--	--	--	--	--	--	--	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--	--	--	--	
*12	Sodium (mg/L)	1000	--	--	1100	--	--	--	--	--	
*13	Potassium (mg/L)	--	--	--	--	--	--	--	--	--	
*14	Calcium (mg/L)	70	--	--	48	--	--	--	--	--	
*15	Magnesium (mg/L)	37	--	--	28	--	--	--	--	--	
*16	Chloride (mg/L)	1100	--	--	970	--	--	--	--	--	
*17	Sulphate (mg/L)	--	--	--	--	--	--	--	--	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	--	--	--	--	--	--	--	--	
*19	Iron (mg/L)	--	--	--	--	--	--	--	--	--	
*20	Manganese (mg/L)	--	--	--	--	--	--	--	--	--	
*21	Zinc (mg/L)	--	--	--	--	--	--	--	--	--	
*22	Copper (mg/L)	--	--	--	--	--	--	--	--	--	
*23	Nickel (mg/L)	--	--	--	--	--	--	--	--	--	
*24	Chromium (mg/L)	--	--	--	--	--	--	--	--	--	
*25	Lead (mg/L)	--	--	--	--	--	--	--	--	--	
*26	Cadmium (mg/L)	--	--	--	--	--	--	--	--	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulpide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

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** : The water depth measured from the top of bore holes to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley

Sample Location : S3A

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	7.12	--	--	--	--	--	--	--	--	
4	Temperature (°C)	27.7	--	--	--	--	--	--	--	--	
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--	--	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	740	--	--	--	--	--	--	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	--	--	--	--	--	--	--	--	
*8	Ammonical Nitrogen (mg-N/L)	680	--	--	--	--	--	--	--	--	
*9	TKN (mg-N/L)	--	--	--	--	--	--	--	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--	--	--	--	
*12	Sodium (mg/L)	760	--	--	--	--	--	--	--	--	
*13	Potassium (mg/L)	--	--	--	--	--	--	--	--	--	
*14	Calcium (mg/L)	77	--	--	--	--	--	--	--	--	
*15	Magnesium (mg/L)	38	--	--	--	--	--	--	--	--	
*16	Chloride (mg/L)	860	--	--	--	--	--	--	--	--	
*17	Sulphate (mg/L)	--	--	--	--	--	--	--	--	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	--	--	--	--	--	--	--	--	
*19	Iron (mg/L)	--	--	--	--	--	--	--	--	--	
*20	Manganese (mg/L)	--	--	--	--	--	--	--	--	--	
*21	Zinc (mg/L)	--	--	--	--	--	--	--	--	--	
*22	Copper (mg/L)	--	--	--	--	--	--	--	--	--	
*23	Nickel (mg/L)	--	--	--	--	--	--	--	--	--	
*24	Chromium (mg/L)	--	--	--	--	--	--	--	--	--	
*25	Lead (mg/L)	--	--	--	--	--	--	--	--	--	
*26	Cadmium (mg/L)	--	--	--	--	--	--	--	--	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulpide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore holes to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley **Sample Location : M8**

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	--	--	7.61	--	--	--	--	--	
4	Temperature (°C)	--	--	--	30.9	--	--	--	--	--	
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--	--	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	--	--	830	--	--	--	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	--	--	--	--	--	--	--	--	
*8	Ammonical Nitrogen (mg-N/L)	--	--	--	940	--	--	--	--	--	
*9	TKN (mg-N/L)	--	--	--	--	--	--	--	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--	--	--	--	
*12	Sodium (mg/L)	--	--	--	1000	--	--	--	--	--	
*13	Potassium (mg/L)	--	--	--	--	--	--	--	--	--	
*14	Calcium (mg/L)	--	--	--	52	--	--	--	--	--	
*15	Magnesium (mg/L)	--	--	--	27	--	--	--	--	--	
*16	Chloride (mg/L)	--	--	--	1000	--	--	--	--	--	
*17	Sulphate (mg/L)	--	--	--	--	--	--	--	--	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	--	--	--	--	--	--	--	--	
*19	Iron (mg/L)	--	--	--	--	--	--	--	--	--	
*20	Manganese (mg/L)	--	--	--	--	--	--	--	--	--	
*21	Zinc (mg/L)	--	--	--	--	--	--	--	--	--	
*22	Copper (mg/L)	--	--	--	--	--	--	--	--	--	
*23	Nickel (mg/L)	--	--	--	--	--	--	--	--	--	
*24	Chromium (mg/L)	--	--	--	--	--	--	--	--	--	
*25	Lead (mg/L)	--	--	--	--	--	--	--	--	--	
*26	Cadmium (mg/L)	--	--	--	--	--	--	--	--	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulpide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore holes to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley

Sample Location : GWMH

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
B	SUITE B FULL ANALYSIS										
1	Water Level (m)**	--	--	--	--	--	--	--	--	--	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	--	--	--	7.07	--	--	7.05	--	
4	Temperature (°C)	--	--	--	--	30.0	--	--	30.3	--	
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	230	--	--	150	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	--	--	--	390	--	--	480	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	--	--	--	27	--	--	22	--	
*8	Ammonical Nitrogen (mg-N/L)	--	--	--	--	600	--	--	610	--	
*9	TKN (mg-N/L)	--	--	--	--	620	--	--	620	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	<0.3	--	--	<0.3	--	
11	Orthophosphate (mg-P/L)	--	--	--	--	1.8	--	--	1.1	--	
*12	Sodium (mg/L)	--	--	--	--	710	--	--	680	--	
*13	Potassium (mg/L)	--	--	--	--	280	--	--	240	--	
*14	Calcium (mg/L)	--	--	--	--	95	--	--	14	--	
*15	Magnesium (mg/L)	--	--	--	--	35	--	--	30	--	
*16	Chloride (mg/L)	--	--	--	--	710	--	--	830	--	
*17	Sulphate (mg/L)	--	--	--	--	<5	--	--	<5	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	--	--	--	3100	--	--	3100	--	
*19	Iron (mg/L)	--	--	--	--	8.5	--	--	6.9	--	
*20	Manganese (mg/L)	--	--	--	--	3	--	--	2.5	--	
*21	Zinc (mg/L)	--	--	--	--	<0.03	--	--	<0.03	--	
*22	Copper (mg/L)	--	--	--	--	<0.02	--	--	<0.02	--	
*23	Nickel (mg/L)	--	--	--	--	0.04	--	--	0.1	--	
*24	Chromium (mg/L)	--	--	--	--	<0.02	--	--	0.1	--	
*25	Lead (mg/L)	--	--	--	--	0.1	--	--	<0.04	--	
*26	Cadmium (mg/L)	--	--	--	--	<0.01	--	--	<0.01	--	
*27	Suspended Solids (mg/L)	--	--	--	--	27	--	--	11	--	
28	Settleable Solids (mg/L)	--	--	--	--	11	--	--	5	--	
29	Oil & Grease (mg/L)	--	--	--	--	<10	--	--	<10	--	
30	Boron (mg/L)	--	--	--	--	1	--	--	0.6	--	
*31	Barium (mg/L)	--	--	--	--	1.5	--	--	1	--	
32	Mecury (ug/L)	--	--	--	--	<1	--	--	<1	--	
33	Ag (mg/L)	--	--	--	--	<0.1	--	--	<0.1	--	
34	Cyanide (mg/L)	--	--	--	--	<0.01	--	--	<0.01	--	
35	Phenol (mg/L)	--	--	--	--	<0.1	--	--	<0.1	--	
36	Sulpide (mg/L)	--	--	--	--	<0.1	--	--	<0.1	--	
37	Total Surfactants (mg/L)	--	--	--	--	0.6	--	--	0.7	--	
38	E.Coli (No./100mL)	--	--	--	--	<1	--	--	<1	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore holes to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESULTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley

Sample Location : DH103

Top Level of Well : 17.66 mPD

Bottom Level of Well : 6.68 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
A	SUITE A FULL ANALYSIS										
1	Water Level (m)**	8.37	8.38	8.38	8.57	8.4	8.39	8.4	8.53	8.37	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	6.5	--	--	--	--	--	--	7.40	--	
4	Temperature (°C)	25.8	--	--	--	--	--	--	27.7	--	
5	Total Organic Carbon (TOC) (mg/L)	<0.3	--	--	--	--	--	--	4	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	28	--	--	--	--	--	--	13	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	<5	--	--	--	--	--	--	<5	--	
*8	Ammonical Nitrogen (mg-N/L)	<0.1	--	--	--	--	--	--	<0.3	--	
*9	TKN (mg-N/L)	<0.1	--	--	--	--	--	--	0.3	--	
*10	Total Oxidized Nitrogen (mg-N/L)	5.4	--	--	--	--	--	--	4.1	--	
11	Orthophosphate (mg-P/L)	<0.2	--	--	--	--	--	--	<0.2	--	
*12	Sodium (mg/L)	23	--	--	--	--	--	--	28	--	
*13	Potassium (mg/L)	5.5	--	--	--	--	--	--	3.4	--	
*14	Calcium (mg/L)	4.3	--	--	--	--	--	--	4.7	--	
*15	Magnesium (mg/L)	1	--	--	--	--	--	--	1	--	
*16	Chloride (mg/L)	15	--	--	--	--	--	--	15	--	
*17	Sulphate (mg/L)	50	--	--	--	--	--	--	13	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	19	--	--	--	--	--	--	24	--	
*19	Iron (mg/L)	4	--	--	--	--	--	--	0.6	--	
*20	Manganese (mg/L)	0.07	--	--	--	--	--	--	<0.04	--	
*21	Zinc (mg/L)	0.05	--	--	--	--	--	--	0.1	--	
*22	Copper (mg/L)	0.03	--	--	--	--	--	--	<0.02	--	
*23	Nickel (mg/L)	<0.03	--	--	--	--	--	--	0.1	--	
*24	Chromium (mg/L)	<0.02	--	--	--	--	--	--	<0.02	--	
*25	Lead (mg/L)	0.12	--	--	--	--	--	--	<0.04	--	
*26	Cadmium (mg/L)	<0.01	--	--	--	--	--	--	<0.01	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulpide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

* : These testing parameters are accerdited under Hong Kong Laboratory Accredited Scheme (HOKLAS).
For those non-accerdited parameters, HKPC shall follow the same QA/QC procedures in the analysis works as required by HOKLAS.

** : The water depth measured from the top of bore hole to water surface in the bore hole.

GROUNDWATER\LEACHATE\SURFACE WATER ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST NEW TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley

Sample Location : DH106

Top Level of Well : 114.86 mPD

Bottom Level of Well : 82.15 mPD

Number	Analyical Parameters	Sampling Date									
		12/94	01/95	02/95	03/95	04/95	05/95	06/95	07/95	08/95	09/95
A	SUITE A FULL ANALYSIS										
1	Water Level (m)**	No Water	No Water	No Water	No Water	No water	31.06	31.06	No water	No water	
2	Water Flow Rate (L/s)	--	--	--	--	--	--	--	--	--	
*3	pH	--	--	--	--	--	--	--	--	--	
4	Temperature (°C)	--	--	--	--	--	--	--	--	--	
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--	--	--	--	
*6	Chemical Oxygen Demand (COD) (mg/L)	--	--	--	--	--	--	--	--	--	
*7	5-day Biochemical Oxygen Demand (BOD_5) (mg/L)	--	--	--	--	--	--	--	--	--	
*8	Ammonical Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
*9	TKN (mg-N/L)	--	--	--	--	--	--	--	--	--	
*10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--	--	--	--	
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--	--	--	--	
*12	Sodium (mg/L)	--	--	--	--	--	--	--	--	--	
*13	Potassium (mg/L)	--	--	--	--	--	--	--	--	--	
*14	Calcium (mg/L)	--	--	--	--	--	--	--	--	--	
*15	Magnesium (mg/L)	--	--	--	--	--	--	--	--	--	
*16	Chloride (mg/L)	--	--	--	--	--	--	--	--	--	
*17	Sulphate (mg/L)	--	--	--	--	--	--	--	--	--	
*18	Alkalinity (as $CaCO_3$) (mg/L)	--	--	--	--	--	--	--	--	--	
*19	Iron (mg/L)	--	--	--	--	--	--	--	--	--	
*20	Manganese (mg/L)	--	--	--	--	--	--	--	--	--	
*21	Zinc (mg/L)	--	--	--	--	--	--	--	--	--	
*22	Copper (mg/L)	--	--	--	--	--	--	--	--	--	
*23	Nickel (mg/L)	--	--	--	--	--	--	--	--	--	
*24	Chromium (mg/L)	--	--	--	--	--	--	--	--	--	
*25	Lead (mg/L)	--	--	--	--	--	--	--	--	--	
*26	Cadmium (mg/L)	--	--	--	--	--	--	--	--	--	
*27	Suspended Solids (mg/L)	--	--	--	--	--	--	--	--	--	
28	Settleable Solids (mg/L)	--	--	--	--	--	--	--	--	--	
29	Oil & Grease (mg/L)	--	--	--	--	--	--	--	--	--	
30	Boron (mg/L)	--	--	--	--	--	--	--	--	--	
*31	Barium (mg/L)	--	--	--	--	--	--	--	--	--	
32	Mecury (ug/L)	--	--	--	--	--	--	--	--	--	
33	Ag (mg/L)	--	--	--	--	--	--	--	--	--	
34	Cyanide (mg/L)	--	--	--	--	--	--	--	--	--	
35	Phenol (mg/L)	--	--	--	--	--	--	--	--	--	
36	Sulpide (mg/L)	--	--	--	--	--	--	--	--	--	
37	Total Surfactants (mg/L)	--	--	--	--	--	--	--	--	--	
38	E.Coli (No./100mL)	--	--	--	--	--	--	--	--	--	

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** : The water depth measured from the top of bore holes to water surface in the bore hole.

Landfill Gas Monitoring Results
for
Pillar Point Valley Landfill

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley Landfill   Sample Location : DH106

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	12.1.95	7.2.95	7.3.95	6.4.95	2.5.95	8.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	>100	>100	>100	>100	>100	>100			42	
2	Methane (% v/v)	60.9	60.9	60.6	62.4	62.6	19.9			2.1	
3	CO_2 (% v/v)	38.6	38.4	38.5	36.9	37.0	13.0			3.1	
4	O_2 (% v/v)	0.4	0.1	0.4	0.2	0.2	13.9	Covered	Covered	20.0	
5	Barometric Pressure (m Bar)*	1011	1004	1005	1003	1000	997			1003	
6	Gas Pressure (Pascal)**	1966	100	70	30	29	Cap broke			0	
7	Gas Temperature (°C)	36.8	33.1	36.8	34.7	18.2	30.7			29.6	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)						0				
2	Methane (ppm v/v)										
3	CO_2 (% v/v)						0				
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)						21.92				
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)						74.48				
8	CO (ppm v/v)						0				
9	H_2 (ppm v/v)						0				

* : Absolute atmospheric pressure.

** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley Landfill Sample Location : A152

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	12.1.95	7.2.95	7.3.95	6.4.95	2.5.95	8.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	>100	>100	>100	>100	>100	>100	>100	>100	>100	
2	Methane (% v/v)	63.3	63.3	63.5	64.5	64.3	63.8	61.8	63.3	69.5	
3	CO_2 (% v/v)	35.1	34.0	33.6	33.5	31.6	32.5	32.6	28.0	24.3	
4	O_2 (% v/v)	0.3	0.1	0.3	0.1	0.1	0.6	0.2	0.9	0.3	
5	Barometric Pressure (m Bar)*	1020	1014	1014	1012	1009	1005	995	1000	1003	
6	Gas Pressure (Pascal)**	1192	78	15	-134	74	15	11	12	19	
7	Gas Temperature (°C)	-	-	-	-	-	-	-	-	-	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)			65.0				71.66			
2	Methane (ppm v/v)										
3	CO_2 (% v/v)			31.0				27.36			
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)			0.3				1.04			
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)			2.0				5.04			
8	CO (ppm v/v)			0.0				0			
9	H_2 (ppm v/v)			0.0				0			

* : Absolute atmospheric pressure.

** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley Landfill Sample Location : DH103

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	12.1.95	7.2.95	7.3.95	6.4.95	2.5.95	8.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	0.0	4.0	0.0	0.0	0.0	4.0	0.0	0.0	0.0	
2	Methane (% v/v)	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	
3	CO_2 (% v/v)	5.0	5.2	5.2	5.1	4.7	4.5	4.6	1.3	5.2	
4	O_2 (% v/v)	13.8	13.4	13.9	14.4	15.5	15.8	15.7	19.9	14.0	
5	Barometric Pressure (m Bar)*	1024	1017	1016	1015	1012	1009	998	1002	1005	
6	Gas Pressure (Pascal)**	0	7	-2	-7	-9	0	0	0	0	
7	Gas Temperature (°C)	20.6	18.3	20.6	22.9	19.3	31.1	2[illegible].9	30.5	30.2	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)				0.0					0	
2	Methane (ppm v/v)										
3	CO_2 (% v/v)				5.4					12.47	
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)				18.0					13.58	
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)				57.0					81.53	
8	CO (ppm v/v)				0.0					0	
9	H_2 (ppm v/v)				0.0					0	

* : Absolute atmospheric pressure.
** : Pressure relative to atmospheric pressure.

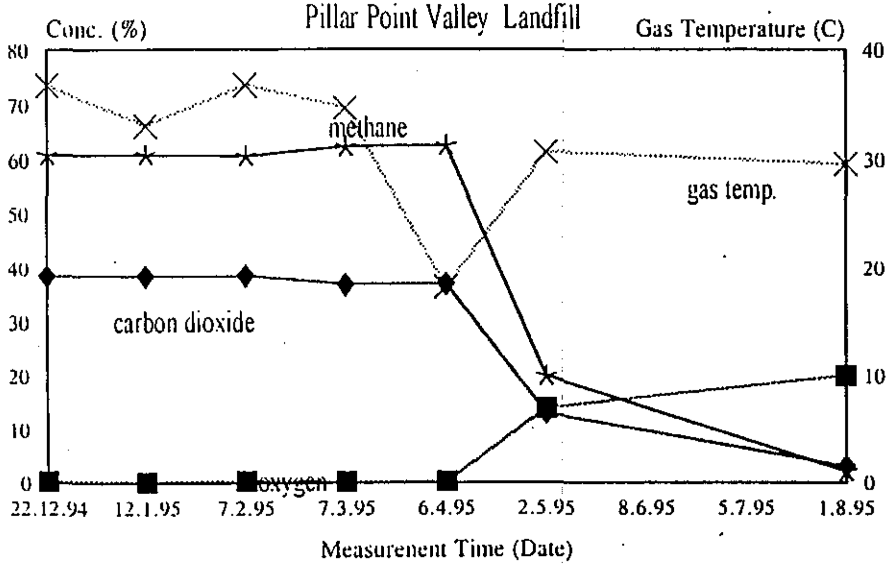
LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Pillar Point Valley Landfill　　　　Sample Location : A151

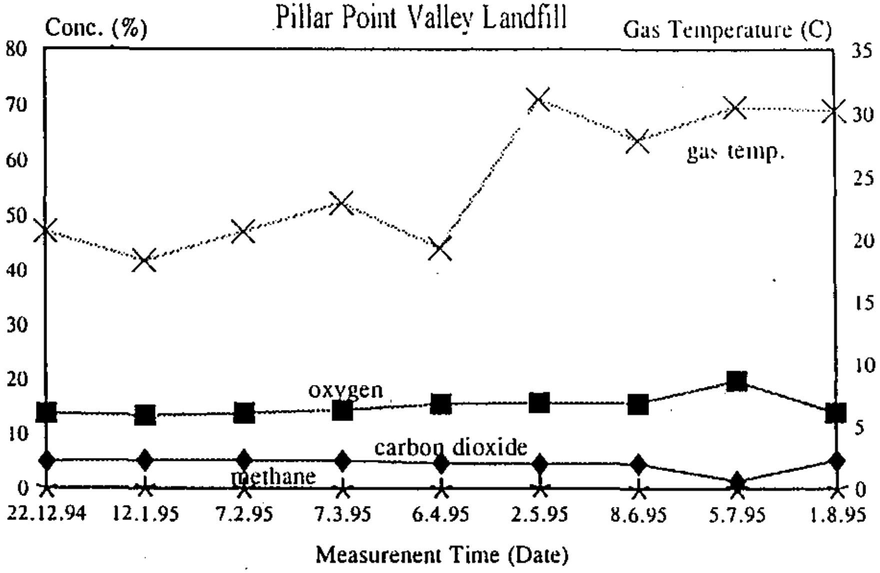
Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	12.1.95	7.2.95	7.3.95	6.4.95	2.5.95	8.6.95	5.7.95	1.8.95	
	LANDFILL GAS – FIELD MEASUREMENT										
1	Methane (% LEL)	>100	>100	>100	>100	>100	>100	>100	>100		
2	Methane (% v/v)	58.8	58.0	57.1	58.1	58.7	56.8	56.8	54.5		
3	CO_2 (% v/v)	48.8	40.8	47.9	40.8	41.7	42.3	42.8	42.5	Cover	
4	O_2 (% v/v)	0.3	0.2	0.4	0.3	0.7	0.7	0.2	1.8	by	
5	Barometric Pressure (m Bar)*	1007	1002	1001	1000	997	993	984	988	rubbish	
6	Gas Pressure (Pascal)**	1108	89	50	-43	93	[illegible]	15	50		
7	Gas Temperature (°C)	–	–	–	–	–	–	–	–		
	LANDFILL GAS – LABORATORY TEST										
1	Methane (% v/v)		63.0			63.95			65.86		
2	Methane (ppm v/v)										
3	CO_2 (% v/v)		36.0			38.89			34.39		
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)		1.0			0			2.03		
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)		2.0			1.74			6.82		
8	CO (ppm v/v)		0.0			0			0		
9	H_2 (ppm v/v)		0.0			0			0		

* : Absolute atmospheric pressure.
** : Pressure relative to atmospheric pressure.

DH106 - Composition of Landfill Gas (Field Measurement)

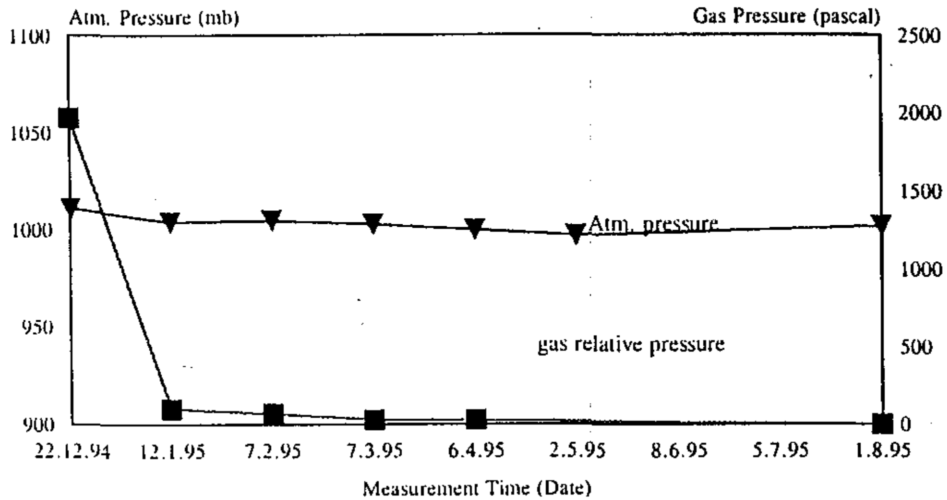


DH103 - Composition of Landfill Gas (Field Measurement)



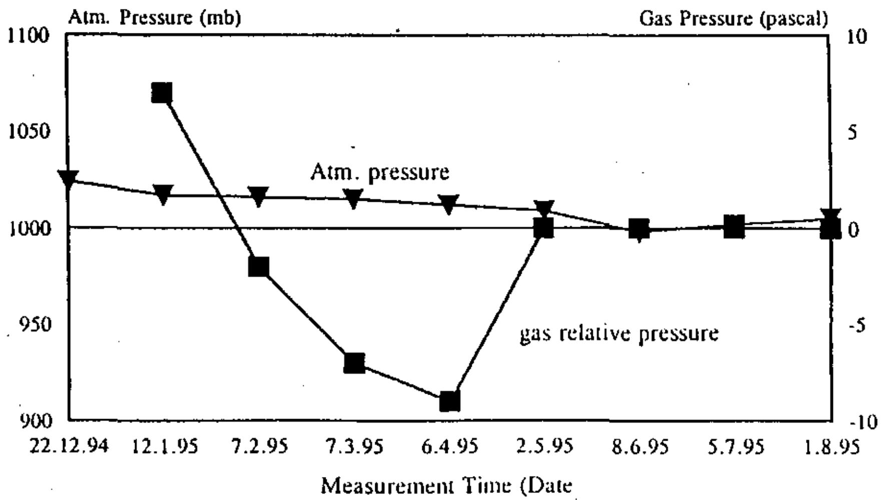
DH106 - Atmospheric Pressure & Gas Relative Pressure

Pillar Point Valley Landfill

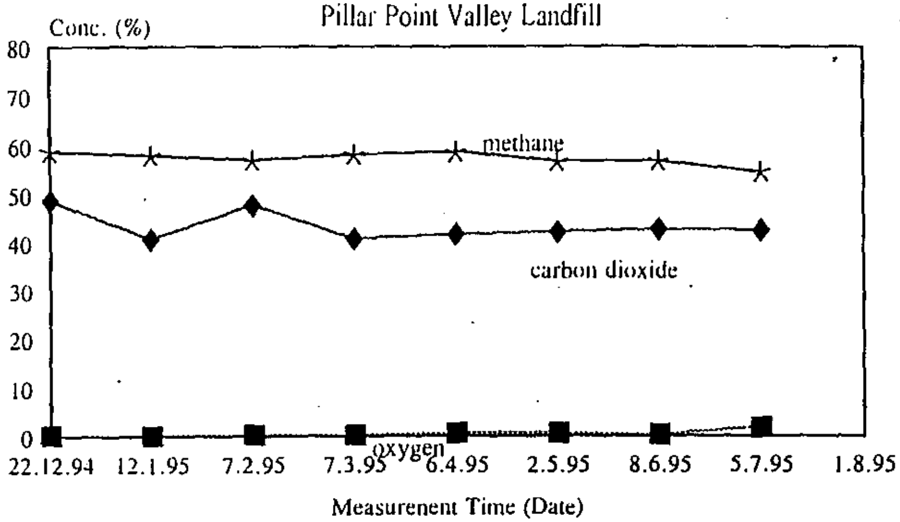


DH103 - Atmospheric Pressure & Gas Relative Pressure

Pillar Point Valley Landfill

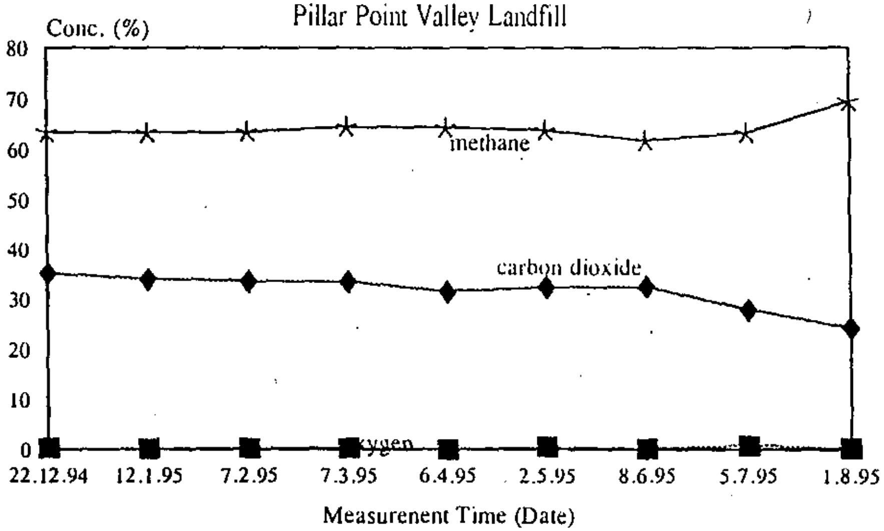


A151 - Composition of Landfill Gas (Field Measurement)
Pillar Point Valley Landfill

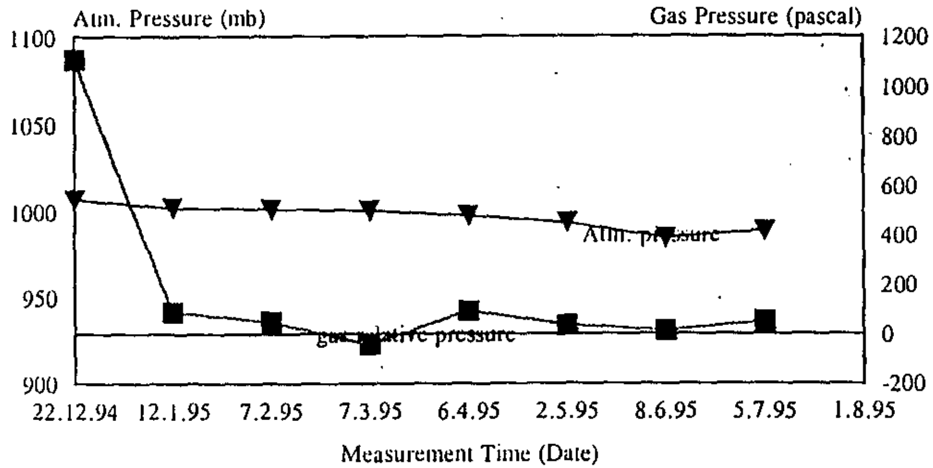


* The monitoring well was covered by rubbish in August 95 and there was no monitoring data

A152 - Composition of Landfill Gas (Field Measurement)
Pillar Point Valley Landfill

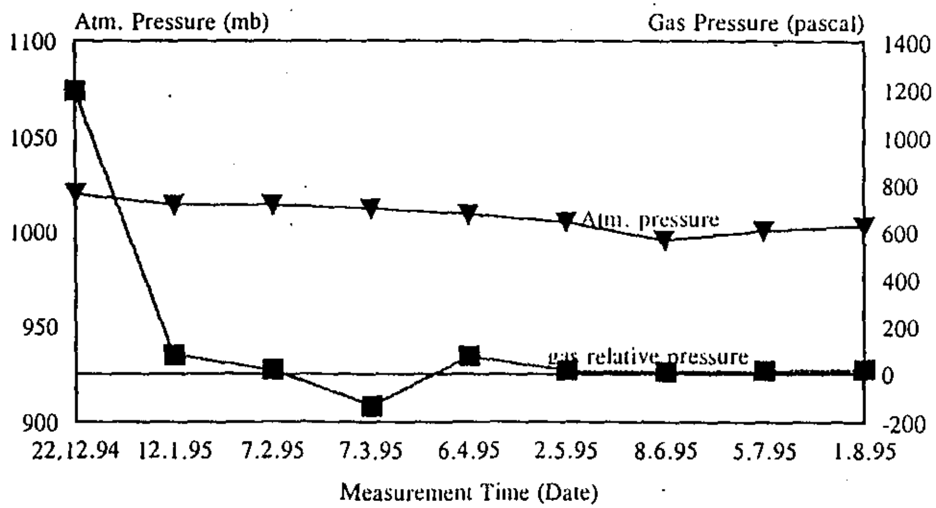


A151 - Atmospheric Pressure & Gas Relative Pressure
Pillar Point Valley Landfill



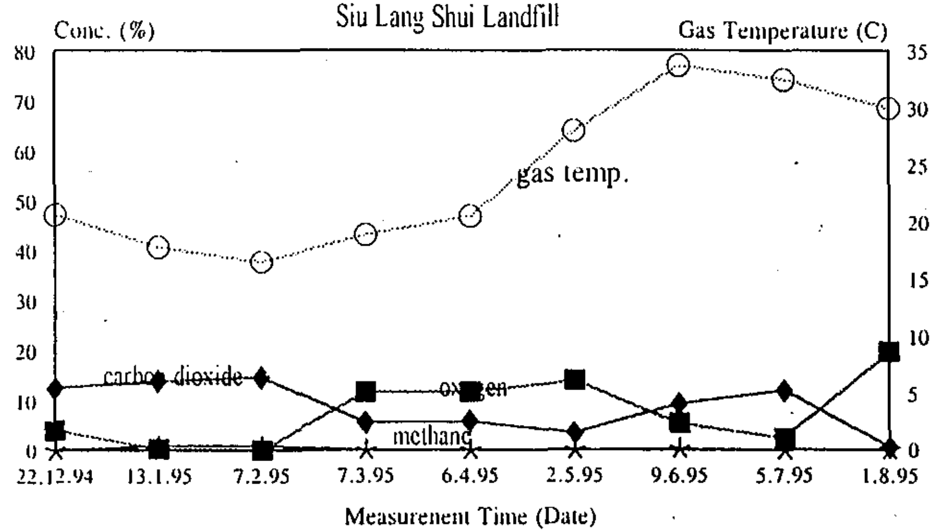
* The monitoring well was covered by rubbish in August 95 and there was no monitoring data

A152 - Atmospheric Pressure & Gas Relative Pressure
Pillar Point Valley Landfill



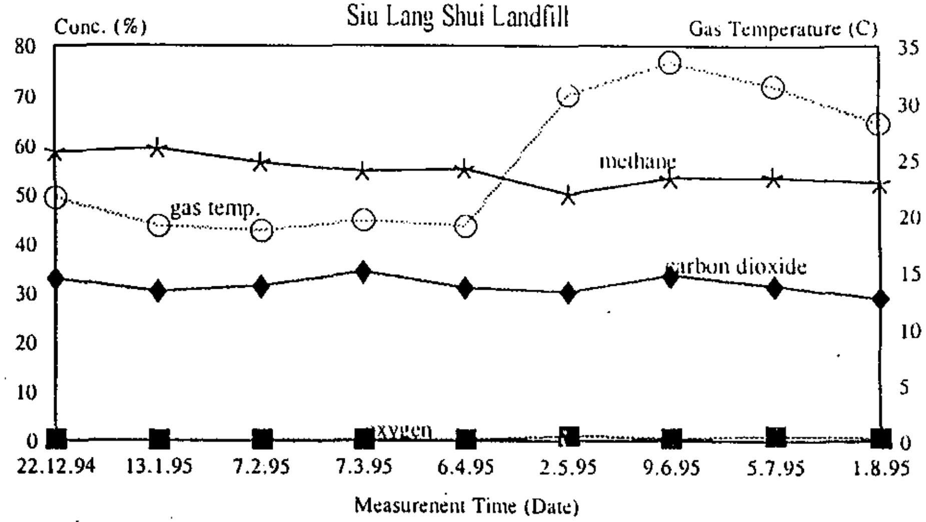
DH204 - Composition of Landfill Gas (Field Measurement)

Siu Lang Shui Landfill



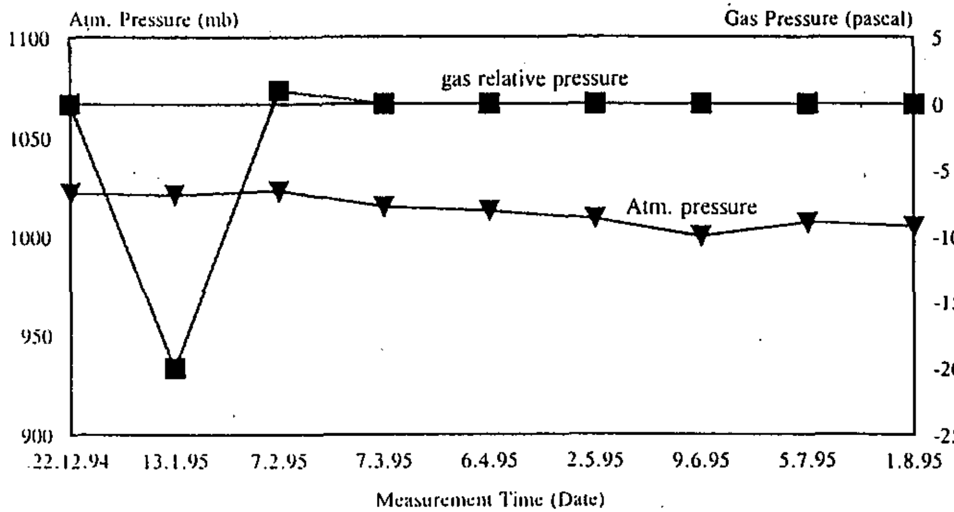
DH207 - Composition of Landfill Gas (Field Measurement)

Siu Lang Shui Landfill



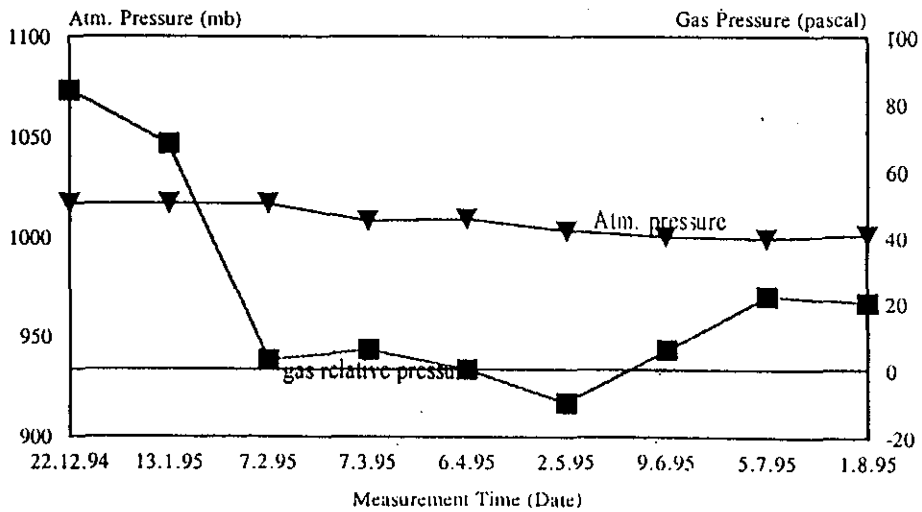
DH204 - Atmospheric Pressure & Gas Relative Pressure

Siu Lang Shui Landfill

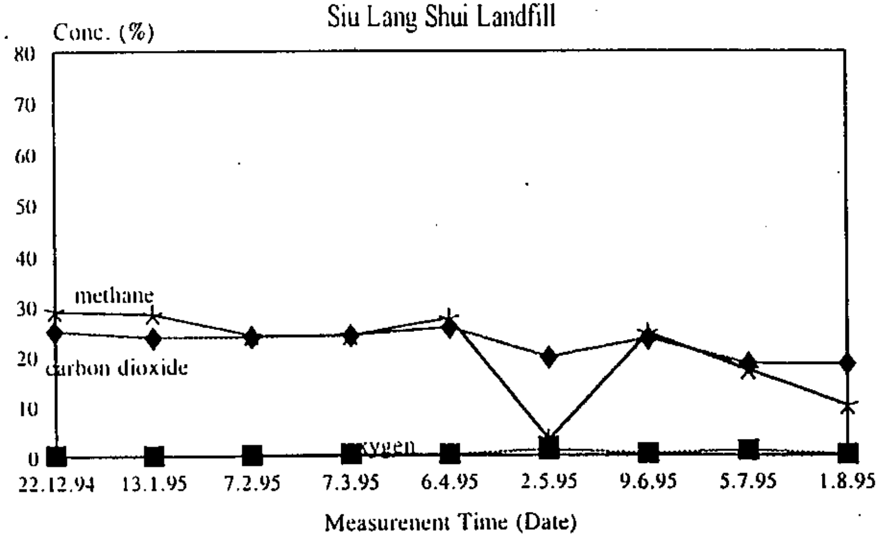


DH207 - Atmospheric Pressure & Gas Relative Pressure

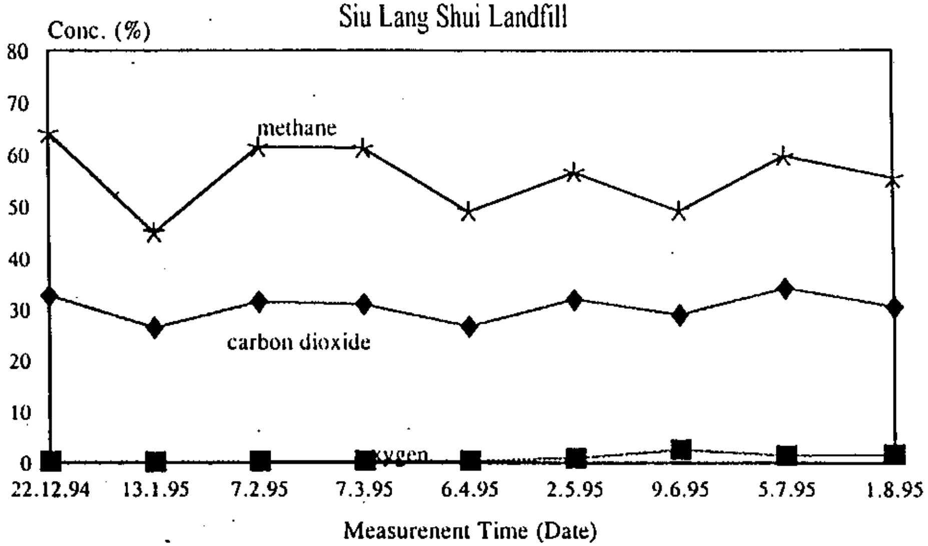
Siu Lang Shui Landfill



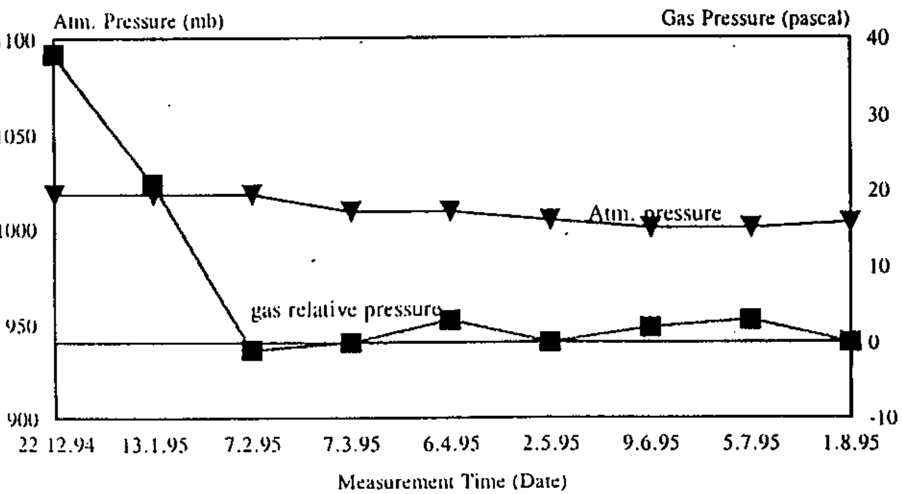
DP219 - Composition of Landfill Gas (Field Measurement)
Siu Lang Shui Landfill



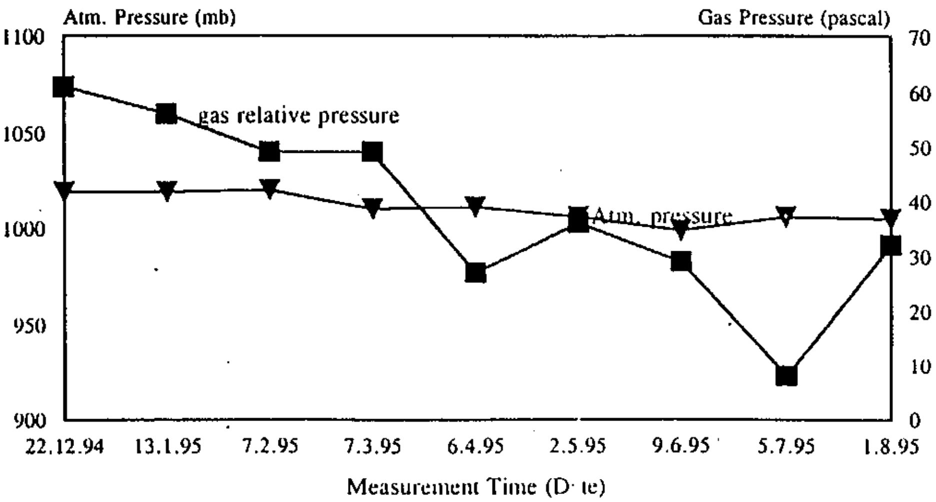
DP217 - Composition of Landfill Gas (Field Measurement)
Siu Lang Shui Landfill

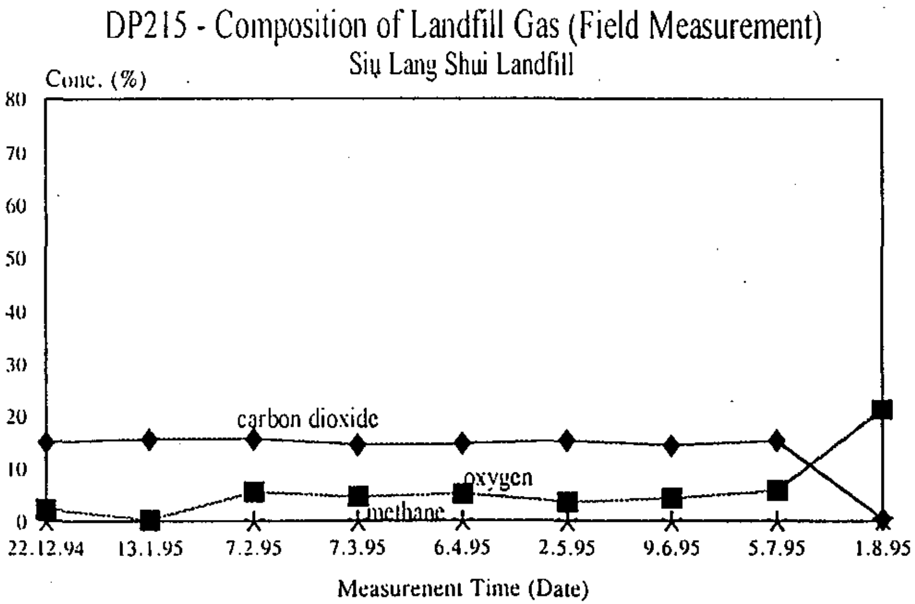


DP219 - Atmospheric Pressure & Gas Relative Pressure
Siu Lang Shui Landfill

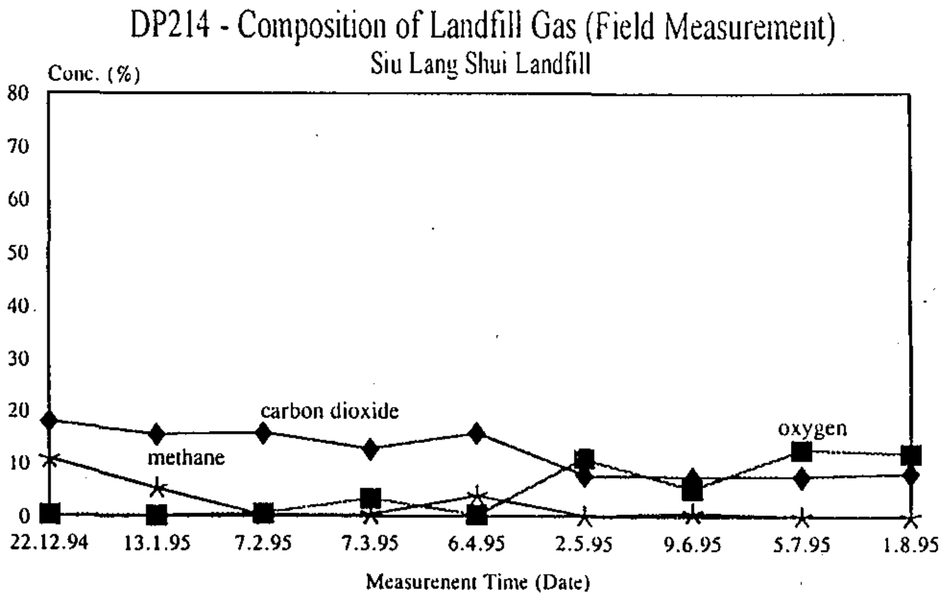


DP217 - Atmospheric Pressure & Gas Relative Pressure
Siu Lang Shui Landfill

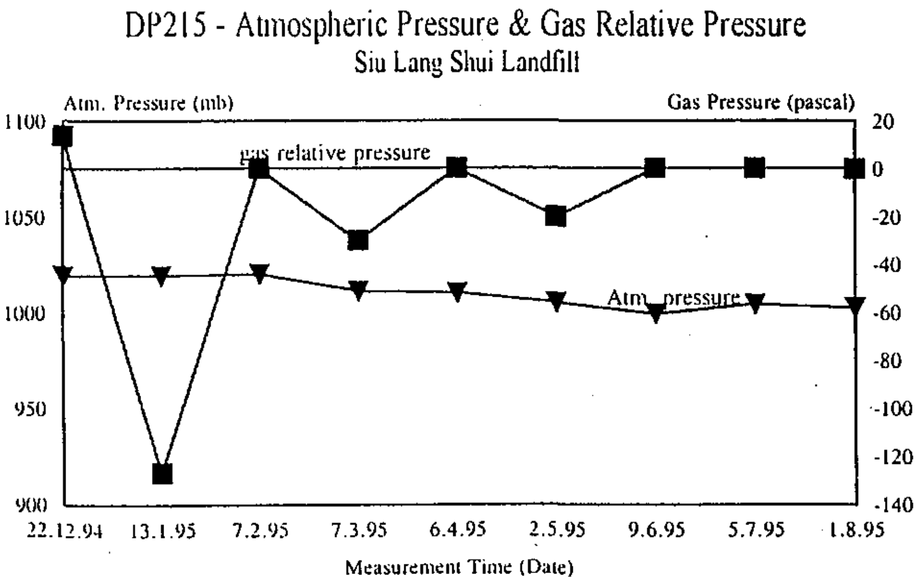




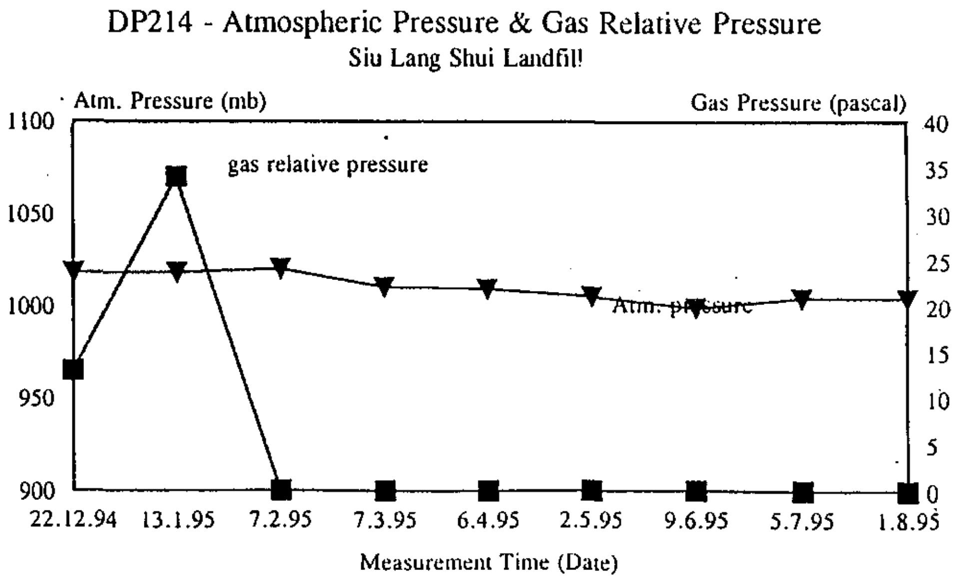
DP215 - Composition of Landfill Gas (Field Measurement)
Siu Lang Shui Landfill
Conc. (%)
80
70
60
50
40
30
20
10
0
carbon dioxide
oxygen
methane
22.12.94
13.1.95
7.2.95
7.3.95
6.4.95
2.5.95
9.6.95
5.7.95
1.8.95
Measurenent Time (Date)



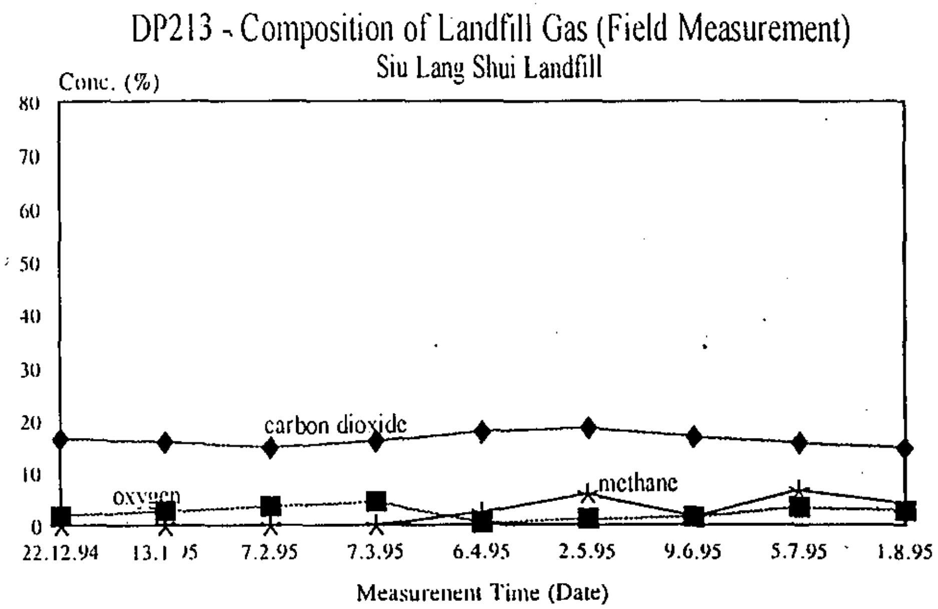
DP214 - Composition of Landfill Gas (Field Measurement)
Siu Lang Shui Landfill
Conc. (%)
80
70
60
50
40
30
20
10
0
carbon dioxide
methane
oxygen
22.12.94
13.1.95
7.2.95
7.3.95
6.4.95
2.5.95
9.6.95
5.7.95
1.8.95
Measurenent Time (Date)

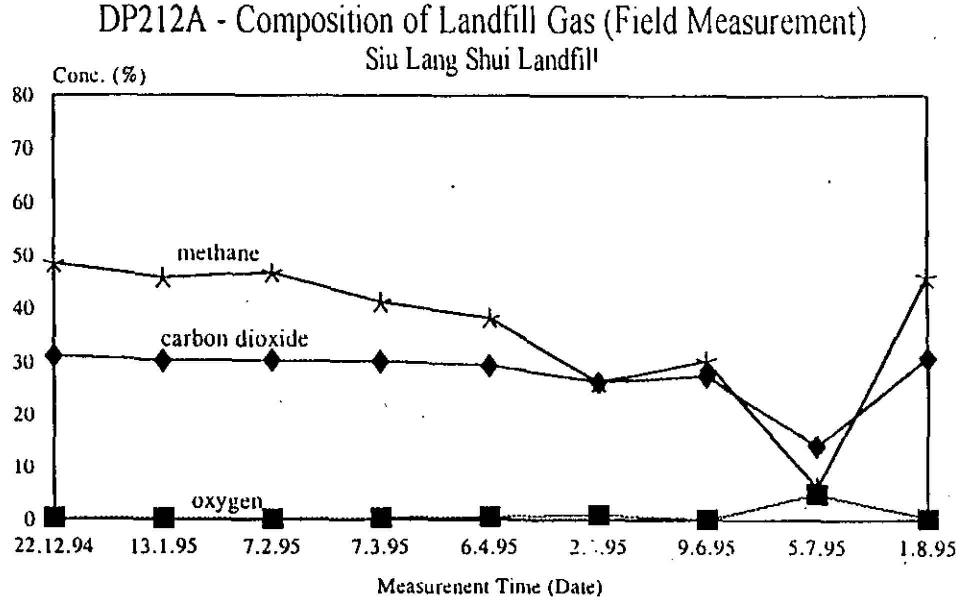


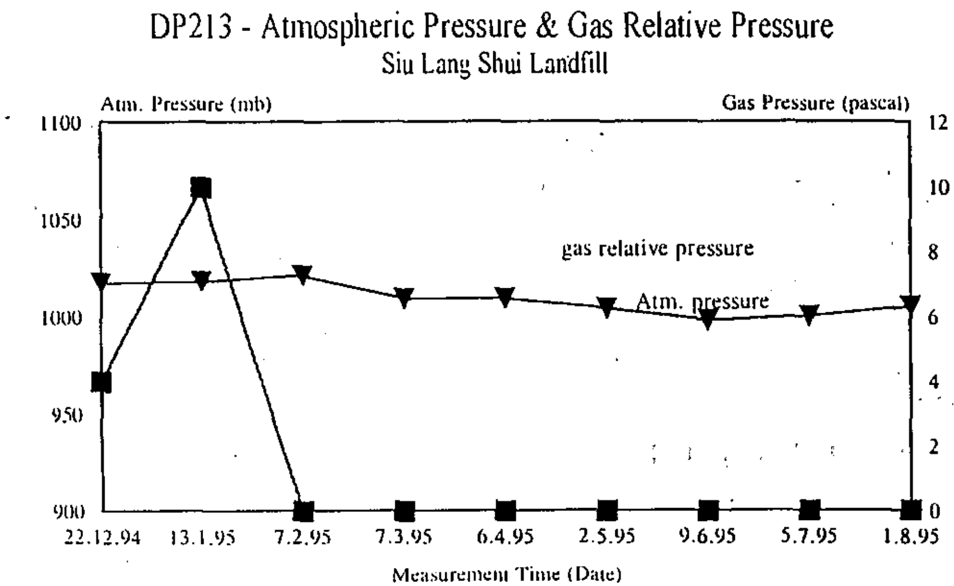
DP215 - Atmospheric Pressure & Gas Relative Pressure
Siu Lang Shui Landfill
Atm. Pressure (mb)
Gas Pressure (pascal)
1100
1050
1000
950
900
20
0
-20
-40
-60
-80
-100
-120
-140
gas relative pressure
Atm. pressure
22.12.94
13.1.95
7.2.95
7.3.95
6.4.95
2.5.95
9.6.95
5.7.95
1.8.95
Measurement Time (Date)

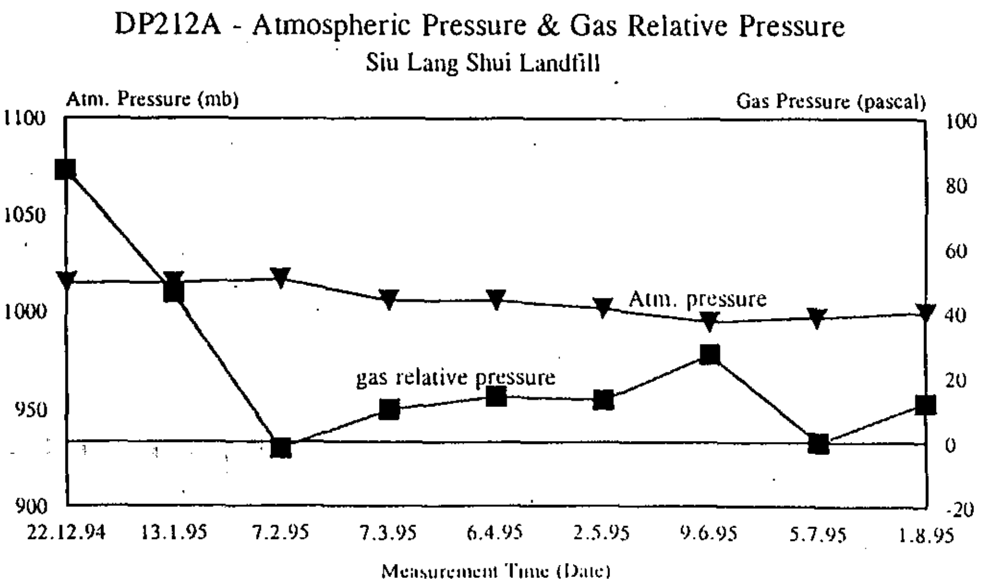


DP214 - Atmospheric Pressure & Gas Relative Pressure
Siu Lang Shui Landfill
Atm. Pressure (mb)
Gas Pressure (pascal)
1100
1050
1000
950
900
40
35
30
25
20
15
10
5
0
gas relative pressure
Atm. pressure
22.12.94
13.1.95
7.2.95
7.3.95
6.4.95
2.5.95
9.6.95
5.7.95
1.8.95
Measurement Time (Date)


DP213 - Composition of Landfill Gas (Field Measurement)
Siu Lang Shui Landfill
Conc. (%)
carbon dioxide
oxygen
methane
22.12.94
7.2.95
7.3.95
6.4.95
2.5.95
9.6.95
5.7.95
1.8.95
Measurement Time (Date)


DP212A - Composition of Landfill Gas (Field Measurement)
Siu Lang Shui Landfill
Conc. (%)
methane
carbon dioxide
oxygen
22.12.94
13.1.95
7.2.95
7.3.95
6.4.95
9.6.95
5.7.95
1.8.95
Measurement Time (Date)


DP213 - Atmospheric Pressure & Gas Relative Pressure
Siu Lang Shui Landfill
Atm. Pressure (mb)
Gas Pressure (pascal)
gas relative pressure
Atm. pressure
22.12.94
13.1.95
7.2.95
7.3.95
6.4.95
2.5.95
9.6.95
5.7.95
1.8.95
Measurement Time (Date)


DP212A - Atmospheric Pressure & Gas Relative Pressure
Siu Lang Shui Landfill
Atm. Pressure (mb)
Gas Pressure (pascal)
Atm. pressure
gas relative pressure
22.12.94
13.1.95
7.2.95
7.3.95
6.4.95
2.5.95
9.6.95
5.7.95
1.8.95
Measurement Time (Date)

Inchcape Testing Services
Labtest

Inchcape Testing Services
Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 1 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DH201

Number	Analytical Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Water Level (m)*	5.20	5.55	5.17	4.30	5.30	5.40
2	Water Flow Rate (L/s)	--	--	--	--	--	--
3	pH	--	7.5	--	--	7.6	--
4	Temperature (C)	--	25.5	--	--	21.2	--
5	Total Organic Carbon (TOC) (mg/L)	--	190	--	--	--	--
6	Chemical Oxygen Demand (mg/L)	--	720	--	--	940	--
7	Biochemical Oxygen Demand (mg/L)	--	50	--	--	--	--
8	Ammonical Nitrogen (mg-N/L)	--	790	--	--	1300	--
9	TKN (mg-N/L)	--	840	--	--	--	--
10	Total Oxidized Nitrogen (mg-N/L)	--	22	--	--	--	--
11	Orthophosphate (mg-P/L)	--	1.1	--	--	--	--
12	Sodium (mg/L)	--	630	--	--	--	--
13	Potassium (mg/L)	--	190	--	--	--	--
14	Calcium (mg/L)	--	90	--	--	--	--
15	Magnesium (mg/L)	--	27	--	--	--	--
16	Chloride (mg/L)	--	700	--	--	--	--
17	Sulphate (mg/L)	--	32	--	--	--	--
18	Alkalinity (mg CaCO3/L)	--	4300	--	--	--	--
19	Iron (mg/L)	--	7.8	--	--	--	--
20	Manganese (mg/L)	--	2.4	--	--	--	--
21	Zinc (mg/L)	--	0.08	--	--	--	--
22	Copper (mg/L)	--	<0.02	--	--	--	--
23	Nickel (mg/L)	--	0.06	--	--	--	--
24	Chromium (mg/L)	--	0.72	--	--	--	--
25	Lead (mg/L)	--	0.26	--	--	--	--
26	Cadmium (mg/L)	--	<0.01	--	--	--	--
27	Suspended Solids (mg/L)	--	370	--	--	--	--
28	Settleable Solids (ml/L)	--	<5	--	--	--	--
29	Oil & Grease (mg/L)	--	<10	--	--	--	--
30	Boron (mg/L)	--	1.9	--	--	--	--
31	Barium (mg/L)	--	<1	--	--	--	--
32	Mercury (mg/L)	--	0.19	--	--	--	--
33	Ag (mg/L)	--	<0.1	--	--	--	--
34	Cyanide (mg/L)	--	<1	--	--	--	--
35	Phenol (mg/L)	--	<0.1	--	--	--	--
36	Sulphide (mg/L)	--	<0.1	--	--	--	--
37	Surfactants (Total) (mg/L)	--	1.5	--	--	--	--
38	E. coli (No/100ml)	--	Nil	--	--	--	--

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 2 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DH203A

Number	Analytical Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Water Level (m)*	6.91	No water	7.14	No water	No water	No water
2	Water Flow Rate (L/s)	--	--	--	--	--	--
3	pH	--	--	--	--	--	--
4	Temperature (C)	--	--	--	--	--	--
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--
6	Chemical Oxygen Demand (mg/L)	--	--	--	--	--	--
7	Biochemical Oxygen Demand (mg/L)	--	--	--	--	--	--
8	Ammonical Nitrogen (mg-N/L)	--	--	--	--	--	--
9	TKN (mg-N/L)	--	--	--	--	--	--
10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--
12	Sodium (mg/L)	--	--	--	--	--	--
13	Potassium (mg/L)	--	--	--	--	--	--
14	Calcium (mg/L)	--	--	--	--	--	--
15	Magnesium (mg/L)	--	--	--	--	--	--
16	Chloride (mg/L)	--	--	--	--	--	--
17	Sulphate (mg/L)	--	--	--	--	--	--
18	Alkalinity (mg CaCO3/L)	--	--	--	--	--	--
19	Iron (mg/L)	--	--	--	--	--	--
20	Manganese (mg/L)	--	--	--	--	--	--
21	Zinc (mg/L)	--	--	--	--	--	--
22	Copper (mg/L)	--	--	--	--	--	--
23	Nickel (mg/L)	--	--	--	--	--	--
24	Chromium (mg/L)	--	--	--	--	--	--
25	Lead (mg/L)	--	--	--	--	--	--
26	Cadmium (mg/L)	--	--	--	--	--	--
27	Suspended Solids (mg/L)	--	--	--	--	--	--
28	Settleable Solids (ml/L)	--	--	--	--	--	--
29	Oil & Grease (mg/L)	--	--	--	--	--	--
30	Boron (mg/L)	--	--	--	--	--	--
31	Barium (mg/L)	--	--	--	--	--	--
32	Mercury (mg/L)	--	--	--	--	--	--
33	Ag (mg/L)	--	--	--	--	--	--
34	Cyanide (mg/L)	--	--	--	--	--	--
35	Phenol (mg/L)	--	--	--	--	--	--
36	Sulphide (mg/L)	--	--	--	--	--	--
37	Surfactants (Total) (mg/L)	--	--	--	--	--	--
38	E. coli (No/100ml)	--	--	--	--	--	--

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.

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Fax (852) 2786 1903

TABLE 3 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DH204

Number	Analytical Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Water Level (m)*	2.45	2.70	3.05	3.40	3.70	3.80
2	Water Flow Rate (L/s)	--	--	--	--	--	--
3	pH	--	7.5	--	--	8.1	--
4	Temperature (C)	--	26.5	--	--	21.6	--
5	Total Organic Carbon (TOC) (mg/L)	--	240	--	--	--	--
6	Chemical Oxygen Demand (mg/L)	--	880	--	--	1900	--
7	Biochemical Oxygen Demand (mg/L)	--	94	--	--	--	--
8	Ammonical Nitrogen (mg-N/L)	--	1300	--	--	3200	--
9	TKN (mg-N/L)	--	1400	--	--	--	--
10	Total Oxidized Nitrogen (mg-N/L)	--	7.9	--	--	--	--
11	Orthophosphate (mg-P/L)	--	5.2	--	--	--	--
12	Sodium (mg/L)	--	630	--	--	--	--
13	Potassium (mg/L)	--	240	--	--	--	--
14	Calcium (mg/L)	--	82	--	--	--	--
15	Magnesium (mg/L)	--	17	--	--	--	--
16	Chloride (mg/L)	--	970	--	--	--	--
17	Sulphate (mg/L)	--	33	--	--	--	--
18	Alkalinity (mg CaCO3/L)	--	8400	--	--	--	--
19	Iron (mg/L)	--	5.8	--	--	--	--
20	Manganese (mg/L)	--	2.4	--	--	--	--
21	Zinc (mg/L)	--	0.08	--	--	--	--
22	Copper (mg/L)	--	0.08	--	--	--	--
23	Nickel (mg/L)	--	0.06	--	--	--	--
24	Chromium (mg/L)	--	0.76	--	--	--	--
25	Lead (mg/L)	--	0.05	--	--	--	--
26	Cadmium (mg/L)	--	<0.01	--	--	--	--
27	Suspended Solids (mg/L)	--	56	--	--	--	--
28	Settleable Solids (ml/L)	--	<5	--	--	--	--
29	Oil & Grease (mg/L)	--	<10	--	--	--	--
30	Boron (mg/L)	--	2.0	--	--	--	--
31	Barium (mg/L)	--	<1	--	--	--	--
32	Mercury (mg/L)	--	<0.001	--	--	--	--
33	Ag (mg/L)	--	<0.1	--	--	--	--
34	Cyanide (mg/L)	--	<1	--	--	--	--
35	Phenol (mg/L)	--	<0.1	--	--	--	--
36	Sulphide (mg/L)	--	<0.1	--	--	--	--
37	Surfactants (Total) (mg/L)	--	1.3	--	--	--	--
38	E. coli (No/100ml)	--	Nil	--	--	--	--

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 4 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DH205

Number	Analytical Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Water Level (m)*	24.80	25.10	25.42	25.60	25.70	26.00
2	Water Flow Rate (L/s)	--	--	--	--	--	--
3	pH	--	8.1	--	--	8.4	--
4	Temperature (C)	--	36.0	--	--	29.4	--
5	Total Organic Carbon (TOC) (mg/L)	--	4600	--	--	--	--
6	Chemical Oxygen Demand (mg/L)	--	14000	--	--	17000	--
7	Biochemical Oxygen Demand (mg/L)	--	6800	--	--	--	--
8	Ammonical Nitrogen (mg-N/L)	--	7100	--	--	7500	--
9	TKN (mg-N/L)	--	8100	--	--	--	--
10	Total Oxidized Nitrogen (mg-N/L)	--	8.4	--	--	--	--
11	Orthophosphate (mg-P/L)	--	40	--	--	--	--
12	Sodium (mg/L)	--	2700	--	--	--	--
13	Potassium (mg/L)	--	630	--	--	--	--
14	Calcium (mg/L)	--	6	--	--	--	--
15	Magnesium (mg/L)	--	8	--	--	--	--
16	Chloride (mg/L)	--	6800	--	--	--	--
17	Sulphate (mg/L)	--	5	--	--	--	--
18	Alkalinity (mg CaCO3/L)	--	3200	--	--	--	--
19	Iron (mg/L)	--	4.4	--	--	--	--
20	Manganese (mg/L)	--	<0.04	--	--	--	--
21	Zinc (mg/L)	--	2.7	--	--	--	--
22	Copper (mg/L)	--	0.08	--	--	--	--
23	Nickel (mg/L)	--	0.24	--	--	--	--
24	Chromium (mg/L)	--	3.2	--	--	--	--
25	Lead (mg/L)	--	0.10	--	--	--	--
26	Cadmium (mg/L)	--	0.01	--	--	--	--
27	Suspended Solids (mg/L)	--	30	--	--	--	--
28	Settleable Solids (ml/L)	--	<5	--	--	--	--
29	Oil & Grease (mg/L)	--	<10	--	--	--	--
30	Boron (mg/L)	--	16	--	--	--	--
31	Barium (mg/L)	--	<1	--	--	--	--
32	Mercury (mg/L)	--	<0.001	--	--	--	--
33	Ag (mg/L)	--	<0.1	--	--	--	--
34	Cyanide (mg/L)	--	<1	--	--	--	--
35	Phenol (mg/L)	--	<0.1	--	--	--	--
36	Sulphide (mg/L)	--	<0.1	--	--	--	--
37	Surfactants (Total) (mg/L)	--	3.5	--	--	--	--
38	E. coli (No/100ml)	--	5	--	--	--	--

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 5 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : A251

Number	Analytical Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Water Level (m)*	12.65	13.00	13.30	13.80	14.00	14.20
2	Water Flow Rate (L/s)	--	--	--	--	--	--
3	pH	--	7.3	--	--	7.1	--
4	Temperature (C)	--	27.8	--	--	20.5	--
5	Total Organic Carbon (TOC) (mg/L)	--	120	--	--	--	--
6	Chemical Oxygen Demand (mg/L)	--	660	--	--	540	--
7	Biochemical Oxygen Demand (mg/L)	--	28	--	--	--	--
8	Ammonical Nitrogen (mg-N/L)	--	860	--	--	650	--
9	TKN (mg-N/L)	--	960	--	--	--	--
10	Total Oxidized Nitrogen (mg-N/L)	--	18	--	--	--	--
11	Orthophosphate (mg-P/L)	--	1.4	--	--	--	--
12	Sodium (mg/L)	--	520	--	--	--	--
13	Potassium (mg/L)	--	150	--	--	--	--
14	Calcium (mg/L)	--	70	--	--	--	--
15	Magnesium (mg/L)	--	26	--	--	--	--
16	Chloride (mg/L)	--	650	--	--	--	--
17	Sulphate (mg/L)	--	20	--	--	--	--
18	Alkalinity (mg CaCO3/L)	--	4500	--	--	--	--
19	Iron (mg/L)	--	14	--	--	--	--
20	Manganese (mg/L)	--	0.32	--	--	--	--
21	Zinc (mg/L)	--	0.28	--	--	--	--
22	Copper (mg/L)	--	0.06	--	--	--	--
23	Nickel (mg/L)	--	0.06	--	--	--	--
24	Chromium (mg/L)	--	0.97	--	--	--	--
25	Lead (mg/L)	--	0.09	--	--	--	--
26	Cadmium (mg/L)	--	<0.01	--	--	--	--
27	Suspended Solids (mg/L)	--	270	--	--	--	--
28	Settleable Solids (ml/L)	--	<5	--	--	--	--
29	Oil & Grease (mg/L)	--	<10	--	--	--	--
30	Boron (mg/L)	--	1.9	--	--	--	--
31	Barium (mg/L)	--	<1	--	--	--	--
32	Mercury (mg/L)	--	0.14	--	--	--	--
33	Ag (mg/L)	--	<0.1	--	--	--	--
34	Cyanide (mg/L)	--	<1	--	--	--	--
35	Phenol (mg/L)	--	<0.1	--	--	--	--
36	Sulphide (mg/L)	--	<0.1	--	--	--	--
37	Surfactants (Total) (mg/L)	--	2.3	--	--	--	--
38	E. coli (No/100ml)	--	Nil	--	--	--	--

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 6 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : A252

Number	Analytical Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Water Level (m)*	18.90	19.10 #	19.20	No Water	No Water	No Water
2	Water Flow Rate (L/s)	--	--	--	--	--	--
3	pH	--	--	--	--	--	--
4	Temperature (C)	--	--	--	--	--	--
5	Total Organic Carbon (TOC) (mg/L)	--	--	--	--	--	--
6	Chemical Oxygen Demand (mg/L)	--	--	--	--	--	--
7	Biochemical Oxygen Demand (mg/L)	--	--	--	--	--	--
8	Ammonical Nitrogen (mg-N/L)	--	--	--	--	--	--
9	TKN (mg-N/L)	--	--	--	--	--	--
10	Total Oxidized Nitrogen (mg-N/L)	--	--	--	--	--	--
11	Orthophosphate (mg-P/L)	--	--	--	--	--	--
12	Sodium (mg/L)	--	--	--	--	--	--
13	Potassium (mg/L)	--	--	--	--	--	--
14	Calcium (mg/L)	--	--	--	--	--	--
15	Magnesium (mg/L)	--	--	--	--	--	--
16	Chloride (mg/L)	--	--	--	--	--	--
17	Sulphate (mg/L)	--	--	--	--	--	--
18	Alkalinity (mg CaCO3/L)	--	--	--	--	--	--
19	Iron (mg/L)	--	--	--	--	--	--
20	Manganese (mg/L)	--	--	--	--	--	--
21	Zinc (mg/L)	--	--	--	--	--	--
22	Copper (mg/L)	--	--	--	--	--	--
23	Nickel (mg/L)	--	--	--	--	--	--
24	Chromium (mg/L)	--	--	--	--	--	--
25	Lead (mg/L)	--	--	--	--	--	--
26	Cadmium (mg/L)	--	--	--	--	--	--
27	Suspended Solids (mg/L)	--	--	--	--	--	--
28	Settleable Solids (ml/L)	--	--	--	--	--	--
29	Oil & Grease (mg/L)	--	--	--	--	--	--
30	Boron (mg/L)	--	--	--	--	--	--
31	Barium (mg/L)	--	--	--	--	--	--
32	Mercury (mg/L)	--	--	--	--	--	--
33	Ag (mg/L)	--	--	--	--	--	--
34	Cyanide (mg/L)	--	--	--	--	--	--
35	Phenol (mg/L)	--	--	--	--	--	--
36	Sulphide (mg/L)	--	--	--	--	--	--
37	Surfactants (Total) (mg/L)	--	--	--	--	--	--
38	E. coli (No/100ml)	--	--	--	--	--	--

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.
Insufficient water for analysis.

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Inchcape Testing Services
Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 8 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH–WEST TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : A254

Number	Analytical Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Water Level (m)*	16.70	16.90	17.20	17.40	16.50	17.80
2	Water Flow Rate (L/s)	--	--	--	--	--	--
3	pH	--	7.7	--	--	8.0	--
4	Temperature (C)	--	35.8	--	--	26.9	--
5	Total Organic Carbon (TOC) (mg/L)	--	680	--	--	--	--
6	Chemical Oxygen Demand (mg/L)	--	2500	--	--	3200	--
7	Biochemical Oxygen Demand (mg/L)	--	190	--	--	--	--
8	Ammonical Nitrogen (mg-N/L)	--	2300	--	--	2700	--
9	TKN (mg-N/L)	--	2400	--	--	--	--
10	Total Oxidized Nitrogen (mg-N/L)	--	12	--	--	--	--
11	Orthophosphate (mg-P/L)	--	7.8	--	--	--	--
12	Sodium (mg/L)	--	1300	--	--	--	--
13	Potassium (mg/L)	--	390	--	--	--	--
14	Calcium (mg/L)	--	27	--	--	--	--
15	Magnesium (mg/L)	--	21	--	--	--	--
16	Chloride (mg/L)	--	1600	--	--	--	--
17	Sulphate (mg/L)	--	93	--	--	--	--
18	Alkalinity (mg CaCO3/L)	--	10000	--	--	--	--
19	Iron (mg/L)	--	11	--	--	--	--
20	Manganese (mg/L)	--	0.20	--	--	--	--
21	Zinc (mg/L)	--	0.65	--	--	--	--
22	Copper (mg/L)	--	0.04	--	--	--	--
23	Nickel (mg/L)	--	0.12	--	--	--	--
24	Chromium (mg/L)	--	2.1	--	--	--	--
25	Lead (mg/L)	--	0.07	--	--	--	--
26	Cadmium (mg/L)	--	<0.01	--	--	--	--
27	Suspended Solids (mg/L)	--	330	--	--	--	--
28	Settleable Solids (ml/L)	--	<5	--	--	--	--
29	Oil & Grease (mg/L)	--	25	--	--	--	--
30	Boron (mg/L)	--	2.2	--	--	--	--
31	Barium (mg/L)	--	<1	--	--	--	--
32	Mercury (mg/L)	--	0.45	--	--	--	--
33	Ag (mg/L)	--	<0.1	--	--	--	--
34	Cyanide (mg/L)	--	<1	--	--	--	--
35	Phenol (mg/L)	--	<0.1	--	--	--	--
36	Sulphide (mg/L)	--	<0.1	--	--	--	--
37	Surfactants (Total) (mg/L)	--	2.5	--	--	--	--
38	E. coli (No/100ml)	--	Nil	--	--	--	--

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 9 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : A255

Number	Analytical Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Water Level (m)*	31.50	32.40	32.80	33.20	33.40 #	32.70
2	Water Flow Rate (L/s)	--	--	--	--	--	--
3	pH	--	8.0	--	--	--	--
4	Temperature (C)	--	32.2	--	--	--	--
5	Total Organic Carbon (TOC) (mg/L)	--	1400	--	--	--	--
6	Chemical Oxygen Demand (mg/L)	--	5600	--	--	--	--
7	Biochemical Oxygen Demand (mg/L)	--	880	--	--	--	--
8	Ammonical Nitrogen (mg-N/L)	--	4600	--	--	--	--
9	TKN (mg-N/L)	--	12000	--	--	--	--
10	Total Oxidized Nitrogen (mg-N/L)	--	12	--	--	--	--
11	Orthophosphate (mg-P/L)	--	8.3	--	--	--	--
12	Sodium (mg/L)	--	2200	--	--	--	--
13	Potassium (mg/L)	--	10	--	--	--	--
14	Calcium (mg/L)	--	31	--	--	--	--
15	Magnesium (mg/L)	--	21	--	--	--	--
16	Chloride (mg/L)	--	4000	--	--	--	--
17	Sulphate (mg/L)	--	62	--	--	--	--
18	Alkalinity (mg CaCO3/L)	--	21000	--	--	--	--
19	Iron (mg/L)	--	76	--	--	--	--
20	Manganese (mg/L)	--	1.1	--	--	--	--
21	Zinc (mg/L)	--	6.7	--	--	--	--
22	Copper (mg/L)	--	0.89	--	--	--	--
23	Nickel (mg/L)	--	0.41	--	--	--	--
24	Chromium (mg/L)	--	11	--	--	--	--
25	Lead (mg/L)	--	0.89	--	--	--	--
26	Cadmium (mg/L)	--	<0.01	--	--	--	--
27	Suspended Solids (mg/L)	--	13000	--	--	--	--
28	Settleable Solids (ml/L)	--	47	--	--	--	--
29	Oil & Grease (mg/L)	--	200	--	--	--	--
30	Boron (mg/L)	--	12	--	--	--	--
31	Barium (mg/L)	--	<1	--	--	--	--
32	Mercury (mg/L)	--	0.007	--	--	--	--
33	Ag (mg/L)	--	<0.1	--	--	--	--
34	Cyanide (mg/L)	--	<1	--	--	--	--
35	Phenol (mg/L)	--	<0.1	--	--	--	--
36	Sulphide (mg/L)	--	<0.1	--	--	--	--
37	Surfactants (Total) (mg/L)	--	2.4	--	--	--	--
38	E. coli (No/100ml)	--	Nil	--	--	--	--

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.
Insufficient water for analysis.

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Inchcape Testing Services
Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 10 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : L206

Number	Analytical Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Water Level (m)*	--	--	--	--	--	--
2	Water Flow Rate (L/s)	--	--	--	--	--	--
3	pH	7.4	8.5	8.2	8.5	8.4	8.3
4	Temperature (C)	27.7	24.1	22.7	22.1	20.0	34.3
5	Total Organic Carbon (TOC) (mg/L)	130	180	200	--	--	--
6	Chemical Oxygen Demand (mg/L)	480	530	530	690	780	860
7	Biochemical Oxygen Demand (mg/L)	49	33	32	--	--	--
8	Ammonical Nitrogen (mg-N/L)	520	660	790	890	970	1100
9	TKN (mg-N/L)	600	690	830	--	--	--
10	Total Oxidized Nitrogen (mg-N/L)	<0.3	18	8.0	--	--	--
11	Orthophosphate (mg-P/L)	1.3	2.2	3.1	--	--	--
12	Sodium (mg/L)	330	380	420	--	--	--
13	Potassium (mg/L)	170	170	190	--	--	--
14	Calcium (mg/L)	62	57	35	--	--	--
15	Magnesium (mg/L)	13	12	12	--	--	--
16	Chloride (mg/L)	370	450	600	--	--	--
17	Sulphate (mg/L)	11	14	19	--	--	--
18	Alkalinity (mg CaCO3/L)	280	3500	3700	--	--	--
19	Iron (mg/L)	4.6	4.7	4.6	--	--	--
20	Manganese (mg/L)	0.20	0.15	0.06	--	--	--
21	Zinc (mg/L)	0.19	0.09	0.11	--	--	--
22	Copper (mg/L)	<0.02	<0.02	<0.02	--	--	--
23	Nickel (mg/L)	<0.03	<0.03	0.03	--	--	--
24	Chromium (mg/L)	0.45	0.58	0.65	--	--	--
25	Lead (mg/L)	<0.04	<0.04	<0.04	--	--	--
26	Cadmium (mg/L)	<0.01	<0.01	<0.01	--	--	--
27	Suspended Solids (mg/L)	17	<5	10	--	--	--
28	Settleable Solids (ml/L)	<5	<5	<5	--	--	--
29	Oil & Grease (mg/L)	<10	<10	<10	--	--	--
30	Boron (mg/L)	1.1	1.2	1.4	--	--	--
31	Barium (mg/L)	<1	<1	<1	--	--	--
32	Mercury (mg/L)	<0.001	0.12	<0.001	--	--	--
33	Ag (mg/L)	<0.1	<0.1	<0.1	--	--	--
34	Cyanide (mg/L)	<1	<1	<1	--	--	--
35	Phenol (mg/L)	<0.1	<0.1	<0.1	--	--	--
36	Sulphide (mg/L)	<0.1	<0.1	<0.1	--	--	--
37	Surfactants (Total) (mg/L)	1.2	1.4	0.6	--	--	--
38	E. coli (No/100ml)	Nil	Nil	Nil	--	--	--

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.

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Inchcape Testing Services
Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 11 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : L207

Number	Analytical Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Water Level (m)*	—	—	—	—	—	—
2	Water Flow Rate (L/s)	No flow	<10	<10	0.03	No flow	No flow
3	pH	7.4	7.3	7.5	7.6	7.6	7.4
4	Temperature (C)	28.7	26.5	26.7	25.6	24.9	37.0
5	Total Organic Carbon (TOC) (mg/L)	370	330	370	—	—	—
6	Chemical Oxygen Demand (mg/L)	1000	1100	910	1000	1000	980
7	Biochemical Oxygen Demand (mg/L)	81	71	77	—	—	—
8	Ammonical Nitrogen (mg-N/L)	1500	1300	1500	1400	1300	1300
9	TKN (mg-N/L)	1600	1600	1600	—	—	—
10	Total Oxidized Nitrogen (mg-N/L)	4.3	25	10	—	—	—
11	Orthophosphate (mg-P/L)	5.9	5.7	6.5	—	—	—
12	Sodium (mg/L)	920	950	780	—	—	—
13	Potassium (mg/L)	310	340	290	—	—	—
14	Calcium (mg/L)	44	42	39	—	—	—
15	Magnesium (mg/L)	24	24	18	—	—	—
16	Chloride (mg/L)	1300	1300	1200	—	—	—
17	Sulphate (mg/L)	<5	34	23	—	—	—
18	Alkalinity (mg CaCO3/L)	660	7000	6600	—	—	—
19	Iron (mg/L)	5.0	5.0	4.8	—	—	—
20	Manganese (mg/L)	0.10	0.06	0.06	—	—	—
21	Zinc (mg/L)	0.08	0.05	0.09	—	—	—
22	Copper (mg/L)	<0.02	<0.02	<0.02	—	—	—
23	Nickel (mg/L)	0.06	0.07	0.07	—	—	—
24	Chromium (mg/L)	0.71	1.2	1.3	—	—	—
25	Lead (mg/L)	<0.04	<0.04	<0.04	—	—	—
26	Cadmium (mg/L)	<0.01	<0.01	<0.01	—	—	—
27	Suspended Solids (mg/L)	20	<5	7	—	—	—
28	Settleable Solids (ml/L)	<5	<5	<5	—	—	—
29	Oil & Grease (mg/L)	<10	<10	<10	—	—	—
30	Boron (mg/L)	3.3	3.1	3.2	—	—	—
31	Barium (mg/L)	<1	<1	<1	—	—	—
32	Mercury (mg/L)	<0.001	0.28	<0.01	—	—	—
33	Ag (mg/L)	<0.1	<0.1	<0.1	—	—	—
34	Cyanide (mg/L)	<1	<1	<1	—	—	—
35	Phenol (mg/L)	<0.1	<0.1	<0.1	—	—	—
36	Sulphide (mg/L)	<0.1	<0.1	<0.1	—	—	—
37	Surfactants (Total) (mg/L)	3.3	1.7	0.6	—	—	—
38	E. coli (No/100ml)	Nil	Nil	Nil	—	—	—

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 12 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : W201

Number	Analytical Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Water Level (m)*	--	--	--	--	--	--
2	Water Flow Rate (L/s)	50	100	<10	24	21	5
3	pH	7.0	5.9	5.8	6.3	6.6	7.0
4	Temperature (C)	24.1	19.7	14.7	16.3	11.1	21.9
5	Total Organic Carbon (TOC) (mg/L)	3	2.3	<1	--	--	--
6	Chemical Oxygen Demand (mg/L)	42	<7	<7	<7	10	<7
7	Biochemical Oxygen Demand (mg/L)	<5	<5	<5	--	--	--
8	Ammonical Nitrogen (mg-N/L)	<0.3	<0.3	1.2	<0.3	<0.3	<0.3
9	TKN (mg-N/L)	7.1	2.0	2.2	--	--	--
10	Total Oxidized Nitrogen (mg-N/L)	<0.3	<0.3	<0.3	--	--	--
11	Orthophosphate (mg-P/L)	<0.2	<0.2	<0.2	--	--	--
12	Sodium (mg/L)	3	4	5	--	--	--
13	Potassium (mg/L)	1.6	1.0	1.4	--	--	--
14	Calcium (mg/L)	<2	<2	<2	--	--	--
15	Magnesium (mg/L)	<1	<1	<1	--	--	--
16	Chloride (mg/L)	7	10	11	--	--	--
17	Sulphate (mg/L)	5	<5	19	--	--	--
18	Alkalinity (mg CaCO3/L)	<2	12	7	--	--	--
19	Iron (mg/L)	<0.6	<0.6	<0.6	--	--	--
20	Manganese (mg/L)	<0.04	<0.04	<0.04	--	--	--
21	Zinc (mg/L)	<0.03	<0.03	<0.03	--	--	--
22	Copper (mg/L)	<0.02	<0.02	<0.02	--	--	--
23	Nickel (mg/L)	<0.03	<0.03	<0.03	--	--	--
24	Chromium (mg/L)	<0.02	0.03	<0.02	--	--	--
25	Lead (mg/L)	<0.04	<0.04	<0.04	--	--	--
26	Cadmium (mg/L)	<0.01	<0.01	<0.01	--	--	--
27	Suspended Solids (mg/L)	--	<5	--	--	--	--
28	Settleable Solids (ml/L)	--	<5	--	--	--	--
29	Oil & Grease (mg/L)	--	<10	--	--	--	--
30	Boron (mg/L)	--	<0.1	--	--	--	--
31	Barium (mg/L)	--	<1	--	--	--	--
32	Mercury (mg/L)	--	<0.001	--	--	--	--
33	Ag (mg/L)	--	<0.1	--	--	--	--
34	Cyanide (mg/L)	--	<1	--	--	--	--
35	Phenol (mg/L)	--	<0.1	--	--	--	--
36	Sulphide (mg/L)	--	<0.1	--	--	--	--
37	Surfactants (Total) (mg/L)	--	0.7	--	--	--	--
38	E. coli (No/100ml)	--	60	--	--	--	--

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 13 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : W204

Number	Analytical Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Water Level (m)*	---	---	---	---	---	---
2	Water Flow Rate (L/s)	2000	No flow	No flow	No flow	No flow	No flow
3	pH	7.7	7.9	8.0	7.8	7.7	7.2
4	Temperature (C)	24.5	20.8	16.7	17.1	12.3	30.5
5	Total Organic Carbon (TOC) (mg/L)	3	5.3	8.6	---	---	---
6	Chemical Oxygen Demand (mg/L)	32	17	24	17	10	17
7	Biochemical Oxygen Demand (mg/L)	<5	<5	<5	---	---	---
8	Ammonical Nitrogen (mg-N/L)	29	25	36	23	17	12
9	TKN (mg-N/L)	35	26	37	---	---	---
10	Total Oxidized Nitrogen (mg-N/L)	<0.3	0.6	<0.3	---	---	---
11	Orthophosphate (mg-P/L)	<0.2	<0.2	0.3	---	---	---
12	Sodium (mg/L)	130	99	1100	---	---	---
13	Potassium (mg/L)	17	8.9	67	---	---	---
14	Calcium (mg/L)	8	8	54	---	---	---
15	Magnesium (mg/L)	15	11	740	---	---	---
16	Chloride (mg/L)	260	180	2500	---	---	---
17	Sulphate (mg/L)	41	29	300	---	---	---
18	Alkalinity (mg CaCO3/L)	15	130	190	---	---	---
19	Iron (mg/L)	<0.6	<0.6	<0.6	---	---	---
20	Manganese (mg/L)	0.08	0.07	0.10	---	---	---
21	Zinc (mg/L)	<0.03	<0.03	<0.03	---	---	---
22	Copper (mg/L)	<0.02	<0.02	<0.02	---	---	---
23	Nickel (mg/L)	<0.03	<0.03	<0.03	---	---	---
24	Chromium (mg/L)	0.03	0.04	0.02	---	---	---
25	Lead (mg/L)	<0.04	<0.04	<0.04	---	---	---
26	Cadmium (mg/L)	<0.01	<0.01	<0.01	---	---	---
27	Suspended Solids (mg/L)	---	<5	---	---	---	---
28	Settleable Solids (ml/L)	---	<5	---	---	---	---
29	Oil & Grease (mg/L)	---	<10	---	---	---	---
30	Boron (mg/L)	---	0.1	---	---	---	---
31	Barium (mg/L)	---	<1	---	---	---	---
32	Mercury (mg/L)	---	0.002	---	---	---	---
33	Ag (mg/L)	---	<0.1	---	---	---	---
34	Cyanide (mg/L)	---	<1	---	---	---	---
35	Phenol (mg/L)	---	<0.1	---	---	---	---
36	Sulphide (mg/L)	---	<0.1	---	---	---	---
37	Surfactants (Total) (mg/L)	---	0.6	---	---	---	---
38	E. coli (No/100ml)	---	50	---	---	---	---

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 41 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DH201

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	26.0	25.6	27.6	27.7	19.8	30.7
2	Atmospheric Pressure (mbar)	1004	1003	1009	1014	1016	1008
3	Relative Pressure (pascal)	0	1	0	1	0	0
4	Methane (%)	0.00	0.00	0.00	0.00	0.00	0.00
5	LEL (%)	0	0	0	0	0	0
6	CO2 (%)	**6.20**	**8.10**	**9.60**	**7.98**	**10.5**	**5.83**
7	O2 (%)	**6.40**	**7.60**	**6.50**	**12.3**	**10.1**	**14.0**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level:
(a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 42 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DH203A

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	30.1	27.3	29.4	28.0	18.2	32.7
2	Atmospheric Pressure (mbar)	999	1001	1009	1015	1016	1008
3	Relative Pressure (pascal)	0	3	0	1	1	4
4	Methane (%)	0.00	0.00	1.04	0.00	0.00	0.00
5	LEL (%)	0	0	**20.8**	0	0	0
6	CO2 (%)	**14.8**	**6.59**	**8.77**	**1.79**	**3.46**	**1.87**
7	O2 (%)	**4.70**	**15.6**	**13.5**	18.8	**16.1**	**17.9**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level:
(a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 43 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DH204

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	27.8	34.5	22.1	28.6	19.2	38.0
2	Atmospheric Pressure (mbar)	999	1003	1000	1006	1014	1008
3	Relative Pressure (pascal)	105	0	0	1	139	0
4	Methane (%)	0.00	1.66	7.19	0.06	0.00	0.00
5	LEL (%)	0	**33.2**	**>100**	1.20	0	0
6	CO2 (%)	**7.30**	**13.6**	**12.7**	**12.0**	**6.20**	**4.64**
7	O2 (%)	**9.70**	**1.70**	**0.90**	**1.50**	**12.0**	**12.1**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	0.0	--	--	--	--	--
2	Carbon Dioxide (%)	9.9	--	--	--	--	--
3	Oxygen (%)	11.6	--	--	--	--	--
4	Nitrogen (%)	81.2	--	--	--	--	--
5	Carbon Monoxide (%)	0.7	--	--	--	--	--
6	Hydrogen (%)	0.0	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level: (a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 44 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DH205

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	33.4	20.7	19.9	24.0	25.1	23.9
2	Atmospheric Pressure (mbar)	998	1000	1009	1014	1012	1008
3	Relative Pressure (pascal)	15	6	3	9	6	10
4	Methane (%)	50.7	48.6	49.7	43.8	41.4	42.6
5	LEL (%)	>100	>100	>100	>100	>100	>100
6	CO2 (%)	32.6	30.7	29.5	30.6	31.1	32.2
7	O2 (%)	0.50	0.80	0.80	1.40	0.80	1.10
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	43.8	--	--	--	--
2	Carbon Dioxide (%)	--	29.7	--	--	--	--
3	Oxygen (%)	--	1.8	--	--	--	--
4	Nitrogen (%)	--	16.8	--	--	--	--
5	Carbon Monoxide (%)	--	0.0	--	--	--	--
6	Hydrogen (%)	--	0.0	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level:
(a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

Landfill Gas Monitoring Results
for
Siu Lang Shui Landfill

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill   Sample Location : DP213

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	0	0	0	0	50	>100	32	>100	82	
2	Methane (% v/v)	0.0	0.0	0.0	0.0	2.5	5.9	1.6	6.6	4.1	
3	CO_2 (% v/v)	16.6	16.0	14.9	16.1	17.9	18.6	16.9	15.7	14.8	
4	O_2 (% v/v)	1.8	2.7	3.5	4.4	0.4	1.1	1.5	3.3	2.7	
5	Barometric Pressure (m Bar)*	1017	1018	1021	1009	1009	1004	998	1000	1005	
6	Gas Pressure (Pascal)**	4	10	0	0	0	0	(	0	0	
7	Gas Temperature (°C)	-	-	-	-	-	-	-	-	-	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)										
2	Methane (ppm v/v)										
3	CO_2 (% v/v)										
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)										
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)										
8	CO (ppm v/v)										
9	H_2 (ppm v/v)										

* : Absolute atmospheric pressure.

** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH–WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill   Sample Location : DP212A

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS – FIELD MEASUREMENT										
1	Methane (% LEL)	>100	>100	>100	>100	>100	>100	>100	>100	>100	
2	Methane (% v/v)	48.5	45.7	46.7	41.2	38.3	26.3	30.3	6.2	46.0	
3	CO_2 (% v/v)	31.2	30.3	30.4	30.2	29.5	26.3	27.5	14.1	30.9	
4	O_2 (% v/v)	0.4	0.2	0.1	0.3	0.6	0.9	0.1	5.0	0.4	
5	Barometric Pressure (m Bar)*	1015	1015	1017	1006	1006	1002	995	997	1000	
6	Gas Pressure (Pascal)**	84	46	–2	10	14	13	27	0	12	
7	Gas Temperature (°C)	–	–	–	–	–	–	–	–	–	
	LANDFILL GAS – LABORATORY TEST										
1	Methane (% v/v)										
2	Methane (ppm v/v)										
3	CO_2 (% v/v)										
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)										
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)										
8	CO (ppm v/v)										
9	H_2 (ppm v/v)										

* : Absolute atmospheric pressure.
** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH–WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill / Sample Location : DP220

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS – FIELD MEASUREMENT										
1	Methane (% LEL)	0	0	0	0	0	0	0	0	0	
2	Methane (% v/v)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3	CO_2 (% v/v)	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
4	O_2 (% v/v)	21.2	20.7	20.7	20.9	20.9	21.0	20.5	21.6	20.9	
5	Barometric Pressure (m Bar)*	1021	1022	1023	1014	1014	1008	998	1006	1005	
6	Gas Pressure (Pascal)**	0	7	0	0	0	0	(	0	0	
7	Gas Temperature (°C)	–	20.7	–	–	–	–	–	–	–	
	LANDFILL GAS – LABORATORY TEST										
1	Methane (% v/v)										
2	Methane (ppm v/v)										
3	CO_2 (% v/v)										
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)										
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)										
8	CO (ppm v/v)										
9	H_2 (ppm v/v)										

* : Absolute atmospheric pressure.

** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill Sample Location : DH201

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	0	0	0	0	0	0	0	0	0	
2	Methane (% v/v)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3	CO_2 (% v/v)	7.6	7.8	10.0	9.2	8.3	3.2	3.2	1.1	2.8	
4	O_2 (% v/v)	9.6	9.4	4.6	5.9	9.6	16.5	16.7	18.9	9.8	
5	Barometric Pressure (m Bar)*	1023	1022	1024	1015	1012	1008	1008	1006	1006	
6	Gas Pressure (Pascal)**	0	0	18	0	0	0	0	0	0	
7	Gas Temperature (°C)	21.2	17.6	18.5	19.2	19.4	24.1	23.6	32.5	30	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)						0	0		0	
2	Methane (ppm v/v)										
3	CO_2 (% v/v)						8.53	2.66		11.11	
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)						18.15	16.23		8.84	
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)						74.58	87.47		88.04	
8	CO (ppm v/v)						0	0		0	
9	H_2 (ppm v/v)						0	0		0	

* : Absolute atmospheric pressure.

** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill **Sample Location : DP221**

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	0	0	0	0	0	0	0		0	
2	Methane (% v/v)	0.0	0.0	0.0	0.0	0.0	0.0	0.0		0.0	
3	CO_2 (% v/v)	10.2	6.9	7.9	7.9	8.0	10.3	9.7	Covered	2.0	
4	O_2 (% v/v)	6.8	12.5	12.5	12.1	12.1	6.8	11.2	by	11.4	
5	Barometric Pressure (m Bar)*	1022	1021	1024	1015	1013	1008	995	Rain Water	1005	
6	Gas Pressure (Pascal)**	68	0	-11	0	-3	0	(		0	
7	Gas Temperature (°C)	-	-	-	-	-	-	-		-	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)										
2	Methane (ppm v/v)										
3	CO_2 (% v/v)										
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)										
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)										
8	CO (ppm v/v)										
9	H_2 (ppm v/v)										

* : Absolute atmospheric pressure.
** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill   Sample Location : DH203A

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	0	0	0	0	0	0	0	0	0	
2	Methane (% v/v)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3	CO_2 (% v/v)	11.4	8.7	4.5	4.3	9.4	0.0	5.6	1.9	9.7	
4	O_2 (% v/v)	11.1	13.0	17.3	17.2	12.9	20.9	13.8	17.6	0.8	
5	Barometric Pressure (m Bar)*	1022	1022	1024	1015	1013	1008	1000	1006	1005	
6	Gas Pressure (Pascal)**	-68	0	-10	0	0	0	0	0	0	
7	Gas Temperature (°C)	21.8	17.7	18.4	18.8	19	28.2	32	33.5	28.4	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)										
2	Methane (ppm v/v)										
3	CO_2 (% v/v)										
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)										
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)										
8	CO (ppm v/v)										
9	H_2 (ppm v/v)										

* : Absolute atmospheric pressure.
** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill Sample Location : DP223

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	0	0	0	0	0	0	0	0	0	
2	Methane (% v/v)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	
3	CO_2 (% v/v)	9.2	5.0	6.3	5.4	6.2	6.3	7.8	1.9	0.0	
4	O_2 (% v/v)	3.5	15.3	14.3	15.3	13.9	14.3	11.1	17.6	20.7	
5	Barometric Pressure (m Bar)*	1022	1022	1024	1015	1013	1008	1008	1006	1005	
6	Gas Pressure (Pascal)**	-22	11	-8	0	0	0	(	0	0	
7	Gas Temperature (°C)	-	-	-	-	-	-	-	-	-	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)										
2	Methane (ppm v/v)										
3	CO_2 (% v/v)										
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)										
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)										
8	CO (ppm v/v)										
9	H_2 (ppm v/v)										

* : Absolute atmospheric pressure.

** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill Sample Location : DP224

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	0	0	0	0	0	0	>100	0	0	
2	Methane (% v/v)	0.0	0.0	0.0	0.0	0.0	0.0	12.8	0.0	0.0	
3	CO_2 (% v/v)	11.4	10.7	12.1	12.3	13.2	12.9	15.1	0.0	6.0	
4	O_2 (% v/v)	4.1	4.7	1.9	3.6	3.7	5.7	1.2	21.2	12.8	
5	Barometric Pressure (m Bar)*	1022	1021	1023	1015	1012	1009	1000	1007	1005	
6	Gas Pressure (Pascal)**	-14	11	-9	-11	0	0	0	0	0	
7	Gas Temperature (°C)	-	-	-	-	-	-	-	-	-	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)										
2	Methane (ppm v/v)										
3	CO_2 (% v/v)										
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)										
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)										
8	CO (ppm v/v)										
9	H_2 (ppm v/v)										

* : Absolute atmospheric pressure.

** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH–WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill   Sample Location : DH204

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS – FIELD MEASUREMENT										
1	Methane (% LEL)	0	18	16	0	0	0	4	0	0	
2	Methane (% v/v)	0.0	0.9	0.8	0.0	0.0	0.0	0.2	0.0	0.0	
3	CO_2 (% v/v)	12.5	13.9	14.7	5.6	5.8	3.4	9.3	12.0	0.6	
4	O_2 (% v/v)	12.0	0.2	0.0	11.7	11.7	14.0	5.4	2.3	19.8	
5	Barometric Pressure (m Bar)*	1022	1021	1023	1015	1013	1009	1000	1007	1005	
6	Gas Pressure (Pascal)**	−46	−20	1	0	0	0	0	0	0	
7	Gas Temperature (°C)	20.7	17.8	16.5	18.9	20.5	28	33.7	32.5	30	
	LANDFILL GAS – LABORATORY TEST										
1	Methane (% v/v)				0.0						
2	Methane (ppm v/v)										
3	CO_2 (% v/v)				7.3						
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)				12.8						
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)				59.3						
8	CO (ppm v/v)				0.0						
9	H_2 (ppm v/v)				0.0						

* : Absolute atmospheric pressure.
** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill   Sample Location : DH207

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS – FIELD MEASUREMENT										
1	Methane (% LEL)	>100	>100	>100	>100	>100	>100	>100	>100	>100	
2	Methane (% v/v)	58.7	59.4	56.6	54.7	55.2	50.2	53.4	53.6	52.4	
3	CO_2 (% v/v)	32.8	30.4	31.5	34.3	31.2	30.4	33.6	31.5	29.0	
4	O_2 (% v/v)	0.3	0.2	0.3	0.4	0.3	1.1	0.6	1.1	0.7	
5	Barometric Pressure (m Bar)*	1017	1017	1017	1008	1009	1003	1000	999	1001	
6	Gas Pressure (Pascal)**	84	68	3	6	0	-10	[illegible]	22	20	
7	Gas Temperature (°C)	21.6	19.1	18.7	19.6	19.1	30.7	33.[illegible]	31.5	28.2	
	LANDFILL GAS – LABORATORY TEST										
1	Methane (% v/v)								59.02		
2	Methane (ppm v/v)										
3	CO_2 (% v/v)								22.4		
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)								3.01		
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)								19.93		
8	CO (ppm v/v)								0		
9	H_2 (ppm v/v)								0		

* : Absolute atmospheric pressure.
** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill   Sample Location : DP219

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	>100	>100	>100	>100	>100	>100	>100	>100	>100	
2	Methane (% v/v)	29.1	28.4	24.1	24.1	27.5	3.2	24.5	17.1	10.1	
3	CO_2 (% v/v)	25.0	23.7	23.8	24.1	25.6	19.6	23.5	18.3	18.3	
4	O_2 (% v/v)	0.3	0.2	0.3	0.4	0.3	1.2	0.4	1.1	0.3	
5	Barometric Pressure (m Bar)*	1018	1018	1018	1009	1009	1004	1000	1000	1003	
6	Gas Pressure (Pascal)**	38	21	-1	0	3	0	2	3	0	
7	Gas Temperature (°C)	-	-	-	-	-	-	-	-	-	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)										
2	Methane (ppm v/v)										
3	CO_2 (% v/v)										
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)										
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)										
8	CO (ppm v/v)										
9	H_2 (ppm v/v)										

* : Absolute atmospheric pressure.

** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill   Sample Location : DP217

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	>100	>100	>100	>100	>100	>100	>100	>100	>100	
2	Methane (% v/v)	64.3	45.0	61.5	61.3	49.1	56.6	49.2	59.8	55.4	
3	CO_2 (% v/v)	32.8	26.5	31.6	31.1	26.8	32.0	29.0	34.3	30.5	
4	O_2 (% v/v)	0.3	0.2	0.3	0.4	0.5	0.9	2.6	1.4	1.7	
5	Barometric Pressure (m Bar)*	1019	1019	1020	1010	1011	1006	999	1006	1005	
6	Gas Pressure (Pascal)**	708	56	49	49	27	36	29	8	32	
7	Gas Temperature (°C)	-	-	-	-	-	-	-	-	-	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)										
2	Methane (ppm v/v)										
3	CO_2 (% v/v)										
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)										
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)										
8	CO (ppm v/v)										
9	H_2 (ppm v/v)										

* : Absolute atmospheric pressure.
** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill Sample Location : DP215

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	0	0	0	0	0	0	0	0	4	
2	Methane (% v/v)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.2	
3	CO_2 (% v/v)	15.0	14.9	15.6	14.5	14.7	15.3	14.4	15.3	0.5	
4	O_2 (% v/v)	2.3	2.2	5.5	4.6	5.1	2.6	4.3	5.8	21.3	
5	Barometric Pressure (m Bar)*	1019	1019	1020	1011	1010	1005	999	1004	1002	
6	Gas Pressure (Pascal)**	14	-127	0	-30	0	-20	0	0	0	
7	Gas Temperature (°C)	-	-	-	-	-	-	-	-	-	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)										
2	Methane (ppm v/v)										
3	CO_2 (% v/v)										
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)										
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)										
8	CO (ppm v/v)										
9	H_2 (ppm v/v)										

* : Absolute atmospheric pressure.

** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill　　　　Sample Location : DP214

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	>100	>100	6	8	78	2	14	0	0	
2	Methane (% v/v)	10.9	5.4	0.3	0.4	3.9	0.1	0.7	0.0	0.0	
3	CO_2 (% v/v)	18.0	15.6	15.9	12.8	15.8	7.8	7.5	7.6	8.1	
4	O_2 (% v/v)	0.3	0.2	0.6	3.4	0.3	11.0	5.2	12.6	11.9	
5	Barometric Pressure (m Bar)*	1018	1018	1020	1010	1009	1005	999	1004	1004	
6	Gas Pressure (Pascal)**	148	34	0	0	0	0	0	0	0	
7	Gas Temperature (°C)	-	-	-	-	-	-	-	-	-	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)										
2	Methane (ppm v/v)										
3	CO_2 (% v/v)										
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)										
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)										
8	CO (ppm v/v)										
9	H_2 (ppm v/v)										

* : Absolute atmospheric pressure.
** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH–WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill		Sample Location : DP209

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS – FIELD MEASUREMENT										
1	Methane (% LEL)	>100	>100	>100	>100	>100	>100	>100	>100	>100	
2	Methane (% v/v)	48.8	49.4	43.2	45.8	45.7	43.1	43.3	45.3	40.1	
3	CO_2 (% v/v)	32.8	30.5	30.6	31.6	31.5	30.9	32.8	29.7	29.5	
4	O_2 (% v/v)	0.3	0.1	0.2	0.4	0.3	0.9	0.8	1.0	0.8	
5	Barometric Pressure (m Bar)*	1015	1015	1016	1007	1007	1002	997	1001	1001	
6	Gas Pressure (Pascal)**	−22	30	−1	7	20	35	15	32	30	
7	Gas Temperature (°C)	–	–	–	–	–	–	–		–	
	LANDFILL GAS – LABORATORY TEST										
1	Methane (% v/v)										
2	Methane (ppm v/v)										
3	CO_2 (% v/v)										
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)										
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)										
8	CO (ppm v/v)										
9	H_2 (ppm v/v)										

* : Absolute atmospheric pressure.
** : Pressure relative to atmospheric pressure.

LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH-WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill   Sample Location : DH208

Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS - FIELD MEASUREMENT										
1	Methane (% LEL)	>100	>100	>100	>100	>100	>100	>100	>100	>100	
2	Methane (% v/v)	64.1	63.5	63.8	62.9	65.0	58.3	57.5	56.4	56.7	
3	CO_2 (% v/v)	35.2	35.3	34.8	35.3	35.0	35.9	35.3	34.8	36.4	
4	O_2 (% v/v)	0.3	0.1	0.3	0.3	0.4	0.9	0.2	0.8	0.4	
5	Barometric Pressure (m Bar)*	1015	1016	1018	1007	1007	1002	996	1000	1000	
6	Gas Pressure (Pascal)**	2490	112	204	227	161	167	107	158	154	
7	Gas Temperature (°C)	28.3	24.7	26.1	29.1	25.6	33.4	32.8	32.5	30	
	LANDFILL GAS - LABORATORY TEST										
1	Methane (% v/v)		63.0								
2	Methane (ppm v/v)										
3	CO_2 (% v/v)		36.0								
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)		1.0								
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)		2.0								
8	CO (ppm v/v)		0.0								
9	H_2 (ppm v/v)		0.0								

* : Absolute atmospheric pressure.

** : Pressure relative to atmospheric pressure.

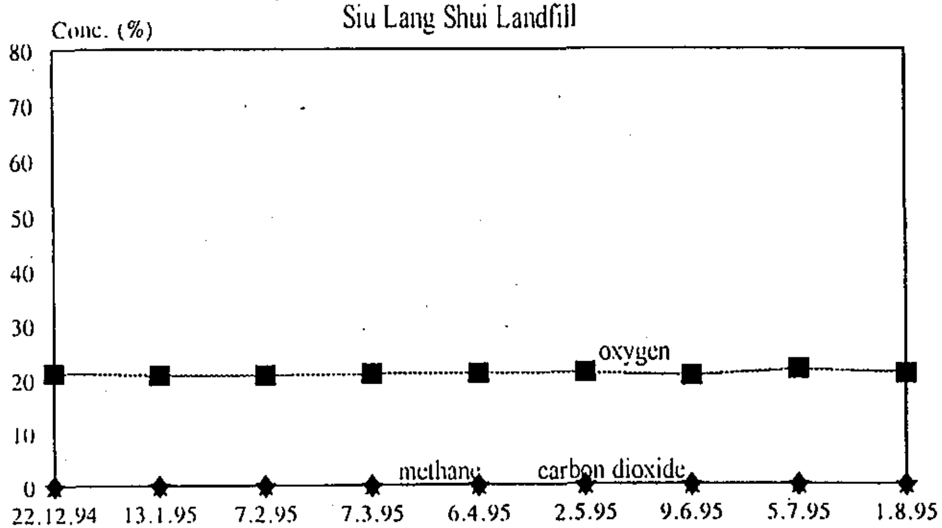
LANDFILL GAS ANALYSIS RESUTLTS FOR RESTORATION OF THE NORTH–WEST TERRITORIES LANDFILLS

Sampling Site : Siu Lang Shui Landfill　　　　Sample Location : DH205

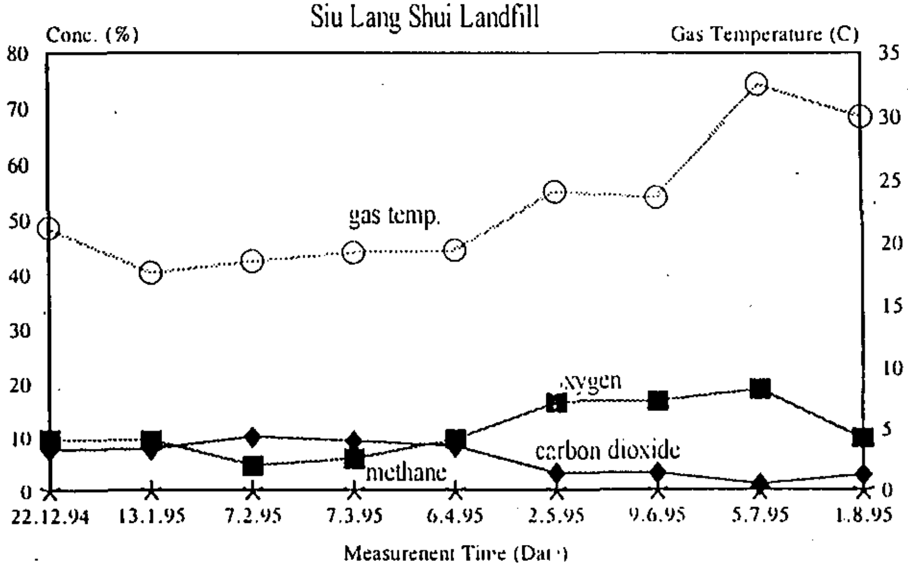
Number	Analyical Parameters	Sampling/Measurement Date									
		22.12.94	13.1.95	7.2.95	7.3.95	6.4.95	2.5.95	9.6.95	5.7.95	1.8.95	
	LANDFILL GAS – FIELD MEASUREMENT										
1	Methane (% LEL)	>100	>100	>100	>100	>100	>100	>100	>100	>100	
2	Methane (% v/v)	57.5	57.2	55.0	53.2	55.3	51.6	51.8	52.4	54.8	
3	CO_2 (% v/v)	36.7	34.5	34.5	35.6	34.3	34.4	35.5	34.9	36.1	
4	O_2 (% v/v)	0.3	0.1	0.2	0.3	0.3	1.0	0.3	1.3	0.6	
5	Barometric Pressure (m Bar)*	1017	1017	1019	1009	1009	1004	997	1000	1001	
6	Gas Pressure (Pascal)**	344	43	38	12	23	25	23	15	12	
7	Gas Temperature (°C)	23.5	18.9	20.1	22.5	20.7	30.9	33.6	33.5	30.3	
	LANDFILL GAS – LABORATORY TEST										
1	Methane (% v/v)					4.89					
2	Methane (ppm v/v)										
3	CO_2 (% v/v)					9.58					
4	CO_2 (ppm v/v)										
5	O_2 (% v/v)					20.06					
6	O_2 (ppm v/v)										
7	N_2 (ppm v/v)					74.48					
8	CO (ppm v/v)					0					
9	H_2 (ppm v/v)					0					

* : Absolute atmospheric pressure.

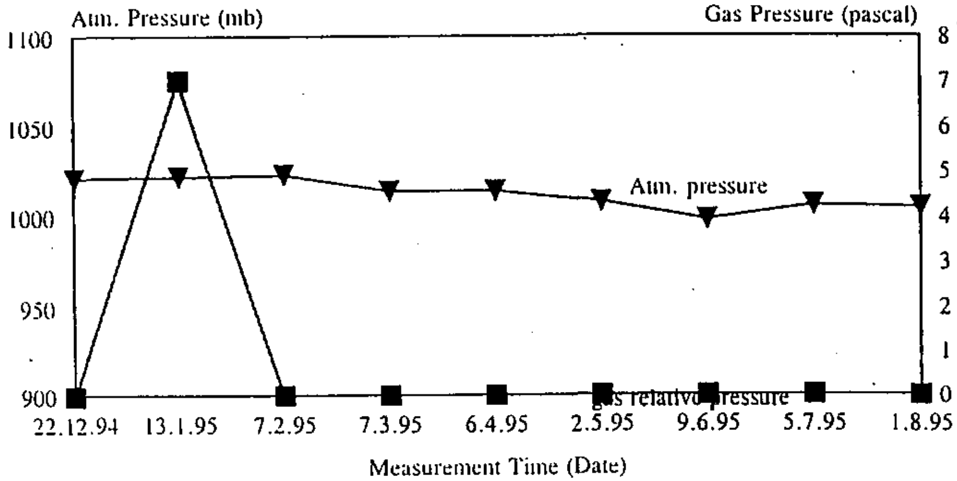
DP220 - Composition of Landfill Gas (Field Measureent)
Siu Lang Shui Landfill



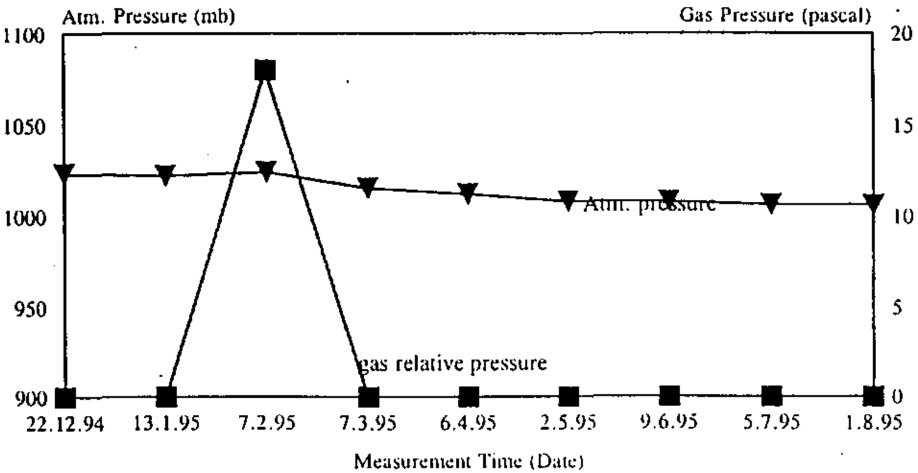
DH201 - Composition of Landfill Gas (Field Measurement)
Siu Lang Shui Landfill



DP220 - Atmospheric Pressure & Gas Relative Pressure
Siu Lang Shui Landfill

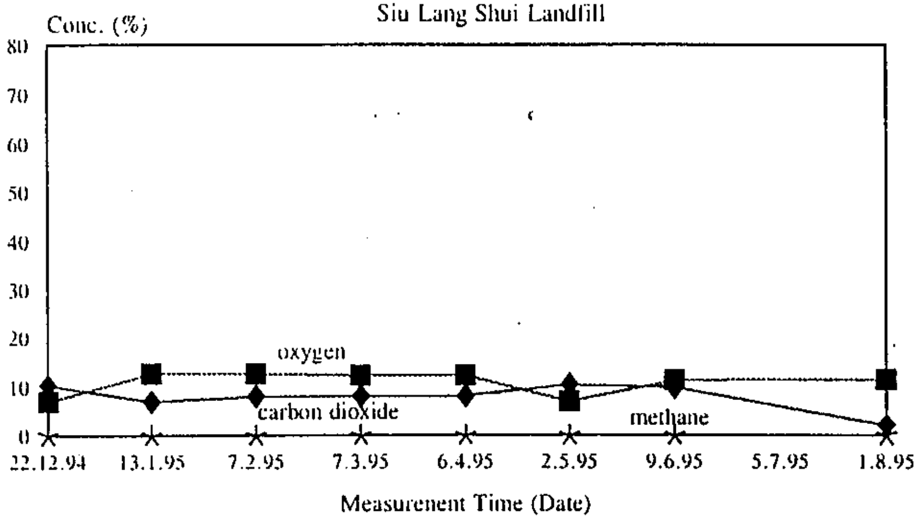


DH201 - Atmospheric Pressure & Gas Relative Pressure
Siu Lang Shui Landfill



DP221 - Composition of Landfill Gas (Field Measurement)

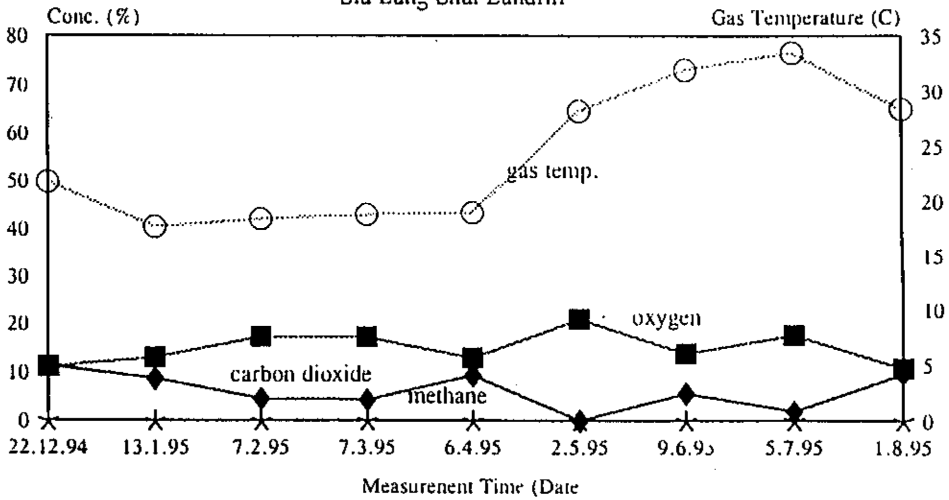
Siu Lang Shui Landfill



* Due to the coverage of the sampling well, no measurement data could be obtained in July, 95

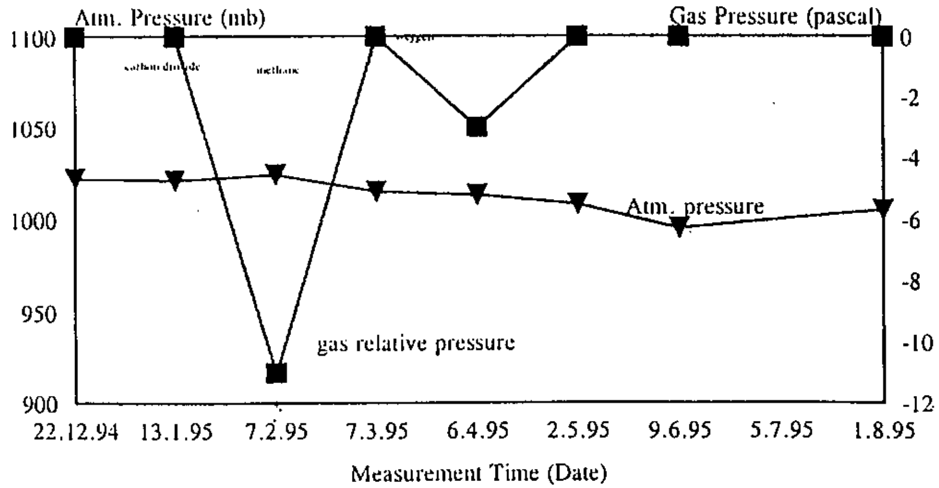
DH203A - Composition of Landfill Gas (Field Measurement)

Siu Lang Shui Landfill



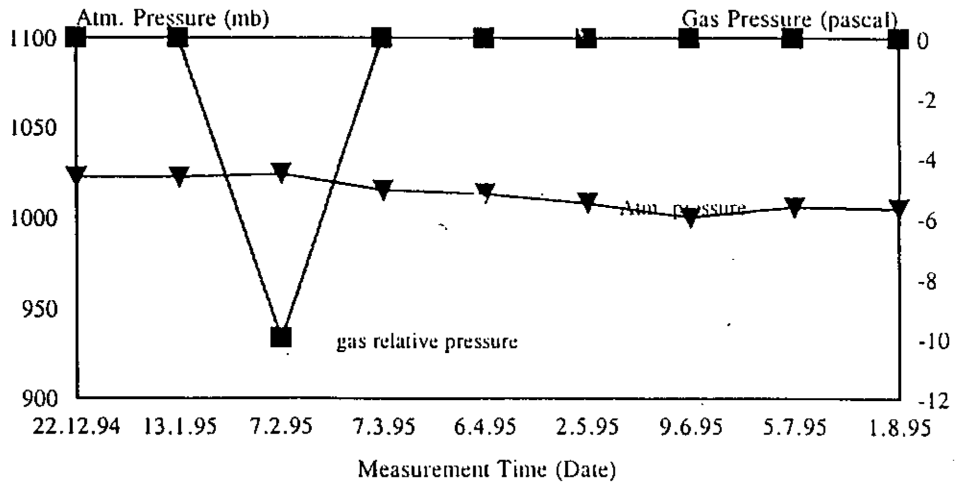
DP221 - Atmospheric Pressure & Gas Relative Pressure

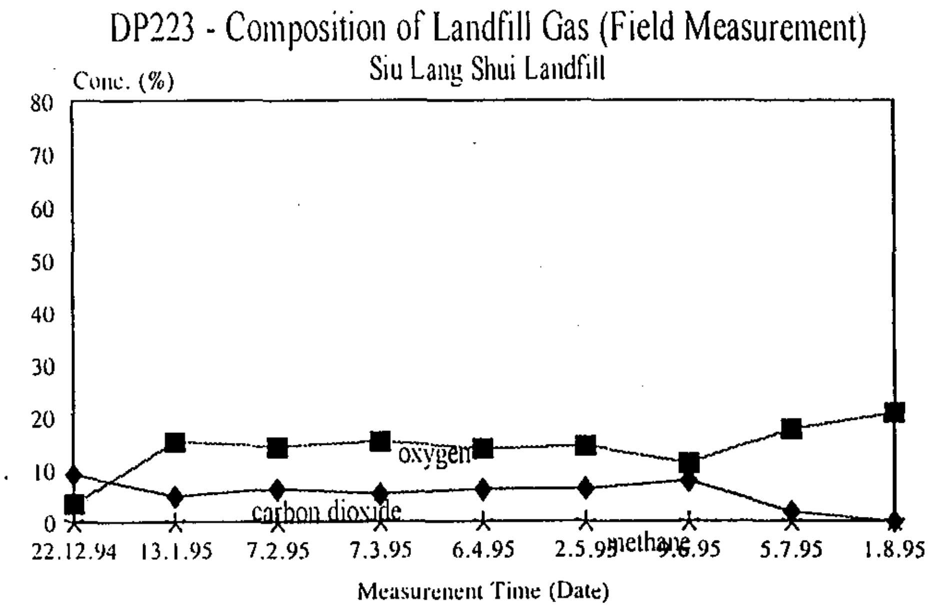
Siu Lang Shui Landfill

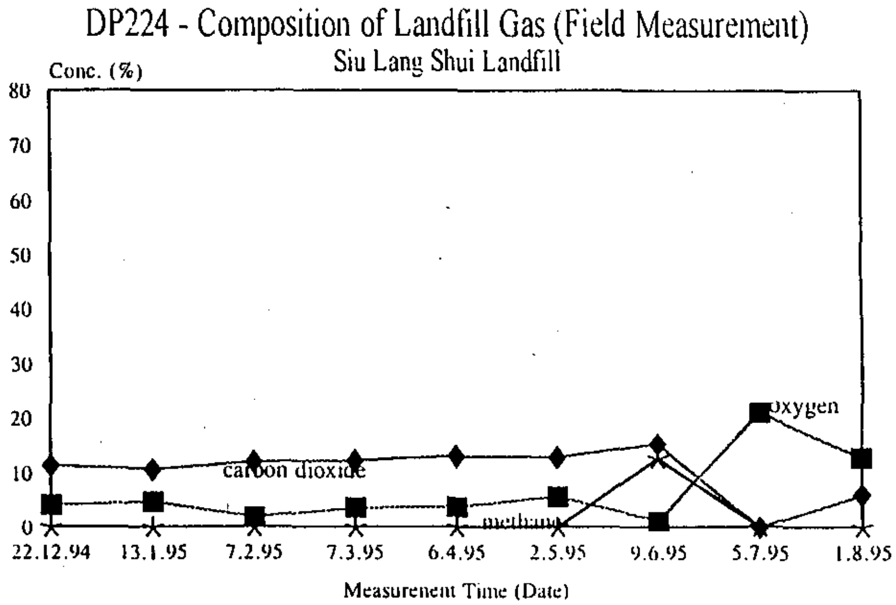


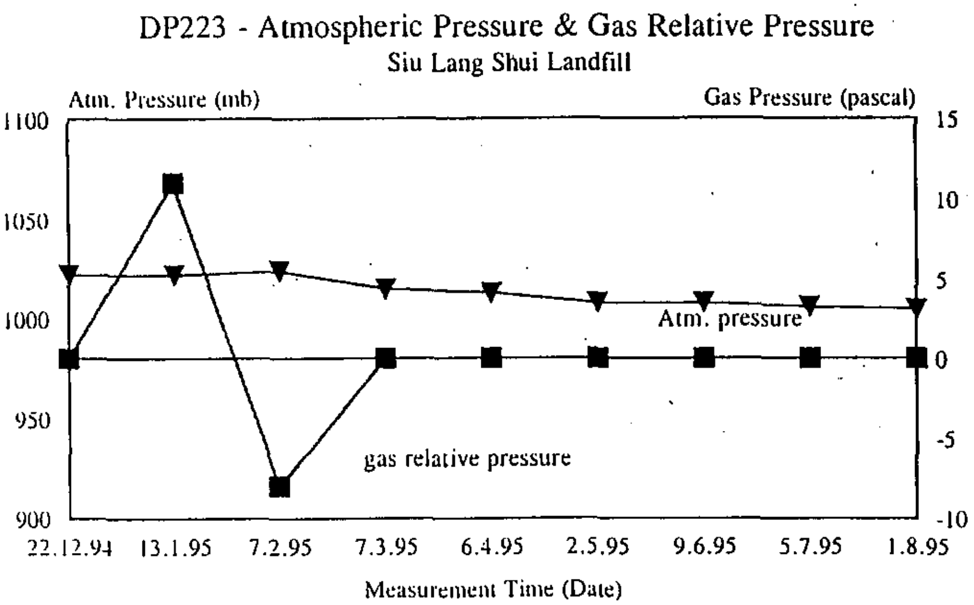
DH203A - Atmospheric Pressure & Gas Relative Pressure

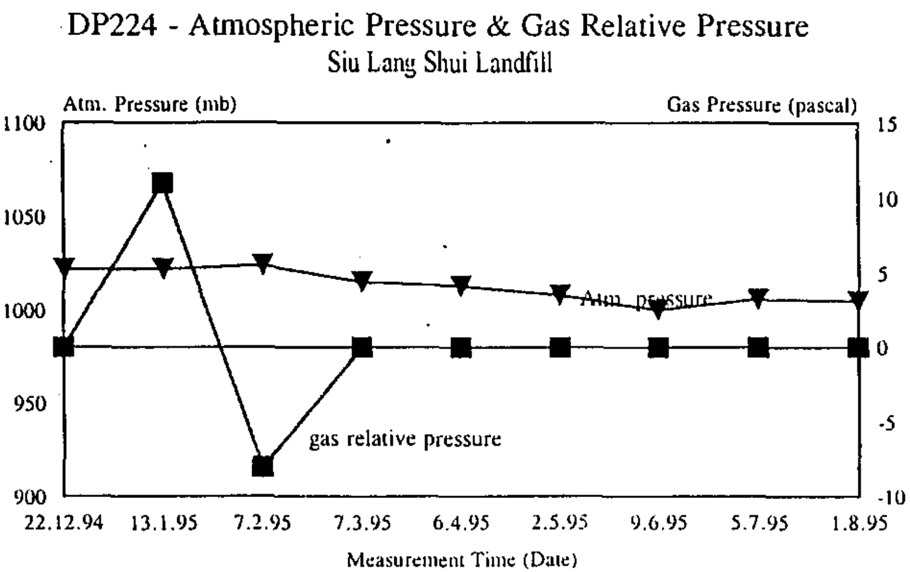
Siu Lang Shui Landfill




DP223 - Composition of Landfill Gas (Field Measurement)
Siu Lang Shui Landfill
Conc. (%)
oxygen
carbon dioxide
methane
Measurement Time (Date)


DP224 - Composition of Landfill Gas (Field Measurement)
Siu Lang Shui Landfill
Conc. (%)
oxygen
carbon dioxide
Measurement Time (Date)


DP223 - Atmospheric Pressure & Gas Relative Pressure
Siu Lang Shui Landfill
Atm. Pressure (mb)
Gas Pressure (pascal)
Atm. pressure
gas relative pressure
Measurement Time (Date)


DP224 - Atmospheric Pressure & Gas Relative Pressure
Siu Lang Shui Landfill
Atm. Pressure (mb)
Gas Pressure (pascal)
gas relative pressure
Measurement Time (Date)

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Hong Kong Ltd.
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576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
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TABLE 45 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DH207

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	33.0	26.7	32.7	20.5	16.1	23.0
2	Atmospheric Pressure (mbar)	996	1000	1008	1013	1014	1009
3	Relative Pressure (pascal)	53	3	5	2	96	5
4	Methane (%)	60.5	54.5	54.1	49.3	48.1	44.9
5	LEL (%)	**>100**	**>100**	**>100**	**>100**	**>100**	**>100**
6	CO2 (%)	**29.1**	**29.9**	**30.2**	**30.7**	**29.9**	**31.0**
7	O2 (%)	**0.60**	**0.40**	**0.70**	**1.00**	**1.00**	**0.90**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level:
(a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 46 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DH208

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	27.6	22.5	20.0	22.6	15.7	27.8
2	Atmospheric Pressure (mbar)	1002	999	1007	1016	1013	1005
3	Relative Pressure (pascal)	232	147	174	221	158	183
4	Methane (%)	58.5	57.6	64.5	59.5	59.8	56.7
5	LEL (%)	**>100**	**>100**	**>100**	**>100**	**>100**	**>100**
6	CO2 (%)	**29.1**	**30.3**	**29.5**	**31.4**	**32.2**	**34.6**
7	O2 (%)	**1.10**	**1.20**	**0.90**	**1.30**	**0.60**	**1.00**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level: (a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 47 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DH209

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	27.8	20.7	14.5	19.2	14.5	24.7
2	Atmospheric Pressure (mbar)	997	1000	1008	1012	1013	1006
3	Relative Pressure (pascal)	0	0	5	1	1	28
4	Methane (%)	38.5	21.6	30.6	15.5	15.3	19.3
5	LEL (%)	**>100**	**>100**	**>100**	**>100**	**>100**	**>100**
6	CO2 (%)	**23.1**	**14.8**	**22.0**	**15.2**	**16.4**	**17.9**
7	O2 (%)	**3.60**	**10.6**	**2.70**	**11.7**	**7.90**	**6.10**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	24.9	--	--	--
2	Carbon Dioxide (%)	--	--	26.1	--	--	--
3	Oxygen (%)	--	--	0.9	--	--	--
4	Nitrogen (%)	--	--	45.5	--	--	--
5	Carbon Monoxide (%)	--	--	0.0	--	--	--
6	Hydrogen (%)	--	--	0.0	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level: (a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 48 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DP212A

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	31.0	21.2	17.4	23.2	15.1	29.1
2	Atmospheric Pressure (mbar)	998	1000	1008	1012	1013	1005
3	Relative Pressure (pascal)	4	3	0	0	3	0
4	Methane (%)	35.0	28.6	27.8	18.5	27.0	1.53
5	LEL (%)	**>100**	**>100**	**>100**	**>100**	**>100**	**30.6**
6	CO2 (%)	**22.7**	**18.4**	**18.4**	**15.2**	**20.3**	**8.56**
7	O2 (%)	**5.20**	**6.50**	**6.70**	**9.70**	**5.80**	**9.30**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level:
(a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Hong Kong Ltd.
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576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 49 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DP213

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	29.2	22.7	17.4	24.5	14.7	28.1
2	Atmospheric Pressure (mbar)	999	1001	1010	1013	1013	1008
3	Relative Pressure (pascal)	0	0	0	0	10	0
4	Methane (%)	0.00	0.00	0.00	0.00	0.00	0.00
5	LEL (%)	0	0	0	0	0	0
6	CO2 (%)	**9.60**	**10.5**	**12.1**	**8.33**	**9.70**	**10.8**
7	O2 (%)	**11.9**	**8.90**	**6.40**	**11.6**	**8.60**	**6.00**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level:
(a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Kowloon, Hong Kong.
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TABLE 50 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DP214

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	31.1	24.0	21.3	24.7	15.5	28.3
2	Atmospheric Pressure (mbar)	998	1001	1009	1014	1013	1008
3	Relative Pressure (pascal)	0	0	0	0	0	0
4	Methane (%)	0.00	0.00	0.00	0.00	0.00	0.00
5	LEL (%)	0	0	0	0	0	0
6	CO2 (%)	**5.90**	**7.39**	**11.3**	**6.24**	**10.1**	**4.84**
7	O2 (%)	**12.7**	**11.9**	**6.20**	**13.0**	**8.50**	**13.5**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level:
(a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Hong Kong Ltd.
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Fax (852) 2786 1903

TABLE 51 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DP215

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	28.4	22.2	19.0	21.1	14.9	25.3
2	Atmospheric Pressure (mbar)	999	1001	1008	1014	1014	1008
3	Relative Pressure (pascal)	0	0	0	0	0	0
4	Methane (%)	0.00	0.00	0.00	0.00	0.00	0.00
5	LEL (%)	0	0	0	0	0	0
6	CO2 (%)	**9.60**	**9.09**	**9.70**	**6.75**	**8.06**	**7.42**
7	O2 (%)	**4.90**	**8.30**	**9.40**	**13.7**	**11.8**	**12.3**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	0.0
2	Carbon Dioxide (%)	--	--	--	--	--	6.3
3	Oxygen (%)	--	--	--	--	--	12.1
4	Nitrogen (%)	--	--	--	--	--	80.3
5	Carbon Monoxide (%)	--	--	--	--	--	0.9
6	Hydrogen (%)	--	--	--	--	--	0.0

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level: (a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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576 Castle Peak Road,
Kowloon, Hong Kong.
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Fax (852) 2786 1903

TABLE 52 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DP217

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	27.7	25.7	21.3	19.2	15.2	26.3
2	Atmospheric Pressure (mbar)	1003	1002	1009	1017	1016	1010
3	Relative Pressure (pascal)	46	23	31	17	2	22
4	Methane (%)	46.5	46.6	39.9	27.3	21.6	34.8
5	LEL (%)	**>100**	**>100**	**>100**	**>100**	**>100**	**>100**
6	CO2 (%)	**29.9**	**28.6**	**23.9**	**15.2**	**16.0**	**22.3**
7	O2 (%)	**0.70**	**1.00**	**0.80**	**9.60**	**9.60**	**5.40**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level:
(a) >20% LEL Methan
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 53 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DP219

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	32.7	27.7	21.1	21.7	14.8	24.4
2	Atmospheric Pressure (mbar)	996	1001	1008	1011	1016	1009
3	Relative Pressure (pascal)	5	1	2	0	24	0
4	Methane (%)	18.6	7.05	15.4	63.4	9.50	3.64
5	LEL (%)	**>100**	**>100**	**>100**	**>100**	**>100**	**72.8**
6	CO2 (%)	**16.0**	**7.55**	**18.3**	**8.22**	**12.8**	**9.60**
7	O2 (%)	**4.60**	**14.0**	**1.20**	**14.1**	**7.30**	**8.80**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level:
(a) >20% LEL Methan
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Hong Kong Ltd.
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576 Castle Peak Road,
Kowloon, Hong Kong.
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Fax (852) 2786 1903

TABLE 54 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill

Sampling Location : DP220

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	34.9	33.3	26.2	20.2	14.2	30.2
2	Atmospheric Pressure (mbar)	1000	1003	1008	1018	1015	1008
3	Relative Pressure (pascal)	172	10	0	1	21	0
4	Methane (%)	0.00	0.00	0.00	0.00	0.00	0.00
5	LEL (%)	0	0	0	0	0	0
6	CO2 (%)	0.00	0.00	0.00	0	0.00	0.00
7	O2 (%)	20.9	21.4	21.3	19.8	20.1	20.0
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level: (a) >20% LEL Methane

(b) >1.5% v/v Carbon Dioxide

(c) <18% v/v Oxygen

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576 Castle Peak Road,
Kowloon, Hong Kong.
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Fax (852) 2786 1903

TABLE 55 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DP221

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	30.2	26.0	21.6	22.0	14.4	26.2
2	Atmospheric Pressure (mbar)	999	1002	1009	1013	1016	1008
3	Relative Pressure (pascal)	0	0	3	1	1	0
4	Methane (%)	0.00	0.00	0.00	0.00	0.00	0.00
5	LEL (%)	0	0	0	0	0	0
6	CO2 (%)	**10.0**	**7.94**	**17.5**	**5.86**	**7.58**	**9.46**
7	O2 (%)	**8.10**	**13.1**	**2.60**	**15.5**	**14.0**	**12.1**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level: (a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Inchcape Testing Services
Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 56 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DP223

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	35.1	33.3	28.6	25.5	14.1	35.8
2	Atmospheric Pressure (mbar)	999	1002	1008	1011	1016	1008
3	Relative Pressure (pascal)	1	0	0	0	7	0
4	Methane (%)	0.00	0.00	0.29	0.00	0.00	0.00
5	LEL (%)	0	0	5.80	0	0	0
6	CO2 (%)	**25.1**	**13.6**	**20.3**	**4.38**	**6.20**	**6.93**
7	O2 (%)	**1.20**	**10.9**	**1.40**	**16.8**	**14.1**	**11.7**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level:
(a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

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Inchcape Testing Services
Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 57 LANDFILL GAS ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Sampling Location : DP224

Number	Field Parameters	Date of Monitoring Analysis					
		Oct 95	Nov 95	Dec 95	Jan 96	Feb 96	Mar 96
1	Temp (C)	34.7	31.5	24.8	25.0	14.4	34.0
2	Atmospheric Pressure (mbar)	1003	1004	1007	1004	1016	1008
3	Relative Pressure (pascal)	0	0	1	2	0	0
4	Methane (%)	0.00	0.00	0.00	0.00	0.00	0.00
5	LEL (%)	0	0	0	0	0	0
6	CO2 (%)	**10.9**	**6.99**	**13.5**	**5.60**	**4.84**	**3.96**
7	O2 (%)	**7.70**	**12.3**	**2.20**	**13.7**	**15.0**	**13.1**
	Laboratory Analysis (GC-TCD)						
1	Methane (%)	--	--	--	--	--	--
2	Carbon Dioxide (%)	--	--	--	--	--	--
3	Oxygen (%)	--	--	--	--	--	--
4	Nitrogen (%)	--	--	--	--	--	--
5	Carbon Monoxide (%)	--	--	--	--	--	--
6	Hydrogen (%)	--	--	--	--	--	--

Remark : Bold faced values represent the reading exceed the following trigger levels.

Trigger Level:
(a) >20% LEL Methane
(b) >1.5% v/v Carbon Dioxide
(c) <18% v/v Oxygen

Inchcape Testing Services
Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 7 LANDFILL GAS ANALYSIS RESULTS FOR FURTHER MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Date of Measurement : 02 May., 1996
Weather : Sunny

Sampling Location	Temp. (C)	Atmospheric Pressure (mbar)	Relative Pressure (pascal)	Methane (%)	LEL (%)	CO2 (%)	O2 (%)
DH201	35.5	997	9	0.00	0	**10.0**	**8.10**
DH203A	35.7	997	60	0.00	0	**6.93**	**9.60**
DH204	34.9	997	0	0.00	0	0	19.8
DH205	30.7	997	7	29.7	**>100**	**23.4**	**5.20**
DH207	28.2	998	31	43.7	**>100**	**31.7**	**0.60**
DH208	35.4	998	170	52.4	**>100**	**32.5**	**0.70**
DH209	37.9	998	0	4.26	**85.2**	**3.65**	**16.8**
DP212A	33.3	997	0	0.00	0	0	19.9
DP213	32.4	997	1	3.09	**61.8**	**10.4**	**5.20**
DP214	34.0	997	0	2.79	**55.8**	**8.86**	**8.60**
DP215	30.3	999	1	0.00	0	**9.60**	**7.50**
DP217	38.8	1001	60	51.2	**>100**	**15.9**	**2.80**
DP219	35.6	999	31	1.57	**31.4**	**3.45**	**14.8**
DP220	31.3	998	2	0.00	0	0	20.0
DP221	31.4	997	24	0.00	0	**2.53**	**11.0**
DP223	35.6	997	0	0.00	0	1.24	18.5
DP224	35.7	997	0	0.00	0	**5.62**	**13.2**

Remark : Bold faced values represent the reading exceed the following trigger levels.
Trigger Level:
(a) > 20% LEL Methane
(b) > 1.5% v/v Carbon Dioxide
(c) < 18% v/v Oxygen

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Inchcape Testing Services
Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 746 8600
Fax (852) 786 1905

TABLE 4 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Date of Measuremen : 02 May., 1996
Weather : Sunny

Number	Analytical Parameters	Sampling Location			
		L206	L207	W201	W204
1	Water Level (m)*	--	--	--	--
2	Water Flow Rate (L/s)	--	No Flow	54	48
3	pH	8.7	7.3	7.5	7.4
4	Temperature (C)	27.1	27.8	29.1	30.3
5	Chemical Oxygen Demand (mg/L)	470	480	<7	10
6	Ammonical Nitrogen (mg-N/L)	550	740	<0.3	3.1

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.

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Inchcape Testing Services
Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 10 LANDFILL GAS ANALYSIS RESULTS FOR FURTHER MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Nubmer	Analytical Parameters	Sampling Location		
		SLS* DP212A	MTL* DH305	NTM* DP415
1	Methane (%)	38.6	0.0	3.3
2	Carbon Dioxide (%)	26.8	3.5	8.1
3	Oxygen (%)	2.2	20.2	14.5
4	Nitrogen (%)	29.3	79.1	77.9
5	Carbon Monoxide (%)	0.0	0.0	0.0
6	Hydrogen (%)	0.0	0.0	0.0

Remark:* SLS = Siu Lang Shui
MTL = Ma Tso Lung
NTM = Ngau Tam Mei

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Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 7 LANDFILL GAS ANALYSIS RESULTS FOR FURTHER MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Date of Measurement : 31 May., 1996
Weather : Sunny

Sampling Location	Temp. (C)	Atmospheric Pressure (mbar)	Relative Pressure (pascal)	Methane (%)	LEL (%)	CO2 (%)	O2 (%)
DH201	30.0	992	116	0.00	0	**4.19**	**5.90**
DH203A	28.0	991	183	0.00	0	**4.37**	**8.50**
DH204	40.2	992	132	0.00	0	**7.85**	**4.80**
DH205	29.8	992	15	43.7	**>100**	**35.7**	**0.60**
DH207	28.4	994	14	46.8	**>100**	**29.8**	**0.90**
DH208	35.3	991	161	54.3	**>100**	**36.5**	**0.50**
DH209	33.4	991	5	18.1	**>100**	**17.1**	**8.90**
DP212A	29.8	998	0	22.8	**>100**	**19.8**	**4.50**
DP213	27.8	992	4	0.29	5.80	**8.20**	**4.00**
DP214	29.3	993	4	0.00	0	**6.97**	**10.4**
DP215	28.3	993	9	0.18	3.60	**13.1**	**3.90**
DP217	35.6	998	4	62.2	**>100**	**23.5**	**0.70**
DP219	32.4	995	22	1.53	**30.6**	**4.28**	**11.5**
DP220	32.2	993	6	0.00	0	0.11	19.4
DP221	29.6	992	30	0.00	0	0.00	19.1
DP223	29.4	991	9	0.00	0	0.00	19.2
DP224	37.3	992	1	0.00	0	0.00	19.6

Remark : Bold faced values represent the reading exceed the following trigger levels.
Trigger Level: (a) > 20% LEL Methane
(b) > 1.5% v/v Carbon Dioxide
(c) < 18% v/v Oxygen

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Inchcape Testing Services
Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1905

TABLE 4 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Date of Measurement : 31 May., 1996
Weather : Sunny

Number	Analytical Parameters	Sampling Location												
		DH201	DH203A#	DH204	DH205	A251	A252	A253	A254#	A255#	L206	L207	W201	W204
1	Water Level (m)*	3.10	6.10	2.45	26.50	14.10	18.95	No Water	19.00	32.65	---	---	---	---
2	Water Flow Rate (L/s)	---	---	---	---	---	---	---	---	---	---	No Flow	98	240
3	pH	6.3	---	7.4	8.1	7.2	---	---	---	---	6.9	7.3	7.0	7.0
4	Temperature (C)	25.5	---	26.6	39.0	30.2	---	---	---	---	27.5	28.9	28.3	28.8
5	Chemical Oxygen Demand (mg/L)	26	---	210	14000	490	---	---	---	---	240	280	<7	<7
6	Ammonical Nitrogen (mg-N/L)	4.5	---	480	8200	800	---	---	---	---	450	490	<0.3	3.8

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.
Insufficient water at DH203A, A252, A254 & A255.

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Inchcape Testing Services
Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 7 LANDFILL GAS ANALYSIS RESULTS FOR FURTHER MONITORING AT NORTH WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Date of Measurement : 28 Jun., 1996
Weather : Sunny

Sampling Location	Temp. (C)	Atmospheric Pressure (mbar)	Relative Pressure (pascal)	Methane (%)	LEL (%)	CO2 (%)	O2 (%)
DH201	31.0	1007	1	0.00	0	**6.77**	**9.10**
DH203A	29.2	1007	2	0.00	0	**9.26**	**1.90**
DH204	33.5	1007	2	0.00	0	**8.19**	**5.80**
DH205	35.6	1005	13	38.6	**>100**	**31.3**	**1.90**
DH207	29.9	1006	1	46.8	**>100**	**29.0**	**0.90**
DH208	36.0	1006	130	51.5	**>100**	**35.3**	**1.20**
DH209	37.9	1005	2	15.3	**>100**	**10.4**	**12.2**
DP212A	34.1	1005	0	34.4	**>100**	**26.1**	**1.60**
DP213	30.5	1006	3	0.00	0	**3.61**	**11.5**
DP214	31.8	1007	1	0.13	2.60	**8.11**	**8.90**
DP215	29.4	1006	2	0.00	0	**12.0**	**3.90**
DP217	38.9	1008	14	53.1	**>100**	**29.3**	**2.10**
DP219	32.0	1007	1	0.29	5.80	**3.73**	**13.1**
DP220	31.6	1007	0	0.00	0	0.00	19.8
DP221	30.8	1007	2	0.00	0	**1.63**	**14.8**
DP223	30.1	1007	6	0.00	0	0.00	20.2
DP224	32.9	1007	3	0.00	0	1.04	18.4

Remark : Bold faced values represent the reading exceed the following trigger levels.
Trigger Level:
(a) > 20% LEL Methane
(b) > 1.5% v/v Carbon Dioxide
(c) < 18% v/v Oxygen

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Inchcape Testing Services
Hong Kong Ltd.
2/F., Garment Centre,
576 Castle Peak Road,
Kowloon, Hong Kong.
Telephone (852) 2746 8600
Fax (852) 2786 1903

TABLE 4 GROUNDWATER/LEACHATE/SURFACE WATER ANALYSIS RESULTS FOR THE FURTHER ENVIRONMENTAL MONITORING AT NORTH-WEST NEW TERRITORIES LANDFILLS

Site : Siu Lang Shui Landfill
Date of Measuremen : 28 Jun., 1996
Weather : Sunny

Number	Analytical Parameters	Sampling Location			
		L206	L207	W201	W204
1	Water Level (m)*	--	--	--	--
2	Water Flow Rate (L/s)	--	0.45	73	180
3	pH	6.8	7.3	7.0	7.5
4	Temperature (C)	29.1	28.5	31.0	29.6
5	Chemical Oxygen Demand (mg/L)	150	650	<7	17
6	Ammonical Nitrogen (mg-N/L)	200	910	<0.3	9.5

Remark : * The water depth was measured from the top of bore hole to water surface in the bore hole.

Annex C

Response to Comments

Response to Comments
River Trade Terminal at Tuen Mun Area 38 Detailed Environmental Impact Assessment - Draft Final Report

No.	Department	Reference	Comments	Consultants' Response
1.	EPD/TAG, Tom Tam	( ) in EP 1/TM/38/5	*Air Quality* i) Section 4.5.2, in order to obtain realistic dust concentration at the receptors (which covering the conservative meteorological condition of F1), the Consultant should use the actual meteorological data to determine the hourly and daily dust concentration at the receptors.	Construction activities during nighttime (dredging and filling) are not dust generating activities. Major dust generating activities such as bulldozing will be carried out daytime and therefore worst case daytime meteorological conditions (D1) were used in the model.
2.			ii) Section 4.6.2, 3rd para., would the Consultant please specify relevant sections of the various Studies quoted which have assessed the air quality impact due to traffic related to the proposed RTT. In addition, the Consultant should also present and compare the predicted traffic flow data and traffic mix at some major road transport networks nearby with and without the RTT scenarios.	Noted and relevant sections of various studies will be specified. Traffic flow of Lung Mun Road, with and without the RTT, will be compared, but this comparision will not affect the conclusion presented in the EIA Study.
3.			*Waste* i) Section 2.3.3 Dredging The 2,400,000 m^3 of spoil generated from dredging for the construction of various marine structures and for maintaining the navigation depth is very significant. The consultant should explore the feasibility of alternative construction method i.e. deep foundation to support breakwater or quay wall in order to reduce the volume of dredging required.	The revised volume of dredged mud has been revised to 3,300,000 m^3. following completion of the Site Investigation Works of which 900,000 m^3 of dredging is for Government Entrusted Works. The engineering design has taken a minimal dredge approach to minimise the amount of marine mud to be dredged prior to reclamation. The volume of dredged mud hase been kept to a minimum by only dredging the required amount below the seawall and reprovisioned outfall and in area within the RTT basin to allow safe navigation of marine traffic. Dredging has been included below seawalls and quaywalls to maintain stability. Deep foundation design is not suitable for the type of vessels envisaged.

No.	Department	Reference	Comments	Consultants' Response
4.			ii) Section 6.4.6 P.8, Section 6.5.5 P. 14 P. 15 Construction Waste, General Refuse and Industrial Waste WENT currently does not receive construction waste and privately collected waste. Public dump is the appropriate outlet for the disposal of suitable construction waste. Disposal of privately collected waste & construction waste with less than 20% inert material should be diverted to other strategic landfills.	Noted. The reference to WENT will be changed to SENT and NENT. The existing text of the *Section 6* makes the recommendation that all suitable construction wastes should be taken to public dumps.
5.			iii) Section 6.4.2 P.4, Section 6.5.4, P.12, P.13 Forecasts on quantities of wastes Construction waste (20m^3 per month), general refuse (15m^3 per day), waste from marine vessels (24m^3 per day), industrial waste (20 to 30m^3 per day) are generally measured in weight unit in Hong Kong. The consultant should make use of the waste generation rates provided in the report "Monitoring of Municipal Solid Waste 1993 and 1994 Hong Kong" to forecast the various waste generation quantities during the life of operation of the River Trade Terminal (RTT) an d make necessary adjustments in light of his knowledge on the waste generation at RTT. Without the derivation of these waste projection figures, it is not sure whether they are realistic or not. From past experience, these estimates appear to be on the low side. The consultant is therefore advised to review their estimates again.	The estimated quantities of waste arisings at the RTT have been based upon information obtained from the operation of other container handling facilities in Hong Kong and are considered to be realistic. The volumes of waste generated at the RTT will be directly related to the container throughput, the extent of the packing and unpacking of containers, the numbers of staff employed and the maintenance activities undertaken in the RTT. However, in response to your comments we will review these figures in the context of the report, "Monitoring of Municipal Solid Waste 1993 and 1994".
6.	Land Dept., J.S. Corrigall	(81) in LD 2/TM/LS/96 VI	I have no comments to make on the above. I think it inappropriate for me to say that I endorse it as it deals with matters which are outside my expertise.	Noted.
7.	Marine Dept., J.S. Lambourn	(24) in PA/S909/111/7(11)	Please note that I endorse the EIA Report. I feel the Sensitive Receiver Section 3.4 of the Water and Sediment Quality Chapter would be incomplete if the live fish storage vessels anchored off Tuen Mun Area 27 and the associated live fish selling business in Area 27 which draw seawater from Area 27 were not mentioned.	Noted. Water Sensitive Receivers (WSR) have been identified in strict accordance with the Hong Kong Planning Standards and Guidelines which do not include such possibly temporary or potentially non-fixed commercial fish selling business activities as WSR's.

No.	Department	Reference	Comments	Consultants' Response
8.	AFD	( ) in AF DVL 11/6 3 Sept. 1996	Chinese White Dolphins Section 7.3.3 (i) Although more than 12 species of marine mammals have been recorded from Hong Kong, most of these are known only from strandings and have never been seen alive in the territory. The majority of these are deep-water animals that would not likely live in Hong Kong.	Agreed.
9.			(ii) Until the extent of the range of the Chinese White Dolphin is known, and some sighting rate information from throughout that range is available, we cannot really estimate a population size of the animals. The estimate made by SWIMS or Dr. Jefferson is an abundance estimate for the number of dolphins in a particular area (North Lantau)	Agreed, the report will be revised to indicate that the figures quoted are an abundance estimates not population estimates.
10.			Section 7.4.3 (iii) Does RTT construction activities involve piling or blasting operations etc.?	It is presently understood that the RTT marine construction will involve no blasting or piling activities; the report will be clarified accordingly.
11.			Section 7.5 (iv) If percussive piling or explosive operations are to be involved in construction, the use of a bubble curtain for dolphin noise mitigation should be considered. This apparatus has been shown to be very effective for the AFRF construction.	See response to AFD comment on Section 7.4.3., Section 7.5 indicated that a bubble curtain could be employed to reduce piling impacts if piling was identified as necessary.
12.			Section 7.6.3 (v) Information about sewage discharge seems unnecessarily excessive and is more relevant to a later EPD study than this study.	Agreed. The information is provided to ensure adequate coverage but as stated by AFD, this issue will be addressed in the forth coming EPD "Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall" Study.
13.			I have passed a copy of the report to my colleagues for comment from the fisheries and marine conservation point of view. I shall be let you know about their comments once available.	Noted.

No.	Department	Reference	Comments	Consultants' Response
14.	Port Development Board	(3) in PDB 11/50/90/3 IX 4 Sept. 1996	Section 4. Table 4.6a I understand that the data shown on this table is extracted from the RTT Traffic Impact Assessment. However, the way it is presented is not understandable and may cause confusion. I suggest the table be restructured and you may need to specify the location of the traffic volume.	Noted. The Table 4.6a will be revised restructured as suggested.
15.	DLOTM Lands Dept.	DLOTM 221/CPD/PA/66 VIII 4 Sept. 1996	I refer to the Draft Final Report and would rather let those environment experts put forward their comments on the same. I agree with D of Lands that it is not appropriate for this office to endorse the report as what is contained therein is outside our expertise.	Noted.
16.	EPD	EP 1/TM/38/5 5 Sept. 1996	Section 6 I note the amount of uncontaminated and contaminated mud was mentioned in the "Water Quality" section. Grateful if you can insert this piece of information in Section 6. Please also state the recommended disposal sites for both of them.	The amount of uncontaminated and contaminated mud has been addressed and dealt with in Section 3. Cross reference will be made in Section 6.
17.			Section 8 You have focused on the study of landfill gas below the ground level. According to Section 3.7 of the Final Inception Report, you should consider the likely "above ground pathways" of the landfill gas that might pose air quality impacts on the atmosphere. However, based on the separation distances between the proposed RTT and both subject landfill sites, it is unlikely to have major air quality impacts on the development.	Noted & Agreed. Due to the large seperation distance between the proposed RTT and both landfill sites, "above ground pathways" will not pose air quality impacts on the development.

No.	Department	Reference	Comments	Consultants' Response
18.	AFD	5 September 1996	para 7.9.3 The present EIA study predicted that prey species of Sousa would be abundant in the waters around the Pillar Point sewage outfall due to the high level nutrient level there. However, this statement should be substantiated by conclusive data.	Studies in the Moray Firth (UK) of *Tursiops truncatus* indicate that they are frequently seen in the vicinity of Longman sewage outfall (Highland Regional Council, Inverness Main Drainage Scheme, Environmental Assessment. Final Study Report, Appendices - Volume II (1990)). Observations from other parts of the UK also suggest that dolphins spend considerable time close to outfall pipes, possibly because these attract fish (Lockyer, C and Morris R J (1986) The history and the behaviour of a wild, sociable bottlenose dolphin (*Tursiops truncatus*) off the north coast of Cornwall. Aquatic Mammals, 12: 3-16. and Morris, R J, Law, R J, Allchin, C R, Kelly, C A & Fileman, C F (1989) Metals and organochlorines in dolphins and porpoises of Cardigan Bay, West Wales, Marine Pollution Bulletin, 20: 512 - 523).
19.			Heavy metals, organochlorines (e.g. PCB) and pathogens present in sewage discharge will definitely affect the health of *Sousa*. Measures in reducing such pollutants entering the waters is very important. The consultants should make reference to the Baseline and Performance Verification Monitoring of the Pillar Point Sewage Outfall when results are available.	Agreed, reference has been made of the forthcoming EPD consultancy study entitled Baseline and Performance Verification Monitoring of the Pillar Point Outfall. This study is scheduled to commence in late 1996.

No.	Department	Reference	Comments	Consultants' Response
20.	AFD (Fisheries)	5 September 1996	I recall that in the Area 38 EIA completed in 1994 covering the general area and developments the principal fisheries/marine ecological issue was considered to be loss of coastal marine habitat on the coastline from Black Point to Tuen Mun, and Secondly the direct loss of fishing grounds.	Both the Expanded Development Study (EDS) for Tuen Mun Area 38 and the brief for the Area 38 SIA EIA did not identify ecological impacts as an issue to be addressed in the Area 38 SIA EIA. Nevertheless, in response to an AFD comment on the draft Area 38 SIA EIA the endorsed Final Area 38 SIA EIA report included a preliminary ecological review. This stated that "the relative quality of the these non-pristine areas is considered low due to degradation as a result of the adjacent industrial land uses. In view of this perceived low relative quality it is considered that these areas may have already suffered damage to their ecological potential for nursery and spawning of marine biota." The review concluded that "... it is anticipated that the proposed development works will have minimal impact on the marine ecology of the study area." No reference was made in the endorsed Final Area 38 SIA EIA report of direct loss of fishing grounds. We believe that the Final Area 38 SIA EIA statements on ecology are still valid and thus do not feel discussion of habitat loss, beyond that provided in the RTT document, is warranted.
21.			Section 7.1 does not seem to build logically on this earlier work, completely omitting the marine habitat loss and introducing terrestrial issues where none exist. Benthic faunal issues are not a key concern, littoral ones may be.	We agree with your consideration that terrestrial impacts do not exist. However, the 500m loss of "littoral" habitat was not considered of conservation significance as the habitat has already suffered severe damage due to degradation as a result of the adjacent industrial land uses and thus has, as reported in the Area 38 SIA EIA, already has significantly reduced ecological potential in terms for nursery and spawning of marine biota. Therefore, as no littoral habitat loss impacts are predicted, mitigation is not considered appropriate. The Final RTT EIA report will be amended to reflect the above issue.
22.			The basic conclusions 7.9.1 & 7.9.2 are acceptable, though for the latter probably for the wrong reasons. The significant gap is failure to address habitat loss and thus address mitigation possibilities.	See response to AFD comment 19. As stated in response to comment 20, as no littoral habitat loss impacts are predicted, mitigation is not considered appropriate and thus the Final RTT EIA report will be amended accordingly.
23.			The approach to fisheries assessment is novel but not necessarily unacceptable. The main omission is 7.4.2 is no mention of the possible value of the shallow sandy areas to be lost as fish nursery habitat.	As stated in the response to to AFD comment on Section 7.1, the littoral habitat (shallow sandy/rocky coastline) which will be directly lost has a significantly reduced ecological potential in terms for nursery and spawning of marine biota. The Final RTT EIA report will be amended to reflect the above issue.

No.	Department	Reference	Comments	Consultants' Response
24.			As regards loss of fishing grounds the report needs to indicate to what depths the reclamation will extend. It seems likely that it may extend to beyond P.D - 4m meaning it will restrict the operation of shrimp trailers and hang trailers that are the major commercial operations in the deeper waters of Urmston Road.	The RTT will extend beyond -4mPD and thus there could be some interference to any commercial fishing operations in the deeper waters of the Urmston Road. However, it should be noted that these waters are heavily trafficked by non-fishing related marine traffic and thus are unlikely to contain preferred fishing grounds due to the navigational hazards involved in trawling in this area. Therefore, reclamation in this area is unlikely to impact key fishing grounds.
25.			The last sentence appears to confuse biological productivity with fishing productivity.	Agreed, the sentence will be modified in the Final RTT EIA to acknowledge that the productivity in the area may not be able to be fully exploited by the fishing industry due to navigational issues associated with fishing in a highly-trafficked area.
26.			Section 7.6.2 It seems likely the RTT will increase marine traffic in the area and thus adversely affect safe fishing operations.	As described in Section 2, the RTT will not directly increase marine traffic, in fact the numbers of Pearl River (PRC) vessels east of the RTT will be reduced by approximately 10% as a result of the consolidation function of the RTT (ie, the container cargo of approximately 10 small PRC vessels will be unloaded at the RTT and loaded onto a large marine "shuttle" vessel which will take the container cargo to the container port at Kwai Chung). Section 7.6.2 of the Final RTT EIA report will be revised accordingly for clarification purposes.
27.			No evidence presented for a potential bioaccumulation impact arising from the RTT such as is inferred from the second paragraph. I suggest this be deleted as irrelevant to this EIA:	Agreed, the referenced section will be deleted.
28.			Please incorporate the above points in your reply also seeking SAFO's comment on the last bullet in 7.2 which is I think quite erroneous: there is nothing statutory or legislative about the values listed.	Agreed. Section 7.2 will be amended to state that this refers to limits set for *ex-gratia* purposes at the Ma Wan mariculture zone.
29.	EPD, Evan K. S. Yung	5 September 1996	Section 3.5.2 Would the RTT construction be concurrent with SIA reclamation work (stage I or II)? If yes, why are they not included in the worst case scenario?	The worst case construction scenario for the RTT is predicted after December 1996. At this time, the final part of Stage 1 of the SIA construction filling of behind a formed seawall will be carried out at the same time. It is considered that as the SIA filling activities will be occuring behind a formed seawall, they will generate a negligible contribution to local SS levels.

No.	Department	Reference	Comments	Consultants' Response
30.			Section 3.5.3 Should mark the newly extended emergency by-pass outfall on an appropriate figure.	Noted. It will be included in our revised final report, but is approximately 700 m in length.
31.			Section 3.6.1 Should indicate how long the new outfall.	Noted. It will be included in our revised final report, but is approximately 2000 m in length.
32.			Should elaborate how "zero discharge can be achieved. Any domestic or commercial discharge? Connection to PPSTW?	Domestic Sewage from the RTT operations will be taken to the PPSTW for treatment.
33.			What is the volume of material that will be excavated during maintenance dredging?	Maintenance dredging will be carried out at a minimum of every 5 years.
34.			More information about the extent of marine sediment contamination should be included in the report for completeness.	Agreed. The Consultant will include this information in the *Annex A* of the revised report.
35.	Transport Department	NR 157/161/TMTL-393 5 Sept. 1996	No comment.	Noted.
36.	Planning Dept.	SPD/TM/005 5 Sept. 1996	Fig. 2.1a A large scale should be adopted to improve the readability of the plan.	This Figure is only used to show the relative location of the RTT in context of the NWNT.
37.			Para 9.2.2 Please clarify what approach or methodology has been adopted in the Impact Assessment stage. It is noted that a viewpoint analysis approach has been adopted in assessing the residual landscape and visual impacts.	The impact assessment stage included a field study of which photographic record was taken. The methodology for this stage is clearly outlined in 9.2.2 "Assessment Methodology" including the establishment of the baseline condition and the assessment of the likely changes to the baseline condition.
38.			Para 9.3.1 The Study Area should be expanded to cover the residential development at Pearl Island as the residents there would be able to view the proposed RTT and these residential developments are also located more closer to the proposed RTT than the new residential development of Tung Chung.	Due to the positioning of the RTT site slightly to the west of the headland at Pillar Point, with Tuen Mun in the foreground, it is not anticipated that the RTT will be visible from Pearl Island. The text will be amended to include a paragraph eliminating Pearl Island from the study area.

No.	Department	Reference	Comments	Consultants' Response
39.			Para 9.3.2 Residential development at Pearl Island should be added.	Refer to previous response.
40.			Appropriate annotation should be incorporated in Fig. 9.3c to illustrate clearly the points made in the main text.	Noted.
41.			Para 9.3.3 It is noted that the overall quality of the existing view would have some bearings on the visual impact of a new development, but the cumulative visual impact of the new development still need to be addressed.	The overall quality of the existing view is taken int consideration when assessing visual impact, in order to establish the extent to which the baseline condition is changed. For example, positioning a power station within an area of undisturbed countryside will have a greater visual impact than if the same power station were positioned in an industrial zone. Of course, in addition to considering the change to the baseline condition, the cumulative visual impact of the new development has been considered (Refer section 9.4)
42.			In considering the visual obstruction, visual intrusion and visual quality, it would appear that subjective rather than objective professional judgement would be based. Please clarify what would determine the existing visual quality.	As stated in para 9.2.2 "Assessment Methodology", in considering the visual obstruction, visual intrusion, and visual quality, a balance between objective and subjective professional opinion is required. This is also the case when assessing the existing visual quality. By using photographs, drawings, photomontages, and based on our previous professional experience, we have striven t achieve as objective an assessment as possible.
43.			For the sensitive viewpoints, adjustment would have to be made with the inclusion of the residential development at Pearl Island.	Refer response to para. 9.3.1
44.			Para. 9.4.1 Please clarify whether some or all the existing trees and shrubs within the Study Area will be removed.	It will be necessary for all of the vegetation within the site area to be removed. This is predominantly scrub and young trees. compensatory planting will be included as part of the proposed RTT.
45.			Para. 9.5.1 Please specify the maximum levels that the heights of storage materials and stock piles should be maintained.	It will be necessary for construction work to be carried out at night-time. The report will be revised to address this issue.
46.			Please also clarify what are the statutory limitations that the night-time working and floodlighting should be kept.	Noted.

No.	Department	Reference	Comments	Consultants' Response
47.			Para 9.5.2 The appearance of the breakwaters should also be soften.	The proposed plant material able to tolerate the extreme conditions experienced in a coastal situation, is as follows and will be included in the report:
48.			Please specify what plant materials that are considered well adopted to the extreme site conditions experienced on coastal sites.	Trees: *Cerbera manghas, Ficus rumphii, Hibiscus tiliaceus.* Shrubs: *Nerium indicum, Scaevola sericea, Thevetia peruviana.* Herbaceous Plants: *Crinium asiaticum.* Groundover Plants: *Wedelia trilobata.*
49.			Please indicate the effectiveness of the bitumen being used for the surface of the RTT in reducing the surface glare in particular during the night time operation of the proposed RTT.	Bitumen is a dark coloured and non reflective material. Dark coloured materials absorb light instead of reflecting it as lighter coloured materials such as concrete do.
50.			Please indicate on a plan where planting would be incorporated within the site (<u>not</u> along the site boundaries) to soften its appearance.	Noted.
51.			Please also indicate the effectiveness of the anti-glare reflectors in eliminating horizontal phasing.	Due to the long throw of the floodlights, it is anticipated that anti-glare reflectors will not be required.
52.			Para 9.6.2 It may be useful to present all the impacts in table form for ease of reference.	Noted, however a table may be too black and white where many contributing factors must be considered in assessing the overall impact.
53.			It is considered not acceptable if the visual impact would be further reduced by making people not coming to Butterfly Beach.	It is not suggested that people will be prevented from going to Butterfly Beach, simply that they are there for shorter periods of time than a resident wound be.
54.			Para 9.7.2 Please clarify what control of the construction practices would be required.	As stated in section 9.5.1, storage materials and stock piles should be maintained at low levels, and the site should be enclosed by hoardings to screen it from Lung Mun Road.
55.	N T West Development	NTW/TM 5/4/38 RTT Pt. 6 6 Sept. 1996	The RTT developer should address on how to prevent floating rubbish being washed out from the site to the Urmston Road and possibly crossed over to the Chek Lap Kok/North Lantau during construction stage. Floating rubbish will attract birds to feed in the area which will affect the operation of the new airport.	It is considered , as reported in Section 3.6.1, that accumulation of any solid and liquid waste within the RTT is not expected, provided the zero discharge can be ensured during RTT operation. As described in Section 6 strict control of solid waste will be implemented in both the construction and operation of the RTT such that floating rubbish arising from the project will not in any way affect the operation of the new airport.

No.	Department	Reference	Comments	Consultants' Response
56.			The developer should address on possible embayment due to the possible late completion of the box culvert (Government entrustment works).	As the referenced box culvert comprises stormwater no adverse impacts to water quality are envisaged from the late completion of the box culvert (Government entrusted works).
57.	WKR/CED	WK D2/48 10 Sept. 1996	Para. 3.5.3 - Dredging (page 17) It is noted from the last paragraph on page 17 of the report that suggestion was made to limit the speed of the working vessels near or within the construction site and to prevent boats or vessels from cruising near the vicinity of the construction site. In view of the busy marine traffic near the River Trade Terminal Site, I consider such a suggested measure to be highly impracticable which would be very difficult to implement. I suggest that you also seek D of M's view on this matter.	Agreed.
58.			Para 3.5.4 - Management of Marine Spoil Disposal (page 20) Please be reminded that the mud disposal site should be allocated by the Fill Management Committee of CED. WBTC No. 22/92 refers.	Agreed, however the disposal site has still to be confirmed by FMC.
59.	AFD	AF DVL 11/6 Annex C 16 Sept. 1996	EM&A Manual - ecological monitoring; 4th bullet: The activities of the Sousa should be closely monitored by trained observers until they leave the "exclusion zone".	Noted. Text will be amended.