For discussion
on 28 November 2005

Legislative Council Panel on Environmental Affairs

PWP Item 5169DR – Restoration of Northwest New Territories Landfills & Gin Drinkers Bay Landfill – aftercare work

Purpose

This paper briefs Members on the Administration's proposal to submit PWP Item **5169DR "**Restoration of Northwest New Territories Landfills (NWNTL) & Gin Drinkers Bay Landfill (GDBL) – aftercare work**"** to the Public Works Subcommittee for upgrading to Category A for continuing the aftercare work at NWNTL & GDBL for a further period of seven years (from June 2007 to May 2014) at an estimated cost of $97.5 million in money-of-the-day (MOD) prices.

Background

2. There are 16 landfills in Hong Kong of which three are operating[1] and serving the public for final waste disposal and the remaining 13 landfills[2] were closed between 1975 and 1996. A plan showing the location of the 16 landfills is at Enclosure 1.

3. Landfills, whether operating or closed, produce landfill gas (LFG) and leachate[3] as products of refuse decomposition. LFG is malodorous and potentially asphyxiating, flammable and explosive. Leachate is highly polluting and, if not properly controlled, may seriously contaminate water bodies due to infiltration or direct discharge of leachate.

4. Municipal solid waste when disposed of at landfills does not exhibit homogeneous geotechnical properties, as it is subject to a continuing

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[1] The three operating strategic landfills are South East New Territories (SENT) Landfill, North East New Territories (NENT) Landfill and West New Territories (WENT) Landfill.

[2] The 13 closed landfills are Shuen Wan Landfill, Urban Landfills (Sai Tso Wan, Ma Yau Tong West, Ma Yau Tong Central, Jordan Valley and Ngau Chi Wan Landfills), Northwest New Territories Landfills (Siu Lang Shui, Ma Tso Lung & Ngau Tam Mei Landfills), Gin Drinkers Bay Landfill, Tseung Kwan O Stage I Landfill, Tseung Kwan O Stage II/III Landfill and Pillar Point Valley Landfill.

[3] "Leachate" is the water which has permeated through the waste mass.

biological decomposition process. This results in differential settlement of the landfill surface which may lead to slope instability problems. We therefore need to monitor and improve slope stability at landfills. For some landfills, we also need to stabilise the natural slopes adjacent to the top platform of landfills to prevent possible boulder falls or soil debris flows.

5. Refuse decomposition in a landfill is a slow process which may last up to 30 years before a landfill is said to be fully restored. Landfills will continue to produce LFG and leachate and be subject to differential settlement during the refuse decomposition process.

6. In view of the problems envisaged, the "White Paper: Pollution in Hong Kong – A Time to Act" issued in June 1989 set out the policy objective of formulating a programme for the comprehensive restoration of closed landfill sites. The landfill restoration programme initiative and target were promulgated in the 1995 Policy Address. The restoration includes mitigating measures to control the leachate and LFG problems, which aims to minimize the potential impacts on the environment and to enable the restored landfills be safe for future beneficial use.

7. Restoration works for the 13 closed landfills have started since 1996. The restoration facilities feature LFG and leachate management systems, a low permeability final cover and surface water drainage system to reduce infiltration of water into the waste mass so as to minimise leachate generation and other ancillary works. When the restoration facilities are completed, the aftercare work such as management of LFG, leachate and groundwater will commence until the landfill is fully restored to ensure the landfill is maintained in a safe condition and is environmentally acceptable for appropriate future land uses. The costs for the restoration and the estimated costs for the aftercare work of all the closed landfills are provided at Enclosure 2.

Northwest New Territories Landfills (NWNTL) & Gin Drinkers Bay Landfill (GDBL)

8. The NWNTL which comprise Siu Lang Shui Landfill (SLSL), Ma Tso Lung Landfill (MTLL) and Ngau Tam Mei Landfill (NTML) were developed in the 1970s, whilst GDBL was developed in the 1950s. The NWNTL are located in different parts of the north-western New Territories and GDBL is located at Kwai Tsing District which is close to industrial area of the District. Site plans showing the NWNTL & GDBL are provided at Enclosure 3.

9. NWNTL and GDBL were closed between 1975 and 1983. They did not have proper LFG and leachate management systems. To minimise the adverse environmental impacts of NWNTL & GDBL and to put the land to productive use, we sought funding approvals from the Finance Committee (FC) vide PWSC(95-96)29 in 1995 and PWSC(97-98)91 in 1998 for NWNTL (PWP Item **5157DR)** and GDBL (PWP Item **5158DR)** respectively, for the design and construction of the restoration facilities[4] and a period of seven years' aftercare work to maintain the facilities and monitor the LFG migration and leachate pollution. On-site LFG utilization[5] is included as a requirement in the contract.

10. In approving funding for **5157DR** and **5158DR**, FC agreed that we should carry out an environmental review five years from the commencement of the aftercare work to determine if the landfill sites have been completely restored and if further aftercare work is needed. If further aftercare work is required, we should seek further funding approval from FC.

11. The construction of the restoration facilities for the NWNTL & GDBL was completed in May 2000 and September 2000 respectively and the aftercare work commenced thereafter[6].

12. The first seven years' aftercare work at the NWNTL and GDBL costs about $33.2 million and $68.6 million (in MOD prices) respectively. It involved LFG and leachate management, site maintenance work as well as about 12 700 annual measurements of LFG, 1 800 annual measurements on leachate quality, and 3 100 annual measurements on groundwater and surface water quality. The monitoring programme is provided at Enclosure 4.

13. In early 2005, the Environmental Protection Department (EPD)

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[4] The restoration facilities include (a) landfill gas management systems to control gas emission and prevent off-site gas migration; (b) leachate management systems to extract, collect, treat and dispose of the leachate; (c) engineered capping layers (with low permeability) and surface water drainage systems to reduce infiltration of rain water into the waste mass thereby reducing the amount of leachate to be treated; and (d) improvements to the slope stability and landscaping of the landfill sites and other ancillary engineering works.

[5] Currently, most of LFG produced in GDBL is used on site as thermal energy for leachate treatment at the treatment plant. Due to the fact that the volume of waste deposited in the NWNTL are relatively small and the landfills have been closed for years, the quantity of LFG produced in NWNTL is relatively small and the methane content is relatively low for use in a proper manner.

[6] Fundings were approved for the first seven years' aftercare work up to May 2007 for NWNTL and September 2007 for GDBL.

conducted an environmental review on the NWNTL and GDBL as required by the FC. The review was completed in mid 2005 and revealed that while the amount of LFG[7] and the pollution level of leachate[8] collected for treatment had decreased since 2000/2001, both the LFG and leachate were still of significant quantities and required continuous control and treatment. Also, landfill settlement was expected to continue and regular maintenance work would be required to maintain the surface drainage, slopes and internal access roads. Therefore, the review confirmed that the aftercare work at the NWNTL and GDBL should be continued to ensure that the sites pose no threat to the safety of the public and have minimal adverse environmental impacts so as to provide a safe environment for future afteruses.

14. As the two projects were tendered and awarded under one contract, it is recommended to group the second 7-years' aftercare work at the four landfills into one new PWP Item and realign the commencement date of the second 7 years' aftercare work to 1 June 2007 for both NWNTL and GDBL, when the first 7 years' aftercare work for NWNTL would expire in order to simplify the administrative work. There is provision in the contract to change the aftercare period without additional cost to the government.

Proposal

15. We propose to continue with the aftercare work at the NWNTL and GDBL for a further period of seven years (from June 2007 to May 2014).

16. The aftercare work comprises –

(a) operation and maintenance of the LFG management systems to control gas emission and to prevent off-site gas migration;

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[7] For example, the LFG generation rates of the NWNTL & GDBL have been reduced from 320 cubic metres per hour (m^3/hr) and 300 m^3/hr in 2001 to 220 m^3/hr and 90 m^3/hr in 2004 respectively. The methane content in the LFG remains fairly constant at NWNTL (28%-35%) and GDBL (44%-55%) between 2001 and 2004. Such LFG quantity and methane content levels still require control and monitoring as the landfills could only be considered as fully restored from the perspective of LFG safety when the methane content is reduced to 1% or below.

[8] The average "total nitrogen" (TN) concentration of leachate from NWNTL & GDBL has been reduced from 4 850 milligrams per litre (mg/l) in 2001 to around 3 750 mg/l in 2004. It still exceeds the acceptable discharge standard on TN of 200 mg/l, which is stipulated in the Technical Memorandum of the Water Pollution Control Ordinance for discharge to Government sewers.

(b) operation and maintenance of the leachate management systems to control surface and groundwater infiltration into the landfills and to extract, collect, treat and dispose of the leachate;

(c) environmental monitoring and auditing; and

(d) maintenance of landscape and site infrastructures.

17. The aftercare work for the closed landfills may last more than two decades (could be up to 30 years). We propose to carry out an environmental review five years after commencing the proposed 7-year period to determine if the monitoring work should continue.

Financial Implications

18. We estimate the cost of the proposed aftercare work for the second seven years to be $97.5 million in MOD prices, made up as follows –

		$ million	**$ million**	**$ million**	
		NWNT	**GDB**	**Total**	
(a)	Operation & maintenance of LFG management systems	10.7	20.7	31.4	
(b)	Operation & maintenance of leachate management systems	9.5	18.4	27.9	
(c)	Environmental monitoring and audit	3.4	6.5	9.9	
(d)	Maintenance of landscape	3.0	6.0	9.0	
(e)	Maintenance of site infrastructure	4.1	8.0	12.1	
(f)	Contingencies	1.5	3.0	4.5	
	Sub-total	32.2	62.6	94.8	(in September 2005 prices)
(g)	Provision for price adjustment	0.9	1.8	2.7	
	Total	33.1	64.4	97.5	(in MOD prices)

19. We estimate that the annual recurrent expenditure comprising mainly staff cost will be about $1.94 million.

20. We estimate that the project will continue to provide 19 existing jobs (9 professional/technical staff and 10 labourers).

Public Consultation

21. We consulted the relevant District Councils in mid-2005 on the progress of the restoration of the NWNTL & GDBL. The Kwai Tsing District Council supported EPD's funding proposal for the continuation of the aftercare work at the GDBL while the Tuen Mun District Council, North District Council and Yuen Long District Council expressed no objection to EPD's funding proposal to continue the aftercare work at SLSL, MTLL and NTML respectively.

Environmental Implications

22. We completed the Initial Environmental Impact Assessment studies, covering both the restoration and aftercare work, as part of the feasibility study for the restoration works of the NWNTL & GDBL in 1995 and 1992 respectively. The studies indicated that the restoration and aftercare work would ensure proper control of the emission and off-site migration of LFG and leachate. This would ameliorate the environmental impacts of the landfills and enable the landfill sites to be put to beneficial use.

23. During the contract period, we will withhold payment to the contractor if there is any non-compliance with the required environmental standards.

24. We estimate that the project will generate about 500 tonnes of Construction and Demolition (C&D) materials. Of these, we will reuse about 350 tonnes (70%) on site, deliver 100 tonnes (20%) to public fill reception facilities[9] for subsequent reuse, and nil (0%) to sorting facilities as sorting will be carried out on site. In addition, we will dispose of 50 tonnes (10%) at landfills. The total cost for accommodating C&D materials at public fill

[9] Sorting facilities and public fill reception facilities are specified in Schedule 3 and Schedule 4 respectively of the Waste Disposal (Charges for Disposal of Construction Waste) Regulation. Disposal of public fill in public fill reception facilities requires a licence issued by the Director of Civil Engineering and Development.

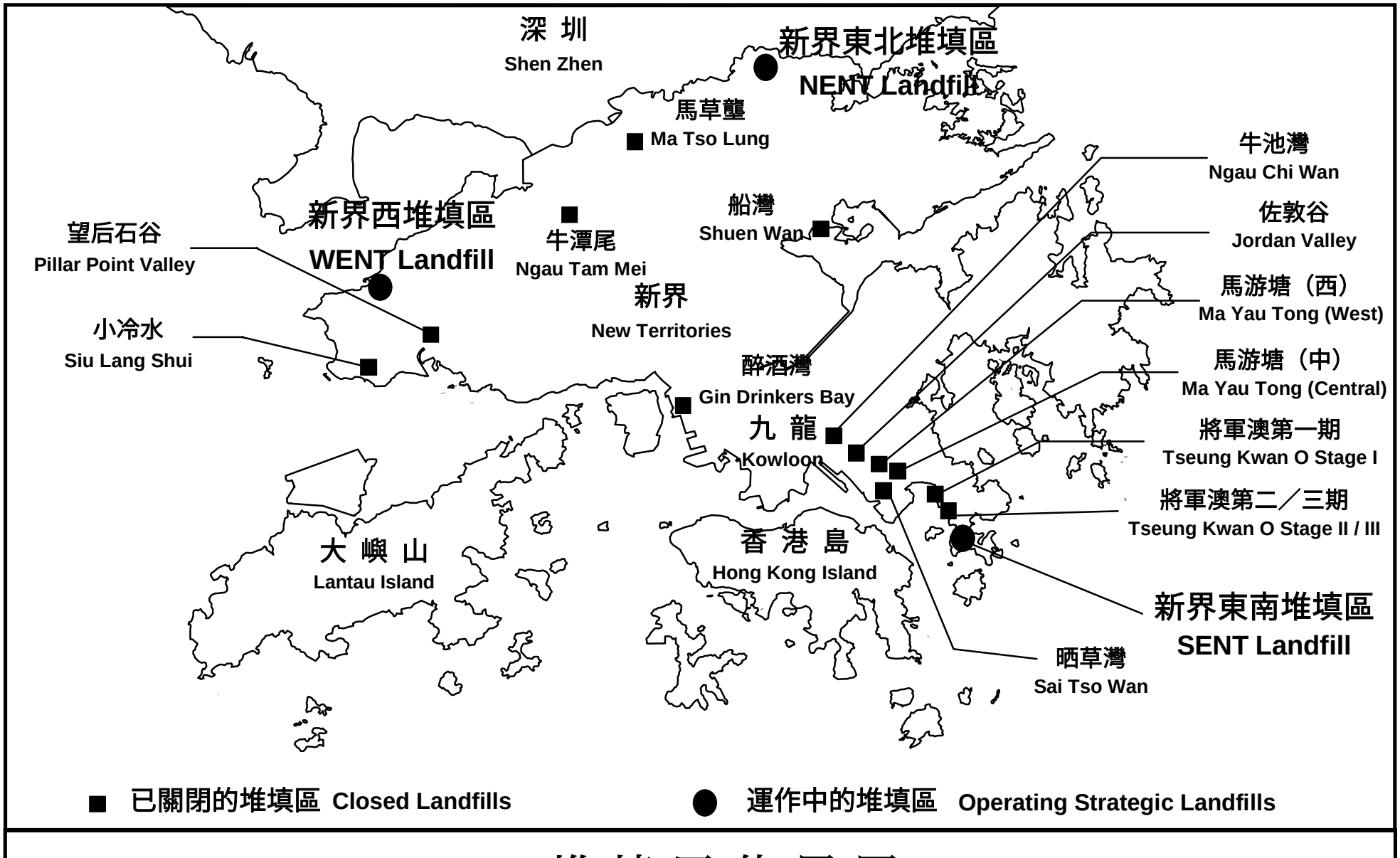
reception facilities and landfill sites, together with the cost for handling the materials at sorting facilities is estimated to be $8,950 for this project (based on a unit cost of $27/tonne for disposal at public fill reception facilities, $100/tonne at sorting facilities and $125/tonne[10] at landfills).

Advice Sought

25. Members are invited to note our proposal of upgrading **5169DR** for consideration by the Public Works Subcommittee in January 2006 with a view to seeking funding approval by FC in February 2006.

Environmental Protection Department
Environment, Transport and Works Bureau
November 2005

[10] This estimate has taken into account the cost for developing, operating and restoring the landfills after they are filled and the aftercare required. It does not include the land opportunity cost for existing landfill sites (which is estimated at $90/m^3), nor the cost to provide new landfills, (which is likely to be more expensive) when the existing ones are filled.



堆 填 區 位 置 圖

Location Plan of Landfills

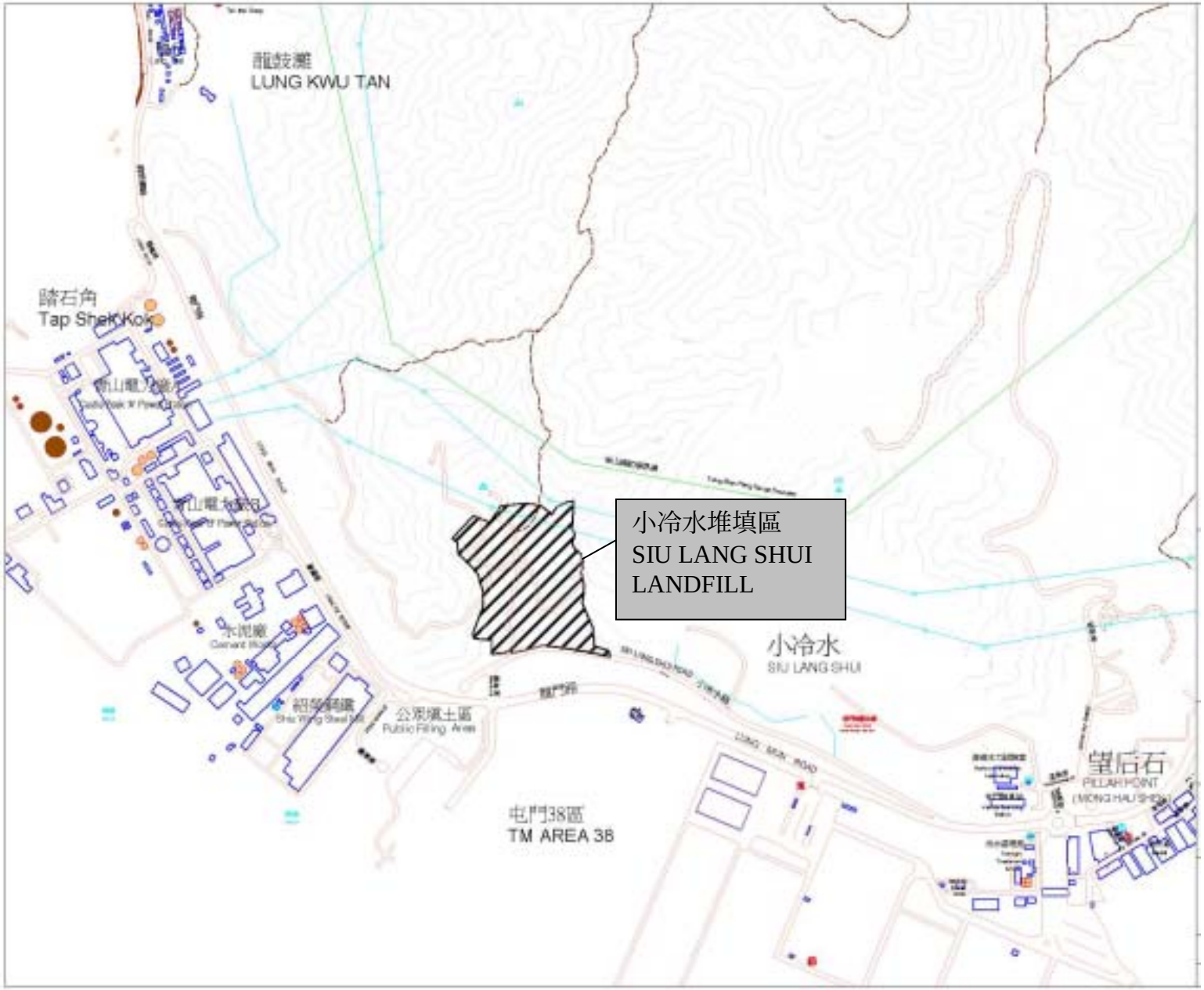
Enclosure 1

The costs for the restoration and estimated costs for aftercare work of the closed landfills

Closed landfill (approximate site area in hectares (ha))	Actual cost for construction of restoration facilities ($ million) (in MOD prices)	Estimated cost for 30 years aftercare work[(1)] ($ million) (in MOD prices)
Shuen Wan Landfill (50 ha)	160	119
Ngau Chi Wan Landfill (8 ha) Sai Tso Wan Landfill (9 ha) Ma Yau Tong West Landfill (5 ha) Ma Yau Tong Central Landfill (11 ha) Jordan Valley Landfill (11 ha)	249	300
Tseung Kwan O Landfill I (68 ha) Tseung Kwan O Landfill II/III (42 ha)	369	422
Ngau Tam Mei Landfill (2 ha) Ma Tso Lung Landfill (2 ha) Siu Lang Shui Landfill (12 ha) Gin Drinkers Bay Landfill (29 ha)	332	435
Pillar Point Valley Landfill (38 ha)[(2)]	221	342
Total	1,331	1,618

(1) Estimates based on 30 years aftercare work. Estimated costs for different landfills vary mainly due to the size of the landfills, the required restoration facilities and treatment, the number of sites under each restoration contract and geographical locations.

(2) The construction of restoration facilities is expected to complete in mid 2006 and the aftercare work will commence thereafter.



圖例:
LEGEND:

堆填區
LANDFILL

工務計劃項目編號 5157 DR –
新界西北堆填區修復計劃 –
修護工作 (小冷水)

PWP Item No. 5157 DR –
Restoration of Northwest New Territories
Landfills – aftercare work (Siu Lang Shui)

圖則名稱 Drawing Title
修復工程工地範圍
SITE LOCATION PLAN

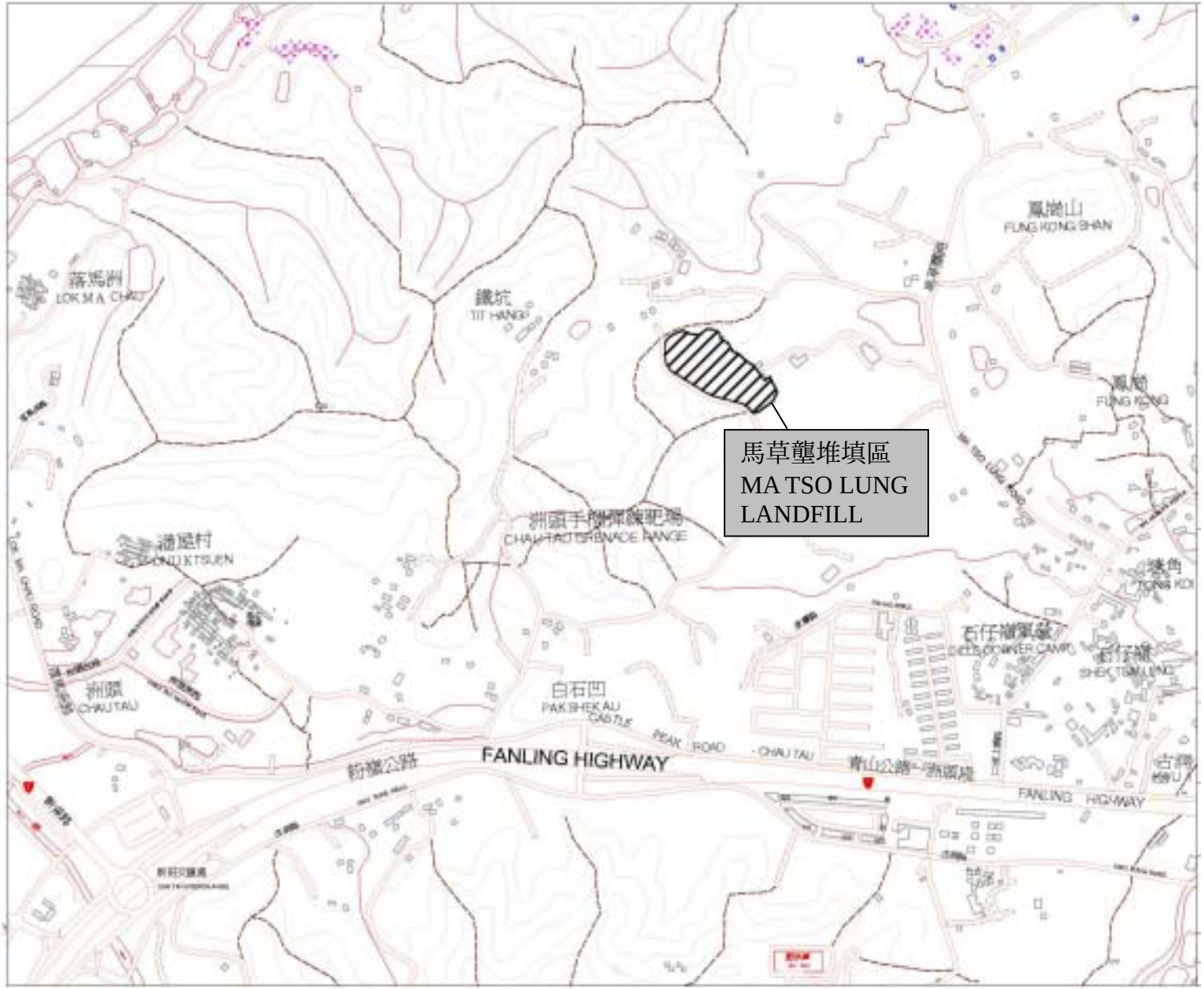
圖則編號 Drawing No.
NWNT Landfills Location Plan.doc

ENVIRONMENTAL PROTECTION
DEPARTMENT
環境保護署

日期 Date : 03-2005

不依比例 NTS

Enclosure 3 - a



圖例:
LEGEND:

堆填區
LANDFILL

工務計劃項目編號 5157 DR –
新界西北堆填區修復計劃 –
修護工作 (馬草壟)
PWP Item No. 5167 DR –
Restoration of Northwest New Territories
Landfills – aftercare work (Ma Tso Lung)

圖則名稱 Drawing Title
修復工程工地範圍
SITE LOCATION PLAN

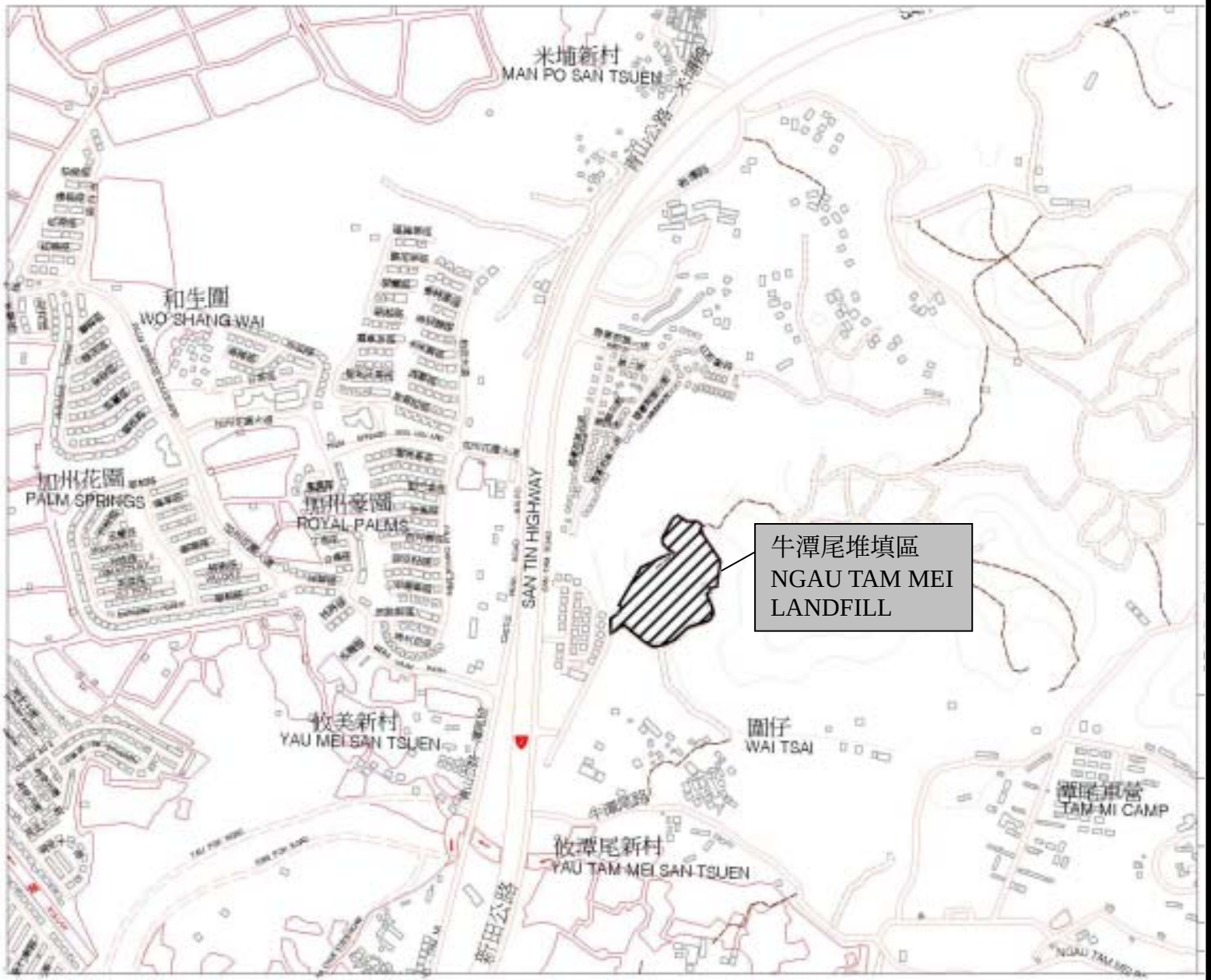
圖則編號 Drawing No.
NWNT Landfills Location Plan.doc

ENVIRONMENTAL PROTECTION
DEPARTMENT
環境保護署

日期 Date : 03-2005

不依比例 NTS

Enclosure 3 - b



圖例:
LEGEND:

堆填區
LANDFILL

工務計劃項目編號 5157 DR –
新界西北堆填區修復計劃 –
修護工作 (牛潭尾)

PWP Item No. 5157 DR –
Restoration of Northwest New Territories
Landfills – aftercare work (Ngau Tam Mei)

圖則名稱 Drawing Title
修復工程工地範圍
SITE LOCATION PLAN

圖則編號 Drawing No.
NWNT Landfills Location Plan.doc

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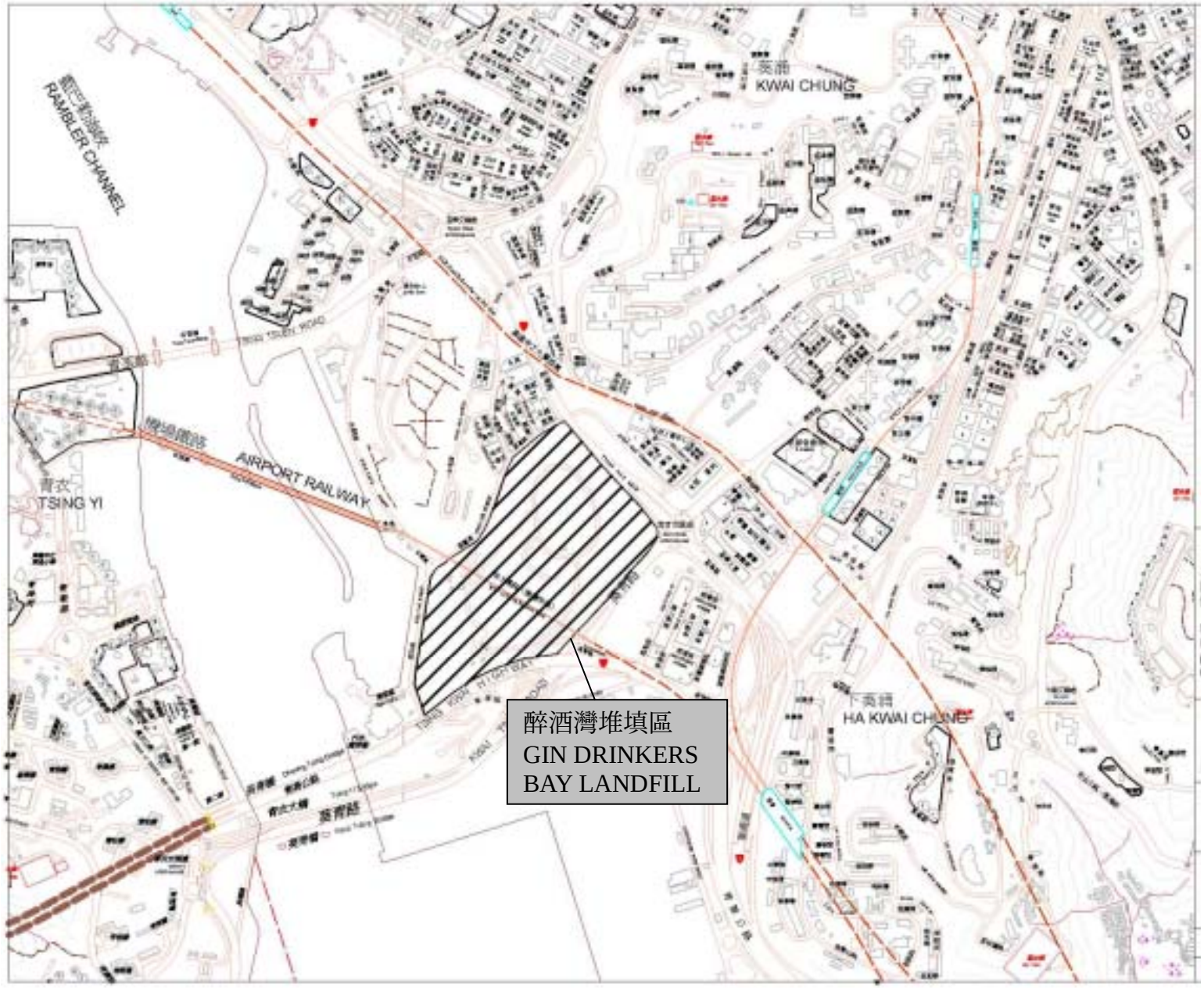
Enclosure 3 - c



圖例:
LEGEND:

堆填區
LANDFILL

工務計劃項目編號 5158 DR –
醉酒灣堆填區修復計劃 –
修護工作

PWP Item No. 5158 DR –
Restoration of Gin Drinkers Bay Landfill –
aftercare work

圖則名稱 Drawing Title
修復工程工地範圍
SITE LOCATION PLAN

圖則編號 Drawing No.
GDB Landfill Location Plan.doc

ENVIRONMENTAL PROTECTION DEPARTMENT
環境保護署

日期 Date : 03-2005

不依比例 NTS

Enclosure 3 - d

The monitoring programme for the Northwest New Territories Landfills and Gin Drinkers Bay Landfill

Category	Monitoring Details	Measurement	Purpose
Landfill Gas	Measure surface landfill gas emission	Methane	To ensure no safety risks to the personnel on site
	Detect landfill gas at perimeter monitoring boreholes, passive vents and utility manholes	Methane , Carbon Dioxide , Oxygen , Temperature	To monitor off site gas migration and safeguard the neighbourhood
	Analyse landfill gas collected from boreholes and extraction wells	Oxygen, Nitrogen, Carbon Monoxide , Carbon Dioxide , Hydrogen , Methane , Ethane , Propane , n-Butane	To monitor changes in the landfill gas quality over the years
	Detect landfill gas in buildings and confined space on site and off site	Methane , Carbon Dioxide , Oxygen	To ensure no safety risk to occupiers of these structures
	Measure landfill gas at the extraction system	Methane , Carbon Dioxide , Oxygen ,Temperature , Differential Pressure, Static Pressure , Flow	To monitor the landfill gas composition to ensure optimal operation of the landfill gas management system
	Analyse emissions of gas flaring facilities	Hydrogen Sulphide, Hydrogen Chloride, Hydrogen Fluoride, Hydrogen Bromide, Sulphur Dioxide, Nitrogen Dioxide, Carbon Monoxide, Total Non-methane Hydrocarbons	To monitor the performance of the landfill gas treatment plants
	Analyse volatile organic compound (VOC)	Trichloroethylene, Vinyl Chloride, Methylene Chloride, Chloroform, 1,2-Dichlorethane, 1,1,1-Trichloride, Carbon Tetrachloride, Tetrachloroethylene, 1,2-Dibromoethane, Toluene, Methane, Benzene	To ensure the VOC contents comply with international standards
Groundwater	Measure groundwater level and quality	Well Depth , Groundwater Level , Temperature, pH, Electrical Conductivity , Dissolved Oxygen , Alkalinity, COD , Chloride, Ammoniacal Nitrogen , Total Kjeldahl Nitrogen , Total Oxidized Nitrogen, Total Nitrogen, Sulphate, Sulphite, Phosphorous, Total Organic Carbon, Sodium, Potassium, Calcium, Magnesium, Iron, Manganese , Cadmium, Copper, Nickel, Lead, Zinc, Mercury, Chromium, Sliver	To monitor groundwater quality

Category	Monitoring Details	Measurement	Purpose
Leachate	Measure level of leachate at monitoring wells	Well Depth, Leachate Level , Temperature , pH , Electrical Conductivity	To avoid excessive water pressure built up at the man-made slope which might affect the overall slope stability
	Measure leachate quality at leachate management system	Temperature, pH, Electrical Conductivity, Alkalinity, COD, BOD, Chloride, Ammoniacal Nitrogen, Total Kjeldahl Nitrogen, Total Oxidized Nitrogen, Total Nitrogen, Sulphate, Total Organic Carbon, Sodium, Potassium, Calcium, Magnesium , Iron , Manganese, Cadmium, Copper, Nickel, Lead, Zinc	To check the strength of leachate in relation to landfill aging
Surface Water	Analyse surface water quality	Appearance, Temperature, pH, Electrical Conductivity, Dissolved Oxygen, Alkalinity, COD, BOD, Chloride, Ammoniacal nitrogen, Total Kjeldahl Nitrogen, Total Oxidized Nitrogen, Total Nitrogen, Sulphate, Total Suspended Solids, Total Organic Carbon, Sodium, Potassium, Calcium, Magnesium, Iron, Manganese, Cadmium, Copper, Nickel, Lead, Zinc	To ensure no discharge of contaminated surface water off site
Nuisance	Dust	Total Suspended Particulates (TSP), Respirable Suspended Particulates (RSP)	To protect the general public, neighbouring residents as well as visitors from nuisance problems
	Noise	Noise Level	
	Odour	Odour	