

**For discussion
on 25 October 2004**

Legislative Council Panel on Environmental Affairs

PWP Item 5166DR – Restoration of Tseung Kwan O Landfills – post-completion environmental monitoring work

Purpose

This paper briefs Members on the Administration's proposal to submit PWP Item **5166DR** "Restoration of Tseung Kwan O Landfills (TKOL) – post-completion environmental monitoring work" to the Public Works Subcommittee for upgrading to Category A for continuing the post-completion environmental monitoring work at TKOL for a further period of seven years (from February 2006 to January 2013) at an estimated cost of \$98.7 million in money-of-the-day (MOD) prices.

Background

2. There are 16 landfills in Hong Kong of which three are operating¹ and serving the public for final waste disposal and the remaining 13 landfills² 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 leachate³ 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

¹ The three operating strategic landfills are Southeast New Territories (SENT) Landfill, Northeast 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 (Ma Tso Lung, Siu Lang Shui & 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 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, post-completion environmental monitoring 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 post-completion environmental monitoring work of all the closed landfills are provided at Enclosure 2.

Tseung Kwan O Landfills (TKOL)

8. The TKOL comprises TKO Stage I Landfill (TKOL-I) and TKO Stage II/III Landfill (TKOL-II/III). They were developed and operated from late 1970s to mid 1990s and are located on the eastern shoreline of Tseung Kwan O Bay and adjacent to residential and industrial developments of the Tseung Kwan O new town. TKOL-II/III is about 1 km south east of the TKOL-I. A site plan showing TKOL is provided at Enclosure 3.

9. TKOL-I and TKOL-II/III were closed in 1995 and 1994 respectively. They did not have proper LFG and leachate management systems. To minimise the adverse environmental impacts of TKOL and to put the land to productive use, we sought funding approval from the Finance Committee (FC) in 1995 vide PWSC(95-96)15 for the design and construction of the restoration facilities⁴ and a period of seven years' post-completion work to maintain the facilities and monitor the LFG migration and leachate pollution under PWP Item **5156DR**. On-site LFG utilization⁵ is included as a requirement in the contract.

10. In approving funding for **5156DR**, FC agreed that we should carry out an environmental review five years from the commencement of the environmental monitoring work to determine if the landfill sites have been completely restored and if further monitoring is needed to seek further funding approval from FC.

11. The construction of the restoration facilities for the TKOL was completed in January 1999 and the post-completion environmental monitoring work commenced thereafter⁶.

12. The first seven years' environmental monitoring work at the TKOL costs about \$105 million (in MOD prices). Such works involved LFG and leachate management, site maintenance work as well as about 13,000 annual measurements of LFG, 2,000 annual measurements on leachate quality, and 4,700 annual measurements on groundwater and surface/marine water quality. The monitoring programme is provided at Enclosure 4.

13. In late 2002, the Environmental Protection Department (EPD) commissioned an environmental review of the TKOL as required by the FC. The review was completed in December 2003 and it revealed that the

⁴ The restoration facilities include (a) landfill gas management systems to control gas emission and prevent off-site gas migration; (b) a leachate management system 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, LFG produced in TKLO-II/III is used on site as thermal energy to treat leachate and to generate electricity for operation of the treatment plant whilst LFG produced in TKOL-I is used to generate electricity to meet the on-site requirement. Leachate arising from TKOL-I is conveyed to the nearby TKOL-II/III for treatment centrally.

⁶ Funding was approved for the first seven years' post-completion environmental monitoring work up to January 2006.

amount of LFG had substantially decreased⁷ since 1999 whereas the pollution level of leachate collected for treatment has only slightly decreased⁸. However, 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 monitoring work at the TKOL 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 afteruse.

Proposal

14. We propose to continue with the environmental monitoring work at the TKOL for a further period of seven years (from February 2006 to January 2013).

15. The environmental monitoring work comprises –

- (a) operation and maintenance of the LFG management systems to control gas emission and to prevent off-site gas migration;
- (b) operation and maintenance of the leachate management system to control surface and groundwater infiltration into the landfills and to extract, collect, treat and dispose of the landfill leachate;
- (c) environmental monitoring and auditing; and
- (d) maintenance of landscape and site infrastructures.

16. The environmental monitoring 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 For example, the landfill gas generation rates of the TKOL-I and TKOL-II/III have reduced from 3 530 cubic metres per hour (m³/hr) and 3 610 m³/hr in 1999 to 1 310 m³/hr and 2 890 m³/hr in 2003 respectively. The methane content in the landfill gas remains fairly constant at 44%-48% between 1999 and 2003. Such landfill gas quantity and methane content levels still require monitoring as the landfills could only be considered as fully restored from the perspective of landfill gas safety when the methane content is reduced to 1% or below.

⁸ The total nitrogen concentration in leachate has reduced from 1 150 milligrams per litre (mg/l) in 1999 to around 1 030 mg/l in 2003. It still exceeds the acceptable discharge standard on total nitrogen, 200 mg/l, stipulated in the Technical Memorandum of the Water Pollution Control Ordinance for discharge to Government sewers.

7-year period to determine if the monitoring work should continue.

Financial Implications

17. We estimate the cost of the proposed post-completion environmental monitoring work for the seven years to be \$98.7 million in MOD prices, made up as follows –

	\$ million	
(a) Operation & maintenance of LFG management systems	32.1	
(b) Operation & maintenance of leachate management systems	28.5	
(c) Environmental monitoring and audit	10.1	
(d) Maintenance of landscape	9.2	
(e) Maintenance of site infrastructure	12.4	
(f) Contingencies	<u>4.6</u>	
Sub-total	96.9	(in September 2004 prices)
(g) Provision for price adjustment	<u>1.8</u>	
Total	98.7	(in MOD prices)

18. We estimate that the annual recurrent expenditure will be about \$1.96 million.

19. We estimate that the project will continue to provide 20 existing jobs (11 professional/technical staff and 9 labourers).

Public Consultation

20. We consulted the Sai Kung District Council (SKDC) in June 2004 on the progress of the restoration/ monitoring work and the potential afteruse of the TKOL. The SKDC expressed no objection to the continuation of the post-completion environmental monitoring work at the TKOL.

Environmental Implications

21. We completed in 1994 an Initial Environmental Impact Assessment study, covering both the restoration and post-completion environmental monitoring work, as part of the feasibility study for the restoration works of the TKOL. The study indicated that the restoration and monitoring 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.

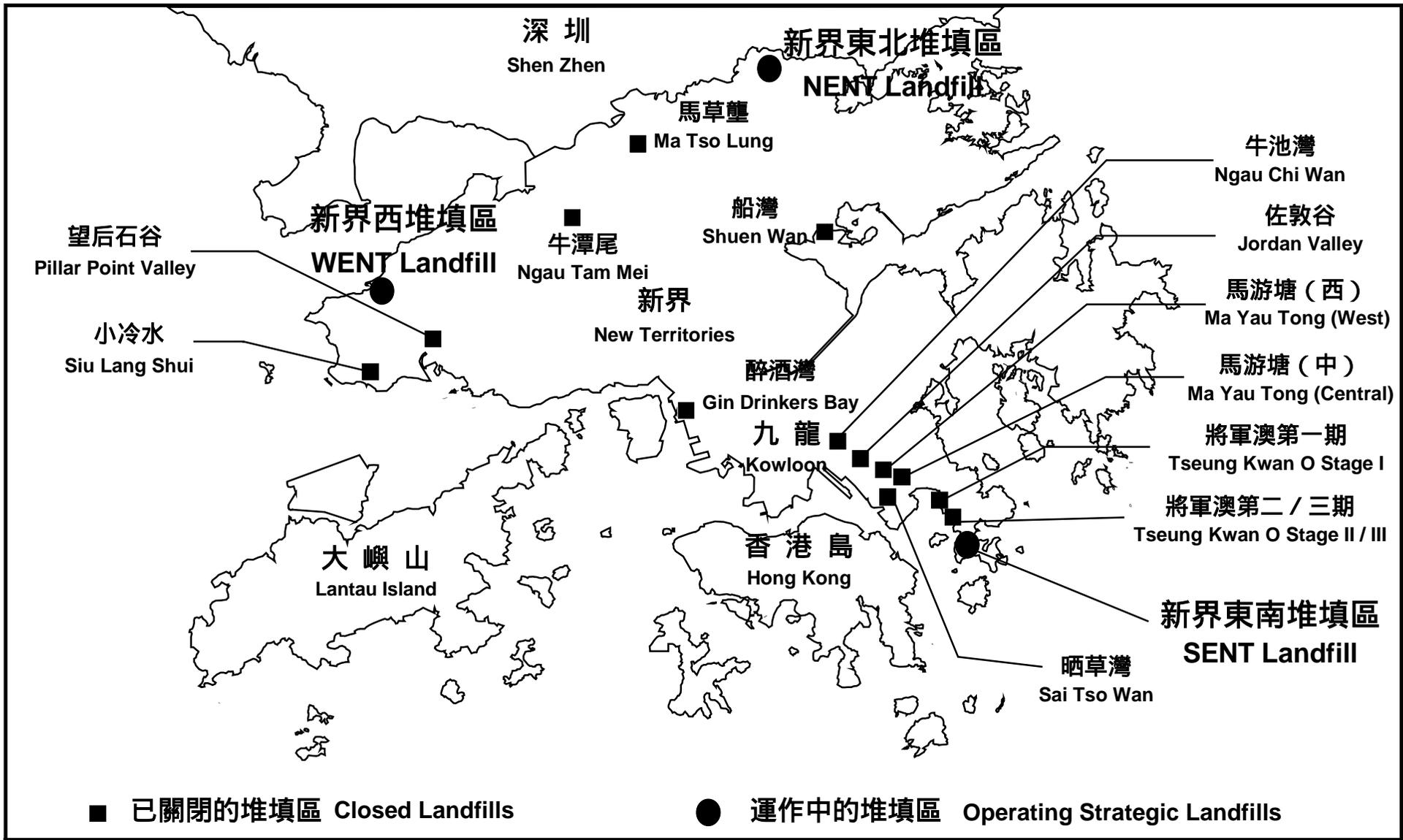
22. During the contract period, we will withhold payment to the contractor if there is any non-compliance with the required environmental standards.

23. We have given due consideration to minimise the generation of construction and demolition (C&D) materials, and to reuse and recycle the C&D materials wherever practicable. C&D materials mainly arises from maintenance of drainage, access roads, capping layer, landscape, treatment plant and other site infrastructure. We will encourage the contractor to use non-timber formwork and recyclable materials for temporary works. We will control the disposal of C&D materials to landfills or other appropriate reception facilities through a trip ticket system recording the disposal, reuse and recycling of C&D materials. We estimate that the project will generate about 1,000m³ of C&D materials, of which we would reuse about 600 m³ (60%) on site, recycle or reuse 300 m³ (30%) as fill materials and dispose of 100 m³ (10%), the non-inert portion, at landfills.

Advice Sought

24. Members are invited to note our proposal of upgrading **5166DR** for consideration by the Public Works Subcommittee in November 2004 with a view to seeking funding approval by FC in December 2004.

Environment, Transport and Works Bureau
October 2004



堆填區位置圖
Location Plan of Landfills

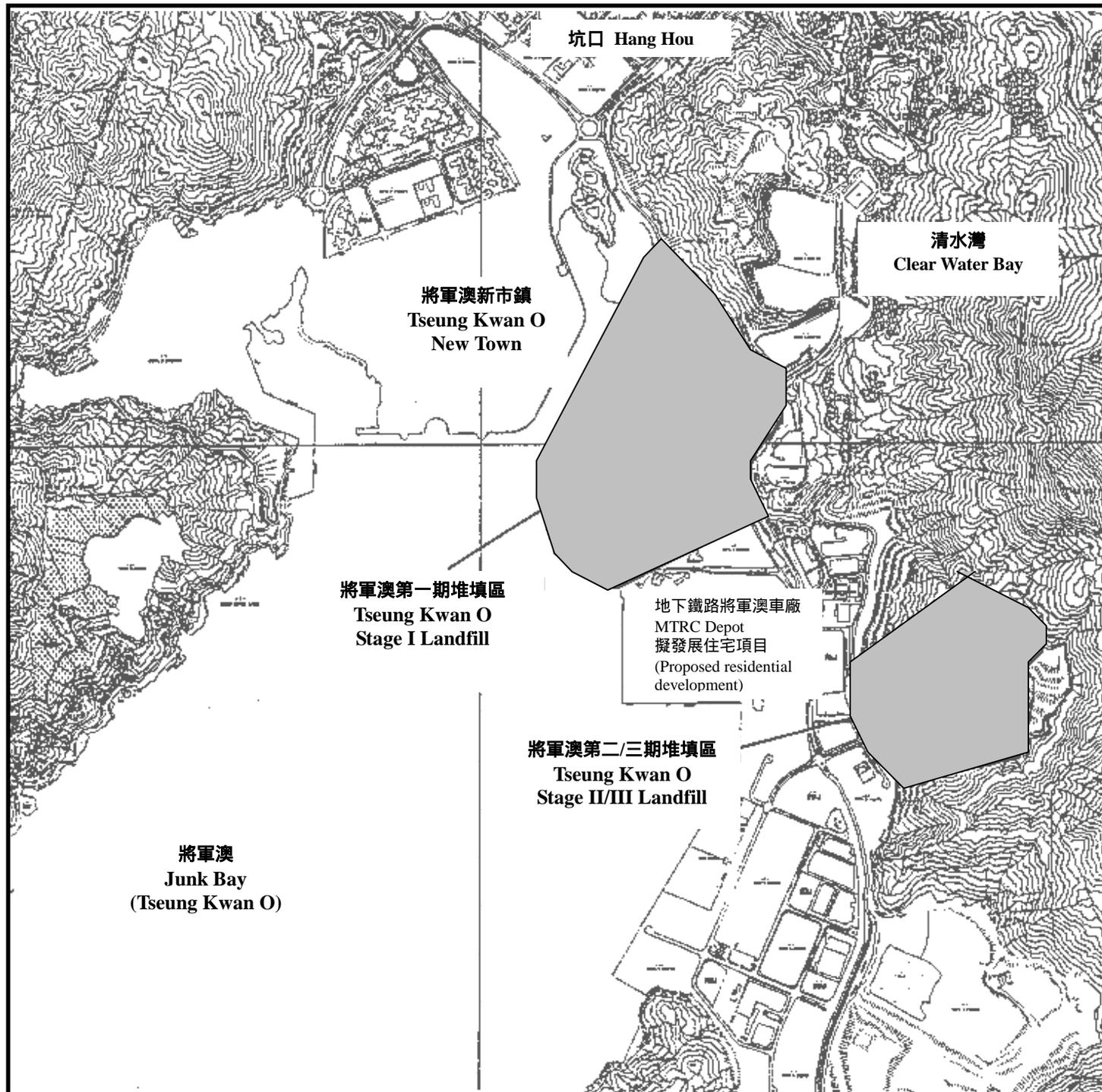
Enclosure 2

The costs for the restoration and estimated costs for post-completion environmental monitoring work of the closed landfills

Closed Landfill (approximate site area in hectares (ha))	Actual Costs for construction of restoration facilities (\$ million) (in MOD prices)	Estimated Costs for 30 years post-completion environmental monitoring works ⁽¹⁾ (\$ million) (in MOD prices)
Shuen Wan Landfill (50 ha)	160	113
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	307
Tseung Kwan O Landfill I (68 ha) Tseung Kwan O Landfill II/III (42 ha)	369	419
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	431
Pillar Point Valley Landfill (38 ha) ⁽²⁾	221	328
Total	1,331	1,598

(1) Estimates based on 30 years post-completion environmental monitoring work.

(2) The cost shown here is the tender price. The construction of restoration facilities is expected to complete in mid 2006 and the post-completion environmental monitoring work will commence thereafter.



圖例:
LEGEND:

 堆填區
LANDFILL

工務計劃項目編號 5166 DR –
將軍澳堆填區修復計劃 –
驗收後的環境監測工程

PWP Item No. 5166 DR –
Restoration of Tseung Kwan O Landfills –
post-completion environmental
monitoring work

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

圖則編號 Drawing No.
TKO_SITE LOCATION.DWG



ENVIRONMENTAL PROTECTION
DEPARTMENT
環境保護署

日期 Date : 08-2004

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不依比例 NTS

The monitoring programme for the Tseung Kwan O landfills

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
	Analyze 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 & 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
	Analyze emissions of gas flaring facilities at TKOL-I and TKOL-II/III	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
	Analyze 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
Marine water	Analyze marine water & sediment	Appearance, Temperature, pH, Electrical Conductivity, Dissolved Oxygen, Salinity, Turbidity , COD, BOD, Ammoniacal Nitrogen, Nitrite-Nitrogen, Nitrate-Nitrogen, Total Nitrogen, Total Phosphorous, Reactive Phosphorous, Total Suspended Solids, Total Organic Carbon, Sulphate, Sulphite, PCB, PAH, Cadmium, Copper, Nickel, Lead, Zinc, Mercury, Chromium, Arsenic, Selenium	To monitor quality of the receiving waters.
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	