6 WASTE MANAGEMENT IMPLICATIONS

6.1 Introduction

This chapter presents the findings of the assessment of waste management implications arising from the WENT Landfill Extension during the construction, operation, restoration and aftercare phases. Opportunities for waste avoidance, minimisation, reuse, recycling and disposal were examined. With the construction material import/export balancing design approach and the appropriate mitigation measures implemented during the different phases of the Project, potential environmental impacts associated with waste management would be insignificant.

The waste management implication assessment has been conducted in accordance with the requirements of Annexes 7 and 15 of the TM-EIAO and Clause 3.4.4 of the EIA Study Brief for the Project.

6.2 Legislation, Standards and Guidelines

The relevant legislation and associated guidance notes applicable to the study for the assessment of waste management implications include:

- Waste Disposal Ordinance (Cap.354) and subsidiary Regulations;
- Environmental Impact Assessment Ordinance (Cap 499) and subsidiary Regulations;
- Land (Miscellaneous Provisions) Ordinance (Cap 28);
- Public Health and Municipal Services Ordinance (Cap 132);
- Hong Kong Planning Standards and Guidelines (HKPSG), Chapter 9 – Environment;
- A Policy Framework for the Management of Municipal Solid Waste (2005-2014);
- Waste Reduction Framework Plan, 1998 – 2007, Planning Environment and Lands Branch, Government Secretariat;
- Code of Practice on the Packaging, Labeling and Storage of Chemical Wastes, EPD (1992);
- Environment, Transport and Works Bureau Technical Circular (Works) (ETWB TC(W)) No. 33/2002 Management of Construction and Demolition Material Including Rock;
- ETWB TC(W) No.31/2004 Trip Ticket System for Disposal of Construction and Demolition Materials;
- ETWB TC(W) No. 19/2005 Environmental Management on Construction Sites;
- ETWB TC(W) No.34/2002 Management of Dredged/Excavated Sediment;
- WBTC No. 12/2002, Specifications Facilitating the Use of Recycled Aggregates; and
- WBTC Nos. 25/99, 25/99A and 25/99C. Incorporation of Information on Construction and Demolition Material Management in Public Works Subcommittee Papers.

6.3 Assessment Methodology

The waste management hierarchy principle was adopted following the order of preference: avoidance > minimisation > reuse > recycling > treatment > disposal. Opportunities for reducing waste generation have been critically assessed for:

- Avoiding or minimising waste generation through changes in the design;
- Implementing management practices to promote segregation of wastes; and
- Reuse and recycling.

Waste types and quantities estimation are made reference to the existing capacities of the waste disposal facilities. Disposal options for each waste type will be determined based on the environmental implications of handling, collection and disposal of such wastes.

The assessment of waste management implication comprises the following:

- Analysis of activities and waste generation to identify the quantity, quality and timing of the waste arising as a result of the construction, operation, restoration and aftercare

activities of the Project, based on the sequence and duration of these activities:

- Construction and operation phases – excavated construction materials from site preparation; chemical waste arising from maintenance of plant and equipment; sludge from leachate treatment plant; general waste from daily activities; and
- Restoration and aftercare phases – chemical waste arising from maintenance of plant and equipment; sludge from leachate treatment plant; general waste from daily activities.

- Proposal for waste management:
  - Prior to considering the disposal options for various types of wastes, opportunities for reducing waste generation, on-site or off-site re-use and recycling are fully evaluated. Measures which can be taken in the planning and design stages e.g. by modifying the design approach and in the construction stage for maximising waste reduction were individually considered;
  - After considering all the opportunities for reducing waste generation and maximising re-use, the types and quantities of the wastes required to be disposed of as a consequence are estimated and the disposal options for each type of waste were described in details. Pretreatment processes for slurry before disposal are addressed in details. The disposal method recommended for each type of waste has also been considered; and
  - The impact caused by handling (including labelling, packaging and storage), collection, and reuse/disposal of wastes is addressed in detail and appropriate mitigation measures have been proposed. The assessment covers the potential hazard, air and odour emissions, noise, wastewater discharge and public transport.

6.4 Identification and Evaluation of Waste Management Implications

6.4.1 Analysis of Activities and Waste Generation

6.4.1.1 Construction and Operation Phases

During the construction and operation phases, a variety of wastes will be generated including excavated construction materials, chemical waste, general refuse and sludge from leachate treatment plant.

Excavated Construction Material

Given the remote location of the site, the site formation works will be based on a material balance approach and no significant import or export of soil materials is expected. To construct the landfill bowl and the realigned Nim Wan Road, ~16.6Mm^3 of construction materials will be excavated whilst ~16.8Mm^3 will be required as fill materials for site formation, daily cover and final capping materials. A total of about 0.2Mm^3 of fill materials are thus required to be imported. On the other hand, a total of about 0.2Mm^3 of non-inert C&D waste (top soil + vegetation) is required to be disposed of at existing WENT Landfill and WENT Landfill Extension. The breakdown of total excavated materials and fill materials is shown on the below table:

Activities		Volume (Mm^3)
Excavation (Inert Materials)	Construction of Landfill Bowl	13.1 [(a)]
	Construction of Realigned Nim Wan Road	3.5
	Fly ash (to be reused on site)	Small quantity (less than 0.1Mm^3)
	Total	16.6
Excavation (Non-inert Materials)	Construction of Landfill Bowl (Top soil & vegetation)	0.2 [(a)]

Activities		Volume (Mm^3)
Filling [(b)]	Operation of Landfill	13.8
	Restoration of Landfill	3.0
	Total	16.8

Note :

(a) The breakdown of 13.1Mm^3 and 0.2Mm^3 for different phases for the bowl construction is given below. In view of the large site area (over 140 ha for Phases 1, 2, 3 and 4), there should be adequate area to store the surplus material from Phases 1, 2, 3 & 4 on site and used as for daily cover and the fill material for Phases 1, 2, 3, 4, 5 & 6. C&D materials generated from the demolition of existing facilities are also included.

Phase	Quantity, m^3			
	Inert C&D Materials to be reused on site			Non-inert C&D Materials to be disposed of at Landfill
	Fill	Cut	Balance	Top Soil and Vegetation
1	1,328,000	3,630,000	2,302,000	40,000
2	291,000	4,961,000	4,670,000	4000
3	426,000	4,439,000	4,013,000	150
4	552,000	4,767,000	4,215,000	100,000
5	1,482,000	418,000	-1,064,000	400
6	1,165,000	116,000	-1,049,000	60,000
Total	**5,244,000**	**18,331,000**	**13,087,000 (say 13,100,000)**	**204,550 (say 200,000)**

(b) With reference to the existing WENT Landfill; during operation stage, volume of daily cover + haul roads + channels is about 13.8Mm^3. During restoration stage, total thickness of final cover = intermediate cover + vegetative layer, thus fill volume (restoration) = 3Mm^3. Thus, total fill required ≈ 16.8Mm^3.

The DBO Contractor will be responsible for sorting construction materials into inert and non-inert portions. Inert portion of construction materials should be reused on-site as far as practicable, whilst any non-inert portion should be reused whenever possible and be disposed of as a last resort. The contract documents should specify that no excavated materials are to be removed from the site.

According to the latest construction methodology, the area near to Tsang Kok Stream Outfall would be first installed with temporary sheet piling to enclose the area. After de-watering, the box culvert would be installed after the associated engineering works. Upon the completion of the backfilling above the box culvert, site office and LFG treatment facilities of the existing WENT Landfill will be constructed accordingly. The existing seawall along the ash lagoon and the berth would also not be modified. Hence, there are no dredging activities in this project.

The amount of C&D waste is estimated to be insignificant.

Chemical Waste

The Waste Disposal (Chemical Waste) (General) Regulation defines chemical waste as any substance being scrap material or unwanted substances specified in its Schedule 1, and

provides a complete list of such substances. Substances likely to be generated by construction and operation activities would mainly arise from the maintenance of plant and equipment. These include:

- Scrap batteries or spent acid/alkali;
- Used engine oils, lubricating and hydraulic fluids and waste fuel;
- Spent mineral oils/ cleaning fluids from mechanical machinery; and
- Spent solvents/ solutions, some of which may be halogenated, from equipment cleaning activities.

However, it is difficult to quantify the amount of chemical waste that will arise from the construction activities since it depends on the Contractor's on-site maintenance requirements and the amount of plant utilised. Besides, it is anticipated that the quantity of chemical waste, such as lubricating fluids and waste fuel produced from plant maintenance, would be small . Nevertheless, the amount of chemical waste expected to be generated will be quantified in the site Waste Management Plan, which becomes part of the Environmental Management Plan according to the requirements as stipulated in ETWB TCW No. 19/2005, to be prepared by the Contractor.

General Refuse

The general refuse during the construction and operation of the WENT Landfill Extension encompasses a wide variety of waste, e.g. site office activities, kitchen refuse, packaging of equipment and construction materials, maintenance of plants and equipment, etc, and the total volume would depend on the employed workforce on-site.

The maximum number of construction workers to be employed is estimated to be 500 workers. Based on a generation rate of 0.65 kg per worker per day, the maximum daily arising of general refuse during the construction period would be about 325 kg. Thus, there will be total 325kg x 365 days x 13 = 1.54Mkg general refuse generated throughout the 13-year construction and operation phases of the future WENT Landfill Extension.

Sludge

The sludge from the future WENT Landfill Extension will be sent to the Sludge Treatment Facilities (STF) which adopt incineration technology at the Ash Lagoon area at Tsang Tsui near Nim Wan, Tuen Mun for disposal.

The existing treatment plant is designed to treat 1,800 m^3/day. The typical quantity of sludge arising from the existing leachate treatment plant during the construction and operation phases of the existing WENT Landfill is about 35 m^3 in 2007.

Assuming the planned treatment capacity of the future treating plant as a worst-case scenario (i.e. 2,600 m^3/day) throughout the 13-year of construction and operation phases of the future WENT Landfill Extension, the total quantity of sludge generated would be about 657 m^3.

Sediment

Excavation of sediment is not required for the construction of box culvert and other structures as surcharge will be added on top of the concerned location for a period of time to facilitate the consolidation process before the construction works to minimise the future settlement.

"What if IWMF not proceed"

The feasibility of IWMF is still being conducted and there is no decision on the implementation programme and site selection. In case the IWMF is not located at the middle ash lagoon, the boundary of the WENT Landfill Extension would be further expanded to include the middle lagoon. This would not increase the spoil material to be generated and hence would not have additional impacts in terms of waste management.

6.4.1.2 Restoration and Aftercare Phases

During the restoration and aftercare phases, chemical waste, sludge from leachate treatment plant, and general refuse will be the major waste stream anticipated. The DBO Contractor should also consider the reuse and recycling of wastes as far as practicable, thereby reducing the level of generation.

Chemical Waste

Similar to the construction and operation phases, it is difficult to quantify the amount of chemical waste that will arise during the restoration and aftercare phases but the amount should not be significant.

General Refuse

Based on the above estimated quantity of general waste 0.65 kg per worker per day and assuming an average ~125 workers would also be present on site for 6 days a week during the 34-year restoration and aftercare phases, the total general refuse arising would be ~0.86Mkg.

Sludge

The quantity of leachate generated from the WENT Landfill Extension during restoration and aftercare phases is estimated to be about 940m^3/day. On pro-rata from the estimated quantity of sludge in section 6.4.1.1, the total sludge arising from the 34 years of restoration and aftercare phases would be about 621 m^3.

A summary of waste generated during construction, operation, restoration and aftercare phases is presented in **Appendix 6.1**.

"What if IWMF not proceed"

Since there will be no significant increase in the generation of chemical waste, general refuse and sludge in case the IWMF is not located at the middle ash lagoon and the boundary of the WENT Landfill Extension would be further expanded to include the middle lagoon, there will be no additional impacts in terms of waste management.

6.4.2 Waste Management Proposal

6.4.2.1 Construction and Operation Phases

Excavated Construction Materials

Although significant amount of excavated construction materials will be generated during site formation stage, there would be no significant import or export of soil materials. With the implementation of proper preventive and mitigation measures for handling, transport and disposal, no insurmountable environmental impact is anticipated.

It is not anticipated to have any significant quantities of excavated construction materials requiring off-site disposal. Notwithstanding this, a trip-ticket system should be put in place in accordance with ETWB TC(W) No.31/2004. Copies/counterfoils from trip-tickets (showing the quantities of construction materials taken off-site) should be kept for record purposes.

Chemical Waste

Chemical waste can pose serious environmental, health and safety hazards if not properly managed. Such hazards include toxic effects to workers, adverse effects on water quality from spills, fire hazards, and disruption of leachate treatment plant should the chemical waste enter the sewerage system. Plant and equipment maintenance schedules should be optimised to minimise the generation of chemical wastes.

The DBO Contractor should register with EPD as a chemical waste producer. Where possible, chemical wastes (e.g. waste lubricants) should be recycled at an appropriate facility. Any transport for off-site treatment and disposal must be conducted by licensed

collectors to licensed disposal facilities, e.g. Chemical Waste Treatment Centre in Tsing Yi.

Collection receipts issued by the licensed chemical waste collector showing the quantities and types of chemical waste taken off-site and details of the treatment facility should be kept for record purposes. With the implementation of proper preventive and mitigation measures for the handling, transport and disposal of chemical waste, no insurmountable environmental impacts would be anticipated.

General Refuse

Potential environmental impacts of general refuse include odour (if the waste is not collected frequently), windblown litter, water quality impacts (if the waste enters water bodies), and visual impacts. The refuse can also attract pests and vermin if the storage areas are not well maintained and regularly cleaned.

Waste disposal at sites other than approved waste transfer or disposal facilities can also lead to environmental impacts. Handling and disposal of general refuse should cope with the presence of peak workforce during the construction period. Receipts of refuse collection should be kept for record purposes.

Regular in-house training for the staff of the DBO Contractor should be conducted to advocate the avoidance, reduction, reuse and recycling of general refuse. Recycling bins for separate collection of paper, plastic bottles and aluminium cans should be provided. Provided that the refuse will be stored and transported in accordance with proper practices and disposed at licensed landfills, no insurmountable environmental impact is anticipated.

Sludge from Leachate Treatment Plant

Although there are rare opportunities to consider the reuse or recycling of sludge from WENT Landfill Extension, there are other ways to reduce the quantity of sludge generated.

The quantity of sludge arising from the operation of the leachate treatment plant will depend on the technology selected, namely conventional aeration lagoon, sequencing batch reactor, membrane biological filter, biological aerated filter, etc. Preference will be given to technology which generates low sludge yield, but the decision will be made by the DBO Contractor. Nevertheless, all the sludge generated will be sent to the Proposed Sluge Treatment Facilities by others, which adopt incineration technology, at Tsang Tsui for disposal and treatment.

Provided that the sludge will be stored and transported in accordance with proper practices, no insurmountable environmental impact is anticipated.

6.4.2.2 Restoration and Aftercare Phases

Chemical Waste

With the implementation of proper preventive and mitigation measures similar to the construction management approach for the handling, transport and disposal of chemical waste, no insurmountable environmental impact is anticipated during the restoration and aftercare phases.

General Refuse

With the implementation of proper preventive and mitigation measures similar to the construction management approach for the handling, transport and disposal of general refuse, no insurmountable environmental impact is anticipated during the restoration and aftercare phases.

Sludge from Leachate Treatment Plant

With the implementation of proper preventive and mitigation measures similar to the construction management approach for the handling, transport and disposal of sludge, no insurmountable environmental impact is anticipated during the restoration and aftercare phases.

The details of implementation of waste management are to be included in the waste management plan as detailed in **Appendix 6.2**.

6.5 Mitigation Measures

6.5.1.1 Excavated Construction Materials

As the design has adopted a construction material balance approach, the impact on the handling, collection, transportation and disposal of construction material is insignificant. Excavated slope, stockpiled material and bund walls will be covered (e.g. by a tarpaulin) until used in order to prevent wind-blown dust during dry weather, and to reduce muddy runoff during wet weather. If any topsoil-like materials need to be stockpiled for any length of time, consideration should be given to hydroseeding of the topsoil on the stockpile to improve its visual appearance and prevent soil erosion.

6.5.1.2 Chemical Waste

Plant/ equipment maintenance schedule should be designed to optimise maintenance effectiveness and to minimise the generation of chemical waste. Chemical waste should be properly stored and transported off-site for treatment by a licensed collector. The DBO Contractor should register with EPD as a chemical waste producer. Where possible, chemical waste (e.g. waste lube oil) should be recycled by licensed treatment facilities.

6.5.1.3 General Refuse

All recyclable materials (separated from the general waste) should be stored on-site in appropriate containers with cover prior to collection by a local recycler for subsequent reuse and recycling. Residual, non-recyclable, general waste should be stored in appropriate containers to avoid odour. Regular collection should be arranged by an approved waste collector in purpose-built vehicles that minimise environmental impacts during transportation.

6.5.1.4 Sludge

Sludge should be collected by a licensed collector at regular intervals, to suit the operation schedule of the leachate treatment plant. The use of purpose-built sludge tankers can minimise the potential of environmental impacts during transportation.

6.6 Residual Impacts

Potential environmental impacts due to wastes generation from the Project will be controlled by means of a construction material balance approach with the implementation of appropriate mitigation measures, which are practical, proven and cost-effective for controlling potential impacts from the waste types. Provided that these measures are adopted and properly implemented during the construction, operation, restoration and aftercare phases, no residual impact is anticipated.

6.7 Environmental Audit

Auditing of each waste stream should be carried out periodically to determine if waste is being managed in accordance with the prescribed procedures in the Waste Management Plan (WMP), which becomes part of the Environmental Management Plan according to the requirements as stipulated in ETWB TCW No. 19/2005. The audits will examine all aspects of waste management including waste generation, storage, recycling, treatment, transportation, and disposal. The general site inspections including waste management issues will be undertaken weekly by Environmental Team to check all construction activities for compliance with all appropriate environmental protection and pollution control measures, including those stimulated in the WMP. Monthly waste management audit will be carried out by the Independent Environmental Checker.

6.8 Implication of STF Implementation

According to the latest information from EPD, other waste management facility - Sludge Treatment Facility (STF) will be implemented in early to mid 2010s. The WENT Landfill and

its extension will be receiving residues from STF.

According to the EIA Report of Sludge Treatment Facilities, the STF is scheduled for completion in 2012 and will be designed with the specifications that the incinerator ash (bottom ask and fly ash) generated under normal operation would comply with the proposed Incineration Residue Pollution Control Limits and leachability criteria as shown on **Table 6.1**.

Table 6.1 - Proposed Incineration Residue Pollution Control Limits

Pollutant Parameter	**Pollution Control Limit**
Each skip load prior to transportation to disposal site	
Residue itself:	
Bottom Ash and Fly Ash:	
• Total organic carbons [(a)]	3% by wt [(d)]
• Dioxins / Furans [(b)]	1 ppb (or 1 μg kg-1)
Leachate derived from the residue:	
pH	>8
Heavy Metals [(c)]	
• Cd	10 ppm (or mg kg^{-1})
• Cr	50 ppm (or mg kg^{-1})
• Cu	250 ppm (or mg kg^{-1})
• Ni	250 ppm (or mg kg^{-1})
• Pb	50 ppm (or mg kg^{-1})
• Zn	250 ppm (or mg kg^{-1})
• Hg	1 ppm (or mg kg^{-1})
• Sn	250 ppm (or mg kg^{-1})
• Ag	50 ppm (or mg kg^{-1})
• Sb	150 ppm (or mg kg^{-1})
• As	50 ppm (or mg kg^{-1})
• Be	10 ppm (or mg kg^{-1})
• Tl	50 ppm (or mg kg^{-1})
• V	250 ppm (or mg kg^{-1})
• Se	1 ppm (or mg kg^{-1})
• Ba	1,000 ppm (or mg kg^{-1})

Notes:
(a) Checking of carbon burnout of the ash is necessary to ensure adequate sterility
(b) I-TEQ (International Toxic Equivalents)
(c) Toxicity Characteristic Leaching Procedure (TCLP) limits for landfill disposal
(d) The EU Directive on Incineration of Waste requires a TOC of 3% by wt.

The total amount of bottom ash and fly ash produced from STF is estimated to be 186 tonnes per day. In view of the small quantity of ash disposal to landfill, the impact on leachate generation in landfill would not be a concern.

To confirm this conclusion, Toxicity Characteristic Leaching Procedure (TCLP) tests will be carried out as proposed in the STF Study. The tests will be carried out for each batch of bottom ash and fly ash to be disposed of at existing WENT Landfill at the initial stage of the STF operation (for a period of 6 months). If the text results confirm that heavy metals or pH are not of concern, the TCLP test can be deleted or reduced to half-yearly intervals.

The other waste product generated during the operation of the incinerator would be flue gas cleaning residues produced in the air pollution control system. It is estimated that the amount of flue gas cleaning residues is about 84 tonnes per day. Flue gas cleaning residues from dry flue gas cleaning systems consist of fine particulate mixtures of fly ash mainly comprising the reaction products of acid gas neutralization and unreacted lime. The flue gas

cleaning residue would be collected in the secondary bag filter and would be stored in a separate residues silo. This residue material is usually soluble in water and it can contain elevated levels of a wide range of metals. The STF will be designed with the specifications that the flue gas cleaning residues produced under normal operation would comply with the proposed Incineration Residue Pollution Control Limits and leachability criteria as shown on **Table 6.1** prior to any stabilization or solidification process as far as practicable.

Yet, the material may occasionally need to be stabilized or solidified in order to meet the proposed Incineration Residue Pollution Control Limits. This would be confirmed by carrying out TCLP tests during the initial stage of the STF operation. Pre-treatment technologies to enable the residue to comply with the leachability criteria may include cement solidification or chemical stabilization, or thermal treatment.

As a conclusion, it is expected that the bottom ash or fly ash or flue gas cleaning residue generated from the STF meeting the Incineration Residue Pollution Control Limit would not contain elevated levels of heavy metals. The impact on leachate generation in landfill would thus not be a concern.

6.9 Conclusion

The waste management assessment has reviewed the potential impacts from various types of wastes generated from the construction, operation, restoration and aftercare stages of the WENT Landfill Extension. Through the analysis of the Project activities, the quantity, quality and timing of waste arising have been identified, including excavated materials from site preparation, chemical waste arising from maintenance of plant and equipment, general waste from daily activities, and sludge from leachate treatment plant. By adopting a material balance approach (e.g. balance cut-and-fill in site formation design, general waste from daily activities to be collected and recycled, etc.) and with the appropriate mitigation measures in place, no adverse environmental impact is anticipated.