2 PROJECT DESCRIPTION

2.1 Need for the Project

2.1.1.1 The Project is to construct and operate a modern Integrated Waste Management Facilities (IWMF) for managing municipal solid waste (MSW) under a design-build-operate (DBO) contract arrangement. The IWMF comprises: (a) an advanced thermal incineration plant with design capacity of 3,000 tonnes per day (tpd) and (b) a mechanical sorting and recycling plant with design capacity of 200 tpd. The non-recyclables sorted from the mechanical plant will be sent to the thermal incineration plant for further treatment. Under any conditions, the total MSW feeding to the thermal incineration plant and the mechanical plant will not exceed 3,000 tpd.

2.1.1.2 Over the past years, the quantity of MSW generated in Hong Kong has been on an increasing trend. At present, Hong Kong generates about 19,000 tonnes of MSW each day, 52% of which are recovered for recycling. The remaining non-recycled MSW together with construction waste, sewage sludge and other waste amounting to 13,800 tonnes each day are disposed of at landfills.

2.1.1.3 Compared with other major cities in the world that have diverse means of disposing of waste, Hong Kong relies solely on three strategic landfills, including the South East New Territories (SENT) Landfill, the North East New Territories (NENT) Landfill and the West New Territories (WENT) Landfill for the disposal of its MSW. Consequently, the three strategic landfills are now projected to approach their capacities in 2014, 2016 and 2018 respectively; hence there is a pressing need for adoption of advanced waste treatment technologies to reduce unavoidable MSW volumes so as to extend the life span of the strategic landfills and their future extensions.

2.1.1.4 To address this imminent waste problem in a holistic manner, the Government has reviewed the action agenda outlined in the "Policy Framework for the Management of Municipal Solid Waste (2005-2014)" (the Policy Framework) published in 2005 against the latest development in January 2011. To ensure solid waste can continue to be handled properly without causing environmental problems, the Government will:

(a) revise upward the MSW recovery target to 55% by 2015 by stepping up publicity and promotional efforts on waste reduction and recycling;

(b) expedite legislative proposals to introduce new Producer Responsibility Scheme (PRS) and extend current PRS to encourage waste reduction;

(c) engage the public in continued discussions on possible options to introduce MSW charging as a direct economic disincentive to reduce waste at source; and

(d) seek funding approval from the Finance Committee of the Legislative Council (LegCo) in early 2012 so that advanced waste treatment facilities (including an IWMF with a treatment capacity of 3,000 tonnes of MSW daily, the first phase organic waste treatment facilities with capacity of 200 tonnes of food/ organic waste daily), and extension to the existing landfills will be commissioned in time to ensure continual and more sustainable management of solid waste.

2.1.1.5 Hong Kong needs to confirm on the development of the first IWMF to significantly reduce the bulk of MSW size as soon as possible, otherwise with the decreasing availability of landfill capacity there will be little suitable disposal facilities to handle the MSW we generate by 2018. There is a need to act in time, taking into account the lead time required for project planning and preparation, as well as the relevant statutory and administrative requirements. Hong Kong will not be able to uphold the high standard of environmental hygiene that the local and international community expects of a world class city if there is no timely and adequate provision of appropriate waste treatment and disposal facilities.

2.1.1.6 There are a number of benefits with the implementation of the first IWMF, including:

- **Substantial Bulk Reduction for Landfill Disposal** - The amount of MSW to be disposed of at landfills will substantially decrease as the volume of waste remained after the thermal treatment process would only be about 10% of the original volume. Hence, the existing landfills and their extensions can serve for a longer period of time.
- **Energy Recovery** - The IWMF could generate and export electricity for gainful uses by the community.
- **Greenhouse Gas Reduction** - The production of greenhouse gases due to landfilling of MSW will be reduced. The IWMF will also generate and export electricity for the community's gainful uses thus replacing fossil fuel use for power generation, leading to overall reduction of greenhouse gas emission in Hong Kong.

2.2 Site Selection

2.2.1 Identification of Potential Sites

2.2.1.1 A site search exercise was conducted in 2008 under the study *Site Search for Integrated Waste* Management *Facilities in Hong Kong for Municipal Solid Waste* to identify the potential sites for the development of the IWMF. The Legislative Council, the Tuen Mun and Islands District Councils and the Advisory Council on the Environment were briefed on the findings of the site search in 2008.

2.2.1.2 The Government formed an Advisory Group (AG) and five AG sub-groups comprising 24 non-official members from the professional bodies, green groups, academic and business sectors. Based on the recommendations from the Advisory Group on Waste Management Facilities, the following 23 types of areas were excluded from the preliminary search for potential sites:

- All areas for Residential and Commercial Use;
- All 23 existing or potential Country Parks;
- All existing or potential Marine Parks and Marine Reserves;
- All Special Areas (outside Country Parks);
- All Sites of Special Scientific Interest (SSSI) (including buffer areas);
- All Restricted Areas (Wildlife);
- The RAMSAR Site (including buffer area);
- All Green Belt (GB) and Urban Fringe Parks;
- All Conservation Areas (CA);
- All Coastal Protection Areas (CPA);
- All Water Gathering Grounds;
- All Wetlands Areas;
- All Fish Culture Zones;
- All Proposed Fisheries Protection Areas;
- All Gazetted Beaches;
- All Declared Monuments, Graded Historical Buildings and Structures, Deemed Monuments and Archaeological Sites;

- All Cemeteries, Burial Grounds or Grave Zones;
- All Fairways and Shipping Lanes and Port Areas;
- All Airports and Restricted Areas around them (including the Military Airport);
- All Tunnels and Roads, existing and proposed Railways;
- All Other Major Infrastructure (including Castle Peak Firing Range);
- All Major Tourism Development Areas; and
- All Priority Sites for Enhanced Conservation promulgated under the New Nature Conservation Policy.

2.2.1.3 **Figure 2.1** shows the locations of the existing or potential Country Parks, the existing or potential Marine Parks and Marine Reserves, and Special Areas (outside Country Parks). In additional to the existing Country Parks, Marine Parks and Marine Reserves, and Special Areas, the potential locations for Marine Parks, and Country Parks (e.g. Po Toi, Tung Lung Chau) were also not considered for the development of the IWMF.

2.2.1.4 Soko Islands were not considered for the development of the IWMF because Soko Islands have been designated for the development of the proposed Soko Islands Marine Park. The area is an important habitat of Chinese White Dolphins and Finless Porpoises, and the only area in Hong Kong with a major spatial overlap in the distribution of these two types of marine mammals. It is also a spawning and nursery ground of commercial fisheries resources. The development of the IWMF in the potential marine park was not considered suitable.

2.2.1.5 Apart from the above recommendations of the AG, the following factors were also taken into account in identifying the potential sites:

- The IWMF should be located in areas compatible with neighbouring activities;
- It should have marine access; and
- It should be less exposed to waves or typhoons in case outlying islands are chosen.

2.2.1.6 The islands in Sai Kung (e.g. Kau Sai Chau, Jin Island) were not considered for the development of the IWMF because the islands and their nearby waters are popular locations for various recreational activities including swimming, diving, golfing, hiking, etc. The southern parts of Kau Sai Chau and Jin Island have been proposed as Landscape Protection Areas and are to be used for seabirds/ other wildlife conservation. The islands are also viewed by the nearby Sai Kung East Country Park, Sai Kung West Country Park, Kiu Tsui Country Park and Clear Water Bay Country Park. The development of the IWMF was not considered compatible with neighbouring activities.

2.2.1.7 The above has resulted in forming an initial list of 21 sites, comprising of 13 closed landfills as follows:

<u>Outlying Islands</u>

- Ex-Lamma Quarry, Lamma Island;
- Artificial Island near Shek Kwu Chau;
- Siu Ho Wan;
- Ha Mei Wan, Lamma Island.

Large Scale Artificial Islands for New Landfill Development

- Eastern Waters;
- Lamma South West;
- North West Lantau;
- South Cheung Chau;
- South East Offshore;
- Tai Long Wan Offshore.

Other Regions

- Ha Pak Nai;
- NENT Landfill Extension B;
- Nim Wan;
- Pillar Point Valley;
- Stonecutters Island;
- Tseung Kwan O Area 137;
- Tuen Mun Area 38;
- Tuen Mun Port (near Black Point Headland);
- WENT Landfill Extension A;
- WENT Landfill Extension B;
- Tsang Tsui Ash Lagoons.

2.2.1.8 The initial list of potential sites was then subject to further consideration with respect to their site characteristics, latest development status, prevailing wind directions and the dominant environmental conditions to form a site proposal.

2.2.1.9 All the 13 closed landfill sites were considered not suitable due to the lack of large flat platforms, unstable foundations and commitment to other uses.

2.2.1.10 Under the study of "Extension of Existing Landfills and Identification of Potential New Waste Disposal Sites", some sites were identified and assessed for the feasibility to be developed as large scale artificial islands for landfill purpose. These large scale artificial islands could be the potential locations for the development of the IWMF. However, since these sites were not selected for the development of new landfills, the development of the IWMF at these sites were not considered.

2.2.1.11 For the remaining sites, commitments have been made to reserve some of them for other developments (e.g. Siu Ho Wan for Organic Waste Treatment Facilities and Stonecutters Island for the Harbour Area Treatment Scheme).

2.2.1.12 As a result, eight potential sites (as shown in **Figure 2.2**) were shortlisted as follows:

- S1 - Tseung Kwan O Area 137
- S2 - Ex-Lamma Quarry, Lamma Island
- S3 - Ha Mei Wan, Lamma Island
- S4 - Artificial Island near Shek Kwu Chau

- S5 - Tsang Tsui Ash Lagoons
- S6 - Tuen Mun Area 38
- S7 - Ha Pak Nai
- S8 - Tuen Mun Port (near Black Point Headland)

2.2.1.13 With due consideration of site availability, land use, traffic, environmental, social and other relevant aspects, it was concluded that the last two of the above sites, Ha Pak Nai (S7) and Tuen Mun Port (S8), be dropped from further consideration. The reasons for dropping the Ha Pak Nai site are that it is located at the ecologically sensitive coastal area at Deep Bay and embraces numerous active fish ponds. The site is zoned as a "Coastal Protection Area" on the Outline Zoning Plan and the proposed development of the IWMF is not in line with the planning intention of the area. Moreover, it is located immediately next to the Ha Pak Nai Archaeological Site which is worthy of preservation. As for Tuen Mun Port site, the site area has not yet been formed. The plan under a previous study was to use part of the site formed through reclamation for the proposed Tuen Mun Port Development (TMPD) project to build the waste treatment facility. As currently there is no programme to implement the TMPD project and no reclamation has been carried out in that area, locating an IWMF on that site is therefore not possible. Moreover, the proposed site is very close to Lung Kwu Sheung Tan where a number of indigenous villages exist, also Lung Kwu Tan has already been developed as a popular recreational spot. It is also close to the Sha Chau and Lung Kwu Chau Marine Park designated for the conservation of Chinese White Dolphins. All these have rendered the Tuen Mun Port site not suitable for the IWMF development.

2.2.1.14 The remaining six sites were the shortlisted sites for further site selection assessment.

2.2.2 Site Selection Criteria

2.2.2.1 The six shortlisted sites were further evaluated based on the following criteria. They were grouped into the following 5 main categories:

<u>Environmental</u>

- Air Quality
- Noise
- Visual and Landscape
- Terrestrial Ecology
- Drainage, Water Quality, Marine Ecology & Fisheries
- Hazard to Life

<u>Engineering / Technical</u>

- Ease of Integration with Existing or Planned MSW Infrastructure
- Site Access
- Constraints to Site Layout
- Utilities
- Construction Duration
- Construction Risk
- Operational Risk

Economics

- Capital Cost
- Operating Cost
- Opportunity Cost of Land

Social

- Land Use
- Land Ownership
- Traffic Impact

Consumer & User

- Community Impacts

2.2.3 Evaluation of Shortlisted Sites

S1 - Tseung Kwan O Area 137

2.2.3.1 The proposed site is located at the southwest edge of Area 137 reclamation near Tit Cham Chau in Tseung Kwan O. It has been reserved for the use of "Potentially Hazardous Installations (PHIs)".

2.2.3.2 This site is currently the only available site in Hong Kong designated for PHIs such as oil depots, gas production plants, explosive depots and liquefied petroleum gas bottling and storage facilities. Due to stringent safety requirements, there is great difficulty in identifying other PHIs sites that could meet with Hong Kong's future PHIs needs. Hence, should this site be taken for the development of the IWMF, there will be no other available site to accommodate Hong Kong's future PHIs requirements.

2.2.3.3 In addition, as the site is directly facing Siu Sai Wan, Chai Wan, and Heng Fa Chuen on the eastern side of Hong Kong Island as well as the Lohas Park of Tseung Kwan O, it would have significant visual impact on the substantial population residing in these areas.

S2 - Ex-Lamma Quarry, Lamma Island

2.2.3.4 The proposed site is located at the ex-Lamma Quarry at the northeast side of the island. It is directly facing a popular tourist spot, Sok Kwu Wan where seafood restaurants and a mariculture zone exist, and is in proximity to various indigenous villages such as Luk Chau village. The overall planning intention for Lamma Island is to conserve the natural landscape and rural character and to enhance the island as a leisure destination. Hence, the development of an IWMF at this location is not compatible with these existing land uses as well as the future planned development, and will fundamentally change the nature of this part of the Island.

2.2.3.5 The IWMF development would be incompatible with the planning intention of the remaining portion of the ex-Lamma Quarry site which is proposed for tourism and recreation purposes, and the adjoining "Comprehensive Development Area" (CDA) site which is planned for comprehensive low-rise residential development. The Planning and Development Study on Hong Kong Island South and Lamma Island has identified the ex-quarry site as having potential for development of tourism and recreation activities. A zoning review of the site will be initiated pending detailed consideration of the appropriate uses/proposal. Regarding the "CDA" site, with an open sea view and easy access to Sok

Kwu Wan ferry pier, it has high potential for a comprehensive residential scheme to bring significant improvement to the existing environment.

2.2.3.6 As the site is directly facing Wah Fu, Aberdeen, Ap Lei Chau and Wong Chuk Hang on the southern side of Hong Kong Island, it would cause significant visual effect on the substantial population residing in these areas.

S3 - Ha Mei Wan, Lamma Island

2.2.3.7 The proposed site is an artificial island to be reclaimed at the west end of Lamma Island, it is close to the core habitat of Finless Porpoises and to the planned marine park near South Lamma Island. Moreover, waters around Ha Mei Wan are high productive fishing grounds and spawning/ nursery grounds. In view of its close proximity to the various ecological sensitive receivers, and that development of the IWMF on this site would entail substantial dredging and massive reclamation works for the creation of an artificial island, there would be substantial adverse impacts on the water quality, the core habitat of Finless Porpoises, the fishing ground, spawning/ nursery grounds and the marine ecology during the construction stage.

2.2.3.8 Like the Ex-Lamma Quarry site, should the IWMF be built here, it would cause significant visual impact on the substantial population residing in Wah Fu, Aberdeen, Ap Lei Chau and Wong Chuk Hang.

S4 - Artificial Island near Shek Kwu Chau

2.2.3.9 The site is to be formed by reclamation at the south-western side of the Shek Kwu Chau which is located to the south of Chi Ma Wan Peninsula of Lantau Island. The key advantages of the site for the IWMF development are:

- It is located far from any major population clusters. There is only a very light population of about 300 persons living in a rehabilitation centre managed by the Society for the Aid and Rehabilitation of Drugs Addicts (SARDA). As such, any visual impact could be insignificant due to the small number of sensitive receivers.
- Regarding air quality impact, the only major air sensitive receivers are residents in Cheung Chau, however the impact should be minimal meeting the air quality requirements. Moreover, the residents in Cheung Chau are not located at the prevailing downwind direction. Since no other emission sources exist in the nearby areas, there are no concerns on the cumulative air quality impact.
- Due to its relatively central location with respect to the refuse transfer stations throughout Hong Kong Island and the outlying islands, the aggregate refuse vessel transfer trip length associated with an IWMF at the artificial island near Shek Kwu Chau would be less than the existing operation of refuse transfer to the WENT Landfill. This would offer more environmental and cost-effective marine transportation over reasonable trip length without undue impact on the marine traffic.
- Since the proposed IWMF would be developed on reclaimed land without encroachment onto the existing island, impacts on the terrestrial habitat on the existing island would be minimal.

2.2.3.10 However, the construction of an IWMF on this site would involve reclamation which might affect the natural coastline, statutory gazetting procedures, and installation of power lines and the utilities, which might impact on the natural landscape and would result in longer construction time, higher cost and the development time table may be subject to greater uncertainty due to more complex technical requirements and statutory procedures. There are also some concerns:

- The nearby marine area is a fish spawning and nursery ground, where Chinese White Dolphin and Finless Porpoise have been sighted.
- The compatibility of the IWMF with the adjacent rehabilitation centre will need to be carefully studied.

S5 - Tsang Tsui Ash Lagoons

2.2.3.11 The Tsang Tsui Ash Lagoons are situated at the northwest New Territories adjacent to the WENT Landfill and the CLP's Black Point Power Station. The ash lagoons were constructed in the 1980s by CLP for the purpose of storing PFA generated from the Castle Peak Power Station. The site is divided by bunds into three approximately equal sized lagoons: the East Lagoon, the Middle Lagoon and the West Lagoon. Consideration is given to use the Middle Lagoon for developing an IWMF. There are several advantages for doing so:

- Being located right next to the WENT Landfill, the site has an operational advantage of sharing the existing infrastructures (e.g. berthing facilities and waste container storage area etc.) and efficient disposal of the ash residues generated by the IWMF to the WENT Landfill. Because of the above synergy effect, the IWMF could occupy a smaller site area, thus translating into both land and cost saving.
- It is also close to the existing power plant. Surplus energy generated from the IWMF can easily be connected to the power grid.
- Unlike the island options, both marine and land transport of waste and ash are possible, and no reclamation is required.
- As there are no major population clusters in the vicinity, the IWMF should not have significant visual impact on the immediate local community.

2.2.3.12 Regarding air quality impact, preliminary assessment has found that the cumulative air quality impact arising from the IWMF and the existing and proposed emission sources nearby, such as the Black Point and Castle Peak Power Stations, as well as the proposed Sludge Treatment Facilities etc. on the nearby sensitive air receivers should meet the air quality requirements. Detailed assessment would need to be carried out to confirm the cumulative air quality impact should this site be selected for the IWMF development.

S6 - Tuen Mun Area 38

2.2.3.13 The site is located in an industrial setting adjacent to the EcoPark and is not far from the WENT Landfill. It is in close proximity to the air sensitive receivers at Tuen Mun New Town, in particular the Melody Garden and Butterfly Estate near the Tuen Mun Pier. The main concern of this site is the adverse cumulative air quality impact from the IWMF and several major emission sources, including the Black Point Power Station, Castle Peak Power Station, Shiu Wing Steel Mill and Green Island Cement Plant etc. In view of its close proximity to the air sensitive receivers in Tuen Mun New Town, it is very likely that this site cannot meet the air quality requirements.

2.2.3.14 Another major constraint of this site is its relatively small size. The site in question is currently reserved for another waste management facility and is only about 5.75 hectares, which is not enough to accommodate an IWMF of capacity of 3,000 tpd and of around 10 hectares. Even if developing the IWMF alone, additional land would need to be acquired from the nearby sites. However, other areas in Tuen Mun Area 38 have been planned for other land intensive facilities including EcoPark, construction and demolition handling facilities and permanent aviation fuel facility, etc. such that there is no surplus land available. In addition, transfer of waste to this site by marine vessels will be constrained. This is because there is limited space for the development of berthing facilities along the waterfront in Tuen Mun Area 38 as the waterfront area has already been reserved to

meet the operational requirements of other planned uses.

2.2.4 Recommendation

2.2.4.1 The outcomes of the assessment indicated that the Tseung Kwan O Area 137 (S1), Ex-Lamma Quarry, Lamma Island (S2), Ha Mei Wan, Lamma Island (S3) and Tuen Mun Area 38 (S6) had some major constraints and were not recommended for further engineering and EIA studies.

2.2.4.2 An artificial island near Shek Kwu Chau (S4) and Tsang Tsui Ash Lagoons (S5) are worth taking forward for detailed studies and further consideration as potential sites for the IWMF. From an air quality aspect, the artificial island near Shek Kwu Chau is comparatively more favourable. However, its potential impacts on the natural coastal landscape, marine ecology, water quality, and fishery would need further study and detailed assessment. In addition, the compatibility of the IWMF with the adjacent rehabilitation centre would need to be reviewed and carefully considered. Regarding the Tsang Tsui Ash Lagoons site, it has relative overall merits because of the ease of integration with the existing landfill and waste reception facilities, much less impact on local ecology, shorter construction time, and lower construction cost. However, the cumulative air quality impact on the air sensitive receivers would still need to be carefully and thoroughly studied and assessed to confirm its acceptability.

2.3 Technology Selection

2.3.1 Identification of Potential Technologies

2.3.1.1 To identify suitable MSW treatment technologies, the Government conducted an Expression of Interest (EoI) exercise in 2002 in which local and overseas companies were invited to submit proposals on waste treatment technologies. A total of 59 submissions were received. An Advisory Group (AG) on Waste Management Facilities comprising members from the professional bodies, green groups and the academic sector was set up to assess the proposals and to recommend suitable waste treatment technologies for Hong Kong. After the assessment of the EoI submissions, it was recommended that the IWMF should adopt a multi-technology approach because of the heterogeneous nature of Hong Kong MSW. Incineration may be adopted as the major component of the IWMF strategy. Other technologies (co-combustion, gasification or similar systems) may be considered if the concerns over the technologies such as cost, market, technical feasibility etc. could be resolved. Mechanical biological treatment (MBT) should also be considered at a suitable scale under particular circumstances and as a component of the overall IWMF strategy.

2.3.1.2 Based on the AG's recommendations, a review of the latest development of the moving grate, fluidized-bed, rotary kiln incineration technologies, eco-co-combustion system, gasification, plasma gasification and pyrolysis technologies was conducted in 2009 under this Study. It reconfirmed the recommendations of the EoI exercise, including:

- Incineration technology (i.e., moving grate incineration technology) could play a core role in the IWMF for MSW treatment;
- The key issues of the eco-co-combustion including its technical feasibility, environmental performance, proprietary/ monopoly issue and long-term commercial viability have still not been satisfactorily solved; and
- Application of the plasma gasification and pyrolysis technologies for untreated MSW treatment is still limited and are of small-scale. These technologies are not able to meet the criteria in the EoI exercise for forming the core technology of the IWMF for treating 3,000 tpd of mixed MSW.

2.3.1.3 Although no proposal on rotary kiln incineration technology was received during the EoI exercise in 2002, a review of its latest development was also carried out in 2009 under this Study because of the reported application for MSW treatment. The review results indicate that most of the rotary kiln incineration systems installed are used for sludge, industrial or hazardous waste treatment; whereas their applications for MSW treatment are uncommon and limited to relatively small scale, and therefore is not well proven for the IWMF. Hence, rotary kiln incineration technologies, eco-co-combustion system, plasma gasification and pyrolysis technologies have not been included for further evaluation.

2.3.1.4 There may be development in the fluidized-bed incineration technology and gasification technology since the EoI exercise in 2002, which may prove them to be as effective as the moving grate incineration technology for mixed MSW treatment. Therefore, these two technologies were further comparatively evaluated with the moving grate incineration technology in order to select the most suitable core technology for the IWMF.

2.3.2 Technology Evaluation Criteria

2.3.2.1 The three thermal treatment technologies, including moving grate incineration, fluidized-bed incineration and gasification technologies are evaluated based on the criteria shown in **Table 2.1** below.

Table 2.1 Criteria for Selection of Thermal Treatment Technology

Main Criteria	Sub-criteria	Assessment Measures
Environmental Factor	Air Emission	The volume of flue gas produced from the furnaces required for treatment and the amount of gas pollutants generated.
Engineering Factors	Flexibility	Are there any special requirements on the quality of feedstock? How capable is the process of adapting to short term and long term variations in the characteristics of the input waste?
	Electricity Production Efficiency	-
	Reliability	What is the maximum demonstrated capacity of a fully commercial plant? What is the scale up risk? The numbers of suppliers which can provide the system for MSW treatment.
	Land Requirement	Footprint of the process, which refers to number of incineration/ gasification unit required for treating 3,000 tpd of MSW.
	Operating Experience for Mixed MSW Treatment	How long have the incineration/ gasification systems been adopted for MSW treatment?
Costs	Capital Cost and Operating Costs	-

2.3.2.2 The selection criteria focus on the environmental, engineering and cost considerations. Other considerations, such as visual impacts, employment opportunities and public acceptance, for moving grate incineration, fluidized bed incineration and gasification are considered to be almost the same since all these treatment technologies are thermal treatment technologies. Public health is also not compared since the most advanced flue gas treatment system will be adopted for all the three technologies to meet the most

stringent air quality standards in the world. Thus, all the three technologies should pose very low or insignificant risk to public health.

2.3.3 Evaluation of Thermal Treatment Technologies

2.3.3.1 **Table 2.2** summarizes the option evaluation for the three thermal treatment technologies based on a qualitative assessment of the criteria.

Table 2.2 Summary of Option Evaluation for Thermal Treatment Technologies(1)

Criteria	Moving Grate Incineration		Fluidized-bed Incineration		Gasification	
Environmental Factors						
Air Emission(2)	Medium	Δ	High	X	Low	O
Engineering Factors						
Flexibility(3)	High	O	Low	X	Low	X
Electricity Production Efficiency	Medium	Δ	Medium	Δ	Medium to High(7)	Δ/O
Reliability - Unit Capacity	10-920 tpd	O	10-80 tpd	X	20-150 tpd	Δ
Reliability - Plant Capacity	20-4,300 tpd		10-200 tpd		30-405 tpd	
Reliability - Key Suppliers for Mixed MSW Treatment(4)	Many, including B&W Volund, CNIM, Fisia, Hitachi, JFE, Kawasaki, Lentijes (formerly called Lurgi), Seghers, Mitsubishi, Takuma & von Roll Inova		Limited, including Hitachi, JFE, Kawasaki and Mitsubishi		Limited, including Ebara(5), Hitachi(5), IET, JFE(5), Kawasaki(5), Mitsubishi(5) and Nippon Steel(5)	
Land Requirements and System Complexity(6)	Low	O	Large	X	Large	X
Operating Experience for Mixed MSW Treatment	Longest track record	O	Limited Experience	Δ	Limited Experience	Δ
Cost Factors						
Capital Costs	Low	O	High	X	High	X
Operation Costs	Low	O	High	X	High	X
Overall	**Most Favorable**		**Least Favorable**		**Less Favorable**	

Note:

(1) **O**, **Δ** and **X** represent the most favourable, medium favourable and the least favourable to the IWMF, respectively. Please note that the ranking shown in each criterion represents comparative rather than absolute ranking.

(2) Air emission criterion refers to the volume of flue gas produced from the furnaces required for treatment and the amount of the air pollutant generated.

(3) Flexibility refers to the applicability of the technology for MSW treatment and the ability to tolerate a fluctuation of the MSW characteristics.

(4) B&W Volund, CNIM, Ebara, Fisia, Hitachi, IET, JFE, Kawasaki, Lentjes, Seghers, Lurgi, Mitsubishi, Nippon Steel, and Takuma refer to Babcock & Wilcox Volund, CHIM/Martin, Ebara Corporation, Fisia Babcock Environment GmbH, Hitachi Zosen, IET Energy, JFE Engineering Corporation, Kawasaki Heavy Industries, Ltd, Lentjes UK Limited, Képpel Seghers, Lurgi Envirotherm GMBH, Mitsubishi Heavy Industries Ltd., Nippon Steel Engineering, and Takuma Co. Ltd, respectively.

(5) The systems are incorporated with ash melting systems.

(6) Land requirement and complexities are compared based on the number of the incineration/ gasification units required for treating 3,000 tpd of mixed MSW.

(7) Electricity production efficiency of gasification is ranked as high if a more efficient approach for converting the chemical energy in syngas to electrical energy is used such as combustion of the syngas after cleaning in a more efficient internal combustion engine or combustion of the syngas after significant cleaning in a gas turbine with further energy recovery though raising steam and generating power in a steam tubine. If the sygnas is combusted in a close coupled combustion chamber, there is no real energy benefits since the electrical energy would be generated from a steam turbine generator similar to conventional incineration plants.

2.3.3.2 As shown in **Table 2.2**, moving grate incineration is more favorable to be adopted as a core technology of the IWMF for treating 3,000 tpd of mixed MSW. The advantages of moving grate incineration over the gasification and fluidized-bed incineration technologies in terms of reliability, operating experience, flexibility, land requirements, and capital and operating costs are summarized as follows:

- It is the only thermal technology which has been adopted for treating over 3,000 tpd of mixed MSW, whereas fluidized bed incineration and gasification technologies for mixed MSW treatment are of much smaller scale;
- It has the least scale-up risks, whereas the other two will suffer higher scale-up risk when being adopted in the IWMF for mixed MSW treatment;
- It has the longest track record of operation (over 100 years of operation experience), whereas the other two have little or limited track record for mixed MSW treatment;
- It shows the highest capability to tolerate the fluctuation of MSW characteristics with robust/ forgiving nature when handling mixed MSW, whereas the other two are less robust and usually require pretreatment of MSW;
- It requires the least land area for the treatment units, whereas the other two have larger land requirement because of the requirement of more treatment units;
- It possess over 10 suppliers and thereby ensure adequate tender competition, whereas there are 5 – 6 suppliers of gasification/ fluidized bed technologies and a key gasification supplier is retreating from the MSW market;
- There is a concern for operation failure of the gasification technology due to unpleasant experience in Germany;
- It possesses the least operation complexity in comparison to fluidized bed incineration and gasification technologies; and
- It requires the least capital and operating costs in comparison to fluidized bed incineration and gasification technologies.

2.3.3.3 Theoretically, gasification technology generates less volume of flue gas and less amount of gas pollutants than the incineration technologies. Since gasification requires just a fraction of the stoichiometric amount of oxygen, the volume of process gas flow is smaller. It is however important to note that the quantity of air emission is not the dominating factor. By applying necessary flue gas treatment systems, the quality of air emissions from the moving grate incineration system can be regulated to meet the most stringent international air emission standards.

2.3.3.4 While extensive information on the types and levels of pollutants generated from incineration is available, there is very little published data on emissions from full-scale gasification process. If available, much of the published data for gasification process is from small scale or pilot operations. Hence comparison of the types and levels of flue gas pollutants generated by different types of thermal treatment technologies based on currently available data is rather difficult, bearing in mind also that a meaningful comparison could only be made provided that the different technologies treated similar type of wastes and employed similar energy recovery system.

2.3.3.5 It was recommended in the EoI exercise that incineration could play a key role in the overall IWMF strategy since it had a favorable treatment cost and was the most cost-effective technology to divert MSW from landfills amongst the other strategy options. Land requirement of incineration is also low. The evaluation result arrives at the same conclusion as the EoI exercise, whereby moving grate incineration technology is the most suitable technology for the IWMF in terms of environmental, engineering and cost factors. It is therefore recommended to adopt moving grate incineration as the core technology for the IWMF for treating of 3,000 tpd of mixed MSW.

2.3.3.6 At the Meeting of Advisory Council on the Environment (ACE) held on 14 December 2009, the Council discussed the findings of the technology review and had no objection to employing moving grate incineration technology as the core thermal treatment technology for the development of the IWMF.

2.3.4 Evaluation of Sorting and Recycling Technologies

2.3.4.1 As highlighted in the EoI exercise, mechanical-biological treatment (MBT) was considered to be a potential sorting and recycling technology to be adopted in the IWMF than the other technologies. This was because MBT could potentially recover both materials and energy from the mixed MSW, whereas the others could only recover recyclables. Due to its ineffectiveness in waste volume reduction and requirement of relatively large footprint than thermal treatment technologies, MBT technology was recommended to be adopted at a small scale in the IWMF.

2.3.4.2 A review of the latest development of the sorting and recycling technologies was conducted in 2009 under this Study. The sorting and recycling technologies considered include the following:-

- Mechanical Treatment alone (MT) - MT adopts various mechanical equipment such as magnets, screen and trommels, etc. to separate mixed MSW into different fractions according to their physical properties.
- Mechanical Biological Treatment (MBT) - MBT employs mechanical sorting and size classification to extract recyclables alongside biological processes (either composting or anaerobic digestion plus composting) to stabilize the biological component of the waste.
- Biological Mechanical Treatment (BMT) - BMT involves biological treatment of waste by composting, followed by mechanical sorting and size.
- Mechanical Heat Treatment (MHT) - MHT involves a series of thermal (heat) and mechanical (separation) treatment of waste. The heat treatment reduces the materials to what is known as a 'flock'. The heat process partially cleans metals and glass, and deforms plastics. After the heat treatment, mechanical separation processes are applied to allow recyclables to be extracted from the waste.

2.3.4.3 The review of these sorting and recycling facilities indicated that the EoI recommendation on adopting a small-scale MBT plant in the IWMF for demonstration purpose remained valid. There is no noticeable advancement in the MBT technology in terms of volume reduction and land requirement since the EoI exercise. The land requirement for MSW treatment, despite being subject to the technology approach selected, odour management adopted, output requirement, waste input characteristics etc, typically ranges from 60 to 130 m^2/tpd, and volume reduction is reportedly about 50%, which are similar to the information (70-90 m^2/tpd, ~50% volume reduction) received during the EoI exercise.

2.3.4.4 At the Meeting of the Waste Management Subcommittee (WMSC) of ACE on 26 January 2010, the WMSC discussed the proposal of whether a sorting and recycling plant should be incorporated in the IWMF project. The WMSC considered the proposal in detail, taking into account previous advice and recommendations by the Advisory Group on Waste Management Facilities in mid 2005 and by the ACE after the delegation's visit to Europe in 2006. As the MBT would generally require more land (about 2-3 times of the footprint required by the incinerator for the treatment of the same amount of waste), and the marketability of the products recovered from the MBT process, such as low quality compost and refuse-derived fuel, was a concern, the WMSC considered there was no strong justification in support of adopting the MBT technology in the context of Hong Kong. However, the WMSC supported in general the adoption of Mechanical Treatment (MT) technology to test the operational viability and cost effectiveness of sorting and recovering the recyclables from the MSW prior to the incineration process. Should this arrangement be found viable and cost effective, the Government could consider putting in place a MT

process of suitable scale prior to incineration in future phases of the IWMF. By doing so, it would reinforce the Government's commitment to minimizing the use of incineration and landfilling in MSW management.

2.3.5 Recommendation

2.3.5.1 Based on the results of the evaluation of the shortlisted treatment options and the recommendations of ACE, it was concluded that moving grate incineration would be the most preferable option and would be adopted as the core treatment technology, supplemented with demonstration-scale mechanical treatment facilities, in the IWMF.

2.4 Scope of the Project

2.4.1 Site Location

2.4.1.1 As shown in **Figure 1.1**, the TTAL site is located at the existing ash lagoons in Nim Wan, Tuen Mun, overlooking Deep Bay in north-western New Territories. The area, comprising the East, Middle and West Lagoons, is leased to China Light & Power Company, Ltd. (CLP) for storing pulverized fuel ash (PFA). The site would occupy an area of approximately 11 hectares in the northern portion of the Middle Lagoon, which was used to stock furnace bottom ash and is currently utilized by CLP for water collection and conservation. Other industrial facilities in the vicinity include the Black Point Power Station (BPPS) to the south-west and the WENT Landfill and its associated waste reception facilities to the east. The Sludge Treatment Facilities, which is under construction would be situated in the northern portion of the East Lagoon adjoining the TTAL site while the planned WENT Landfill Extension would be developed in phases in the Nim Wan area covering the West Lagoon and the remaining portions of the other two ash lagoons as well as the area between the Black Point Power Station and WENT Landfill.

2.4.1.2 The artificial island near SKC as shown in **Figure 1.2** will be formed by reclamation at the south-western coast of Shek Kwu Chau, an island located to the southwest of Cheung Chau and to the south of Chi Ma Wan Peninsula, Lantau Island. The IWMF development would include approximately 11.8 hectares of reclaimed land and berth area, and 4.1 hectares of breakwater protecting the berth area of the IWMF and water basin from strong waves. The area enclosed by the breakwater would be about 31 hectares (including the area of the breakwater). To avoid direct impact on the terrestrial ecology of Shek Kwu Chau and to conserve the natural shoreline of Shek Kwu Chau, the reclamation area will not be connected to Shek Kwu Chau. Instead, the coast of Shek Kwu Chau and the reclamation area will be separated by a water channel.

2.4.1.3 Shek Kwu Chau is granted to the Society for the Aid and Rehabilitation of Drug Addicts (SARDA) for use as a rehabilitation centre, which presently has a population of about 300 rehabilitators and staff. There is no other existing or planned residential, commercial or industrial development on the island.

2.4.2 Project Facilities

2.4.2.1 The infrastructure for this Project would comprise an advanced incineration plant, a mechanical sorting and recycling plant, and ancillary & supporting facilities. The facilities of the IWMF mainly include the following:

Incineration Plant

- MSW receiving, storage and feeding system
- Moving grate incineration furnaces
- Waste heat recovery and power generation system
- Boiler feedwater treatment system
- Flue gas treatment system
- Flue gas discharge system with stack
- Ash storage and handling system
- Reagent reception and storage system
- Odour control system
- Process control and monitoring system

Mechanical Treatment (MT) Plant

- MSW receiving, storage and feeding system
- Mechanical treatment system including shredding and sorting facilities
- Products and by-products storage and handling system
- Odour control system
- Process control and monitoring system

Ancillary & Supporting Facilities

- Weighbridge
- Site security
- Administration building / Visitors and environmental education centre
- Vehicle washing facilities
- Maintenance workshop
- Fuel storage tanks
- Water treatment plant
- Wastewater treatment plant
- Electricity supply and export system
- Utilities
- Berthing area for marine vessels and storage of refuse containers (for the artificial island near SKC only)

2.4.2.2 Design-Build-Operate (DBO) contract arrangement would be adopted for the Project and the operation period would be 15 years. Under this contract arrangement, a DBO

contractor would be engaged to conduct the detailed design, construction and operation of the IWMF.

2.4.2.3 For the purpose of the EIA Study, a reference design for the IWMF was prepared. The preliminary layouts showing the IWMF facilities at the TTAL site and the artificial island near SKC are presented in **Figures 2.3 and 2.4** respectively.

2.4.2.4 The incineration plant is designed to meet the target emission limits as shown in **Table 2.3**. Advanced air pollution control system, including selective catalytic reduction (SCR) for nitrogen oxides (NOx) removal, activated carbon for dioxins removal, bag filters for particulates removal, dry/semi-dry scrubber for acid gas removal, and continuous emissions monitoring system will be installed for the IWMF to ensure that the emissions from the IWMF stacks will meet the target emission limits. Apart from NOx standard, these target emission limits are based on the internationally most stringent European Union (EU) standard for MSW incinerators and the Hong Kong Best Practicable Means for Incinerators. For NOx, as it is the most critical parameter in Hong Kong in complying with the Air Quality Objectives (AQOs), the Government is decided to set a more stringent NOx limit and adopt the most advanced air pollution reduction measures for the IWMF. The daily average emission limit of NOx is lowered to 100 mg/m^3, which is 50% reduction when compared with the EU standard, which is set at 200 mg/m^3.

2.4.2.5 In the reference design, the incineration plant consists of six incinerator units, each with a design capacity of 600 tpd. Most of the facilities of the IWMF would be housed inside buildings. The Incineration Plant and Administrative & Mechanical Treatment (MT) Process Building are the two major building structures in the IWMF. The approximate dimensions of the major building structures are shown in **Table 2.4**.

Table 2.3 Air Emission Limits for the IWMF

Air Pollutants	Emission Limits (mg/m^3) (1)		Monitoring Requirements
	Daily	Half - Hourly	
Particulates (2)	10	30	Continuous
Organic Compounds	10	20	Continuous
Hydrogen Chloride (HCl)	10	60	Continuous
Hydrogen Fluoride (HF)	1	4	Continuous
Sulphur Dioxide (SO_2)	50	200	Continuous
Carbon Monoxide (CO) (3)	50	100	Continuous
Nitrogen Oxides (NO_X) as Nitrogen Dioxide (NO_2)(7)	100	200	Continuous
Mercury	0.05 (4)	-	Intermittent
Total Cadmium & Thallium	0.05 (4)	-	Intermittent
Total Heavy Metals (5)	0.5 (4)	-	Intermittent
Dioxins & Furans (6)	1×10^{-7}	-	Intermittent

Notes: (1) The emission limit is expressed at reference conditions of 0°C temperature, 101.325 kPa pressure, dry and 11% oxygen content conditions.
(2) The particulate emission limit is assumed to be respirable suspended particulates (RSP).
(3) CO emission limits do not apply to the start-up and shut-down periods.
(4) Average values over a sampling period of a minimum of 30 minutes and a maximum of 8 hours.
(5) Including Sb, As, Pb, Co, Cr, Cu, Mn, V and Ni.
(6) The unit is I-TEQ (The emission limit is equal to 0.1 ng I-TEQ m^{-3}), according to the BPM 12/1(08), the averaging time for dioxin is 6 to 8 hours.
(7) The emission levels for NOx are half of that stipulated in European's Emission Limits in EC's Waste Incineration Directive.

Table 2.4 Dimensions of Major Building Structures of IWMF

Major Building Structures of IWMF	Area (ha)	Height	
		(m)	(mPD)
Stack	-	150	+155mPD
Incineration Plant	2.2	50	+55mPD
Administrative & MT Process Building	1.2	15	+20mPD

2.4.2.6 An on-site desalination plant will be provided for supplying water to the IWMF. The desalination plant would involve membrane separation of dissolved ions such as chloride ions from seawater, and would not involve any boiling or burning processes.

2.4.2.7 An on-site wastewater treatment plant will be provided to treat the wastewater generated from floor/vehicle washing and from staff/visitors. The treated effluent will be reused in the incineration plant or mechanical treatment plant or for washdown and landscape irrigation within the IWMF. No effluent would be discharged to the nearby water body or the existing sewerage or drainage systems.

2.4.2.8 The heat produced during the incineration process will be recovered and used for electricity generation. The electricity generated from the incineration process will be used to support the normal operation of the facilities within the IWMF. Surplus energy will be exported to other users via the existing electricity grids maintained by power companies.

2.4.2.9 For exporting the surplus electricity from the TTAL site, no installation of submarine cables will be required as laying underground cables to the nearby CLP's Black Point Power Station is the only option. For exporting the surplus electricity from the artificial island near SKC, various energy export options have been explored, all of which involve installation of submarine cables. The options involve exporting energy from the artificial island near SKC to the CLP's power grid in Lantau or to the HEC's Lamma Power Station in Lamma Island. As the artificial island near SKC is located closer to South Lantau than Lamma Island, the length of submarine cables to South Lantau (about 5.6km from SKC to Cheung Sha, South Lantau) will be shorter than that to Lamma Island (various between 13.3km to 21.8 from the artificial island to Lamma Power Station depending on the route selected). Considering the potential environmental impacts and costs related to the installation and maintenance of longer submarine cables as well as the potential constraints in laying submarine cables across the proposed HEC's wind farm and HEC's existing submarine gas pipeline, the energy export routes to Lamma Power Station is less preferable than the energy export routes to Cheung Sha. The potential alignment of the preferred energy export route from the artificial island near SKC to Cheung Sha is shown in **Figure 2.5**.

2.4.3 Construction of the IWMF

TTAL Site

2.4.3.1 The Project would require decommissioning of the Middle Lagoon, formation of about 1.2 hectares of pond habitat for Litter Grebe and about 9.8 hectares of land and associated roads and drains, followed by foundation works, construction of superstructures and installation of plants and equipment for the various systems of the IWMF.

2.4.3.2 Currently, the land is largely formed by PFA that was filled to this site in previous years. As there are no existing structures in the site area, the works related to the decommissioning of the lagoon would be minimal.

2.4.3.3 The finished ground level of the IWMF will be at a level higher than the average ground level of the existing Middle Lagoon. Therefore, the formation of land for the IWMF would

involve mainly filling and levelling work. No disposal of PFA will be required during the construction phase.

2.4.3.4 The construction of the IWMF will include the following stages:

- Site drainage;
- Site formation;
- Foundation piling;
- Civil and building works;
- Mechanical & electrical plant installation;
- Roads, utilities, services and landscaping; and
- Ancillary instrumentation and control works.

Artificial Island near SKC

2.4.3.5 Reclamation will be needed to form about 11.8 hectares of land for the IWMF. Due to occasionally rough sea condition in the vicinity of the artificial island near SKC, breakwater will be provided to ensure safe loading and unloading operation at the berth area of the IWMF. The locations of the reclamation area, cellular cofferdam and breakwater are shown in **Figure 2.6**. The approximate area of the reclamation area, cellular cofferdam, berth and breakwater are as follows:

- Reclamation area, berth and cofferdam = about 11.8 ha
- Breakwater = about 4.1 ha
- Total area enclosed by the breakwater (including the breakwater) = about 31 ha

2.4.3.6 The reclamation will be formed with filling materials supported on the insitu marine deposits with suitable geotechnical ground treatment (such as surcharge loading, installation of vertical band drains, etc.) at a finished ground level of about +5mPD high. Seawalls will be constructed to confine the reclamation area and breakwaters will be provided to protect the water basin. To minimize dredging and filling activities and the associated environmental impacts, vertical cellular structure consisting of circular cells instead of sloping gravity structure is proposed to be adopted for the construction of the seawalls and breakwaters. The cellular breakwater protecting the reclamation area and the water basin would be about +9mPD high for resisting waves with significant heights.

2.4.3.7 Cellular cofferdams are self-supporting gravity structures consisted of circular cells constructed using straight web sheet piles. The piles are interlocked and driven to form closed cells (or circular cells) which are then filled with filling materials as shown in photos (a) and (b) of **Figure 2.7**. To achieve continuity of the wall, the circular cells are connected together using fabricated junction piles and short arcs as shown in photo (c) of **Figure 2.7**.

2.4.3.8 The installation of cellular cofferdams involves driving of sheet piles in place using vibratory hammer or hydraulic impact hammer. To guide the placement of the sheet piles at correct position and to stabilize the circular cell during backfill, “templates” are required during the installation of cellular cofferdams (see photo (d) of **Figure 2.7**). A template is first placed at the target location of the circular cell. All piles are then temporarily fixed on the template. After fixing the piles on the template, the sheet piles are driven into the seabed. Circular cells are backfilled after the sheet piles reach the design depth. To ensure the stability of the cell, the template remains in place during backfilling. After completion of two circular cells, the arcs connecting the two cells will be installed as shown in photo (c) of **Figure 2.7**.

2.4.3.9 As a preventive measure to reduce the loss of fine from the filling of circular cells as well as arc cells, silt curtain would be applied around the circular cell or arc cell during the filling process. The loss of fine during the filling of circular cells would be minimal as the filling would be carried out within completed sheet pile cell, which would be further surrounded by silt curtain. Further discussion will be provided in **Section 5b.7.2.1**. To avoid scouring around the cofferdam at the seabed level, an anti-scouring protection layer, which comprises of a layer of rock material, will be installed along the cofferdam at the seabed level. A shallow trench (approximately 1m in depth and 5-10m in width) will be formed by dredging and then filled by rock material up to the seabed level.

2.4.3.10 The berth area, which will be extended from the seawall at the northwest side of the reclaimed area, will be formed by a piled deck structure with precast slab. Tubular piles are proposed to form the foundation of the berth. Non-percussive bore piling method would be adopted for the installation of tubular piles.

2.4.3.11 The construction of the IWMF will include the following stages:-

- Construction of cofferdam surrounding the reclamation area;
- Site filling for reclamation;
- Surcharge loading for reclamation area;
- Construction of breakwater;
- Pilling for berth area;
- Site drainage;
- Foundation (spread footing);
- Civil and building works;
- Mechanical & electrical plant installation;
- Roads, utilities, services and landscaping; and
- Ancillary instrumentation and control works.

2.4.3.12 The submarine cables would be installed by burying method using water jets. A cable burying machine would include an injector lowered to the seabed. The injector fluidizes a trench using high pressure water jets and a cable is immediately laid within the trench. The sides of the trench slip around the cable, burying it and leaving a small depression in the seabed.

2.4.4 Operation of the IWMF

2.4.4.1 The IWMF will be operated on a 24-hour basis daily, while the reception of MSW would be limited from 8 am to 8 pm.

2.4.4.2 For the artificial island near SKC, about 3,000 tpd MSW in sealed containers would be delivered by marine vessels from the existing refuse transfer stations, including Island East Transfer Station, Island West Transfer Station and West Kowloon Transfer Station. For TTAL site, about 3,000 tpd MSW in sealed containers currently delivered to the berth of WENT Landfill by marine vessels or delivered directly to the WENT Landfill or its extension by land transport will be diverted from the WENT Landfill to the adjoining TTAL site by land transport.

2.4.4.3 At the reception hall of the incineration plant, MSW from the containers will be discharged to a bunker. The MSW will then be fed into incineration furnaces for combustion. The heat energy released will be recovered to generate electricity through waste heat boilers and steam turbine generators. Flue gas generated from the incineration furnaces will be

treated before discharging to the atmosphere. Bottom ash, fly ash and air pollution control (APC) residues produced from the incineration process will be collected and disposed of at the WENT Landfill or its extension if they have met the disposal requirements or will be reused if possible.

2.4.4.4 MSW delivered to the MT plant will be discharged to a bunker. A grab bucket will cut the plastic bags commonly used for household waste collection and convey the MSW to the hopper of the mechanical treatment facilities. Large-size MSW will first be cut into smaller pieces by a shredder. The well-prepared MSW will then run through a series of mechanical treatment processes and separate into different types of outputs, including recyclable materials (e.g. metals, papers and plastics) to be collected by recyclers, sorted combustible MSW to be sent to the incineration plant for treatment with other MSW, and non-combustible MSW to be disposed of at the WENT Landfill or its extension.

2.4.5 Construction Programme

2.4.5.1 The tentative construction programmes for the TTAL site and the artificial island near SKC are shown in **Table 2.5** and **Table 2.6** respectively.

Table 2.5 Construction Programme of the IWMF at the TTAL Site

Description	Date
Award of Contract	March 2013
Site Clearance & Backfilling	March 2013 – August 2013
Foundation (Pilling)	June 2013 – February 2015
Civil and E&M Works	November 2013 – May 2016
Testing and Commissioning	2016 –2017

Table 2.6 Construction Programme of the IWMF at the Artificial Island near SKC

Description	Date
Award of Contract	March 2013
Construction of Cofferdam Surrounding Reclamation Area Phase 1	June 2013 – November 2013
Construction of Breakwater Phase 1	June 2013 – November 2013
Construction of Cofferdam Surrounding Reclamation Area Phase 2	June 2014 – July 2014
Site Filling for Reclamation	January 2014 – October 2014
Surcharge Loading for Reclamation Area	May 2014 – July 2015
Construction of Breakwater Phase 2	June 2014 – October 2014
Installation of Anti-scouring Layer	November 2014
Pilling for Berth Area	June 2014 – November 2014
Construction of Submarine Cables	June 2015
Foundation (Spread Footing)	May 2015 – October 2015
Civil and E&M Works	August 2015 – February 2018
Testing and Commissioning	2018 –2019

2.5 Consideration of Alternatives

2.5.1 Introduction

2.5.1.1 According to the findings and recommendations of the site selection and technology selection processes described in **Section 2.2** and **Section 2.3**, and the construction and operation requirements mentioned in **Section 2.4**, the scope of the Project at the two potential sites is developed. It should be noted that in addition to the consideration of alternative site and technology for the development of the IWMF, the following alternatives have also been considered in the Study in arriving at the preferred scope of the Project.

2.5.2 Treatment Capacity

2.5.2.1 A review of the existing incineration plants in the world was conducted. Based on the existing installations in the world, most of the incineration plants have a treatment capacity ranging from less than 1,000 tpd to 4,000 tpd. Selection of plant capacity is normally dependent on local requirements and constraints. Localized small scale incineration plants are likely have less traffic impact when compared to centralized large scale incinerations. The advantages of large scale incineration plants are that they are more efficient in cost and land utilization when compared with small scale incineration plants. With due regard to the scarcity of suitable land in densely populated cities and considerations of economy of scale, there is a tendency to maximize the potential of a site and to plan for an incineration plant with higher treatment capacity. Some overseas examples with installed treatment capacity larger than 3,000 tpd are listed below:

- Tuas South Incineration Plant and Senoko Incineration Plant in Singapore with an installed capacity of about 4,300 tpd and 3,300 tpd, respectively; and
- Afval Energie Bedrijf (AEB) Incineration Plant in Amsterdam, Netherland with an installed capacity of about 4,000 tpd.

2.5.2.2 In Hong Kong, there is already a very well organized and efficient refuse transfer station network whereby MSW collected in the urban area are being compressed into large dedicated containers and then transferred away in bulk by marine transport. The usual constraint of potential adverse traffic impact on transport network in the vicinity of large scale incineration plants therefore does not exist. To achieve good economy of scale and making reference to the capacity of similar facilities in other densely populated cities e.g. Singapore with similar demographic and geographic situations, it is decided that the first IWMF will have a treatment capacity of 3,000 tpd, which has taken into consideration the waste reduction and recycling programme, the proven reliability of the proposed scale of incineration plants and the site and environmental constraints.

2.5.3 Stack Height

2.5.3.1 With reference to the “A Guidance Note on the Best Practicable Means for Incinerators (Municipal Waste Incineration) BPM 12/1(08)”, EPD, the design of the chimney height shall be determined by mathematical or physical dispersion modelling techniques. Therefore, wind tunnel tests (physical dispersion modelling technique) were conducted to determine and verify that the stack height for the IWMF would not result in adverse terrain and building wake effects at the TTAL site and the artificial island near SKC. The wind tunnel tests consisted of plume visualization for 75m, 100m, 125m and 150m stack heights.

2.5.3.2 Visualization of stack plume behaviour under various wind directions and speeds has been conducted to provide a qualitative understanding of the effect of the immediate terrain and building structures on the dispersion of the plume emitted from the IWMF

stack. The visualization also serves to check whether the plume from the IWMF stack will hit the critical Air Sensitive Receivers in close proximity to the TTAL site and the artificial island near SKC. The findings of the wind tunnel tests verified that both 125m and 150m stack heights for the IWMF would not result in adverse terrain and building wake effects at both the TTAL site and the artificial island near SKC.

2.5.3.3 Besides, a Good Engineering Practice (GEP) stack height requirement has been established in the United States for major air emission sources. GEP stack height is the height necessary to insure that emissions from the stack do no result in excessive concentrations of any air pollutant in the immediate vicinity of the source as a result of atmospheric downwash, eddies or wakes which may be created by the source itself, nearby structures or nearby terrain obstacles. In general terms, GEP stack height is defined as the height of nearby structure(s) plus 1.5 times the lesser dimension of the height or projected width of nearby structure(s). Given that the maximum height of the structures in the vicinity of the IWMF would not be higher than 50m. The GEP stack height would thus be about 125m for the IWMF. In other words, both 125m and 150m stack heights would satisfy the GEP stack height requirement.

2.5.3.4 With a view to further alleviate the potential air quality impacts at critical air sensitive receivers (ASRs) but at the same time to minimize potential visual impact associated with a tall stack, 150m is selected as the stack height for the IWMF at both the TTAL site and the artificial island near SKC. It has considered the air quality benefit and visual impact due to a tall stack.

2.5.4 Layout Arrangement

2.5.4.1 With a view to minimize the land use and the associated environmental impacts at the two sites, in particular at the artificial island near SKC, the layout for the IWMF is considered appropriate taking into consideration the functional need for operation of the IWMF, reasonable flexibility in design for future DBO contractor and allowance of suitable size of land for provision of visitors and community facilities. Based on the proposed layouts, the footprint requirement for treating per tonnage of MSW daily is approximately $32m^2$ at the TTAL site and $38m^2$ at the artificial island near SKC respectively. The area for compensated habitat for Little Grebe at the TTAL site and the area for breakwater at the artificial island near SKC were excluded in the unit footprint calculation. A larger footprint requirement at the artificial island near SKC is due to the additional land required for the berth area.

2.5.4.2 The unit footprint requirement of the IWMF is comparable with other overseas incineration plants, including Afval Energie Bedrijf (AEB) Incineration Plant with design capacity of 4,000 tpd in Netherland and Tokyo Edogawa Incineration Plant with design capacity of 600 tpd in Japan. Based on the existing overseas installations, the footprint requirement for treating per tonnage of MSW daily is normally in the range of $30m^2$ to $40m^2$ subject to the area provided for other uses including visitors and community facilities.

2.5.4.3 At the artificial island near SKC, the artificial island for construction of the IWMF was designed to be apart from the existing SKC Island in order to minimize the impact on the coastline and the associated ecological impact. On the other hand, the artificial island was placed as close to the SKC Island as possible in order to utilize the shallow water area and hence minimize the depth of reclamation and impact on the navigation channel to the south of the artificial island near SKC during the construction and operation of the IWMF. According to the Marine Department, a minimum distance of 100m between the artificial island and the navigation channel is required.

2.5.4.4 Furthermore, the breakwater at the artificial island near SKC was designed to provide protection to the marine vessels and to maintain the loading and unloading needs even during typhoon signal no. 3.

2.5.5 Construction Sequences

2.5.5.1 Alternative sequences of construction, including concurrent construction sequence and phased construction sequence, were considered.

2.5.5.2 Concurrent construction sequence involves various construction activities occurring at the same time. The environmental benefit of this construction sequence would be the reduction of the construction period and hence the duration of impact due to the construction. However, the magnitude of the overall environmental impact could be larger.

2.5.5.3 Phased construction sequence involves construction activities being carried out one after another. This construction sequence would help in reducing the magnitude of the overall impacts, but the construction period would be longer.

2.5.5.4 As the two approaches have their environmental benefits and dis-benefits, a balancing approach which involves a combination of concurrent and phased construction sequences at different stages of the construction has been adopted to alleviate the potential environmental impact and to meet the target commissioning date. For instance, at the artificial island near SKC, the construction of the breakwater and berth area would start off after completion of the cellular cofferdam installation surrounding the reclaimed area so as to minimize magnitude of the overall environmental impact.

2.5.6 Construction Methods

2.5.6.1 To minimize the potential environmental impacts, alternative construction methods were considered. For the piling works at the TTAL site, percussive piles and socketted H-piles were considered. Percussive piles would cause substantial noise and vibration impacts, whereas the noise and vibration impacts due to the construction of socketted H-piles would be significantly lower. Considering the environmental benefits and dis-benefits of the alternative piling methods, socketted H-piles is recommended for this Project to minimize the potential noise impact during the construction.

2.5.6.2 Sloping seawall was originally proposed to be used at the artificial island near SKC. The width of the sloping seawall at the seabed level would be about 100m. The construction of the seawall involves dredging of a trapezoid trench to a width of 140m, and depth of 10m along the proposed location of the seawall at the seabed, filling of the trench with sand up to 2.5m below the seabed level and formation of the seawall above the sand fill by rock fill. The site area and dredging volume for the construction of the seawall is substantial. To minimize dredging and filling activities and the associated environmental impacts, cellular cofferdam and circular cell breakwater instead of sloping seawall were adopted for the construction of the seawalls and breakwaters, respectively.

2.5.7 Cooling System

2.5.7.1 The heat energy of the air getting out from the furnace is transmitted to water, converting the water to high pressure steam. The high pressure steam is used to rotate a steam turbine and generate electricity. After the electricity generation process, the high pressure steam becomes low pressure steam, which is further cool down by a cooling system. Alternative cooling systems, including water-cooled condenser and air-cooled condenser, were considered. A water-cooled condenser involves exchange of the heat of the low pressure steam to water, which is then discharged to the nearby water body. An air-cooled condenser involves exchange of the heat of the low pressure steam to air, which is then discharged to the atmosphere. To minimize the potential impact to the nearby water bodies due to discharge of cooling water, air-cooled condenser was adopted in the IWMF. Another advantage of air-cooled condenser is water consumption will be greatly reduced.

2.6 Interfaces with Other Projects

2.6.1 Tsang Tsui Ash Lagoon

WENT Landfill Extension

2.6.1.1 This project involves development of the WENT Landfill Extension (about 200 hectares with capacity of 81Mm³) to maintain the continuity of landfill capacity in the West New Territories.

2.6.1.2 The proposed WENT Landfill Extension will be located to the west of the existing WENT Landfill. It will occupy the West Lagoon and the southern part of the Middle and East Lagoon as well as the area between the Black Point Power Station and the WENT Landfill. The preliminary site boundary of the proposed WENT Landfill Extension is shown on **Figure 1.1**. The WENT Landfill Extension will be developed under six phases to allow progressive use of the overall landfill area. The site formation of the Phase 1 is tentatively scheduled to commence in 2016/17.

2.6.1.3 As the construction of the IWMF at the TTAL site is scheduled for completion in 2016, the construction works for the IWMF would not be concurrent with the proposed WENT Landfill Extension. No cumulative construction impact due to construction of the IWMF and the WENT Landfill Extension is expected.

Sludge Treatment Facilities (STF)

2.6.1.4 The proposed Sludge Treatment Facilities (STF) are designed to treat 2,000 wet tonnes/day of the dewatered sludge generated after the sewage treatment process in the Stonecutters Island Sewage Treatment Works (STW) and 10 other regional sewage treatment works, by fluidized bed incineration technology to substantially reduce the volume of sewage sludge for disposal to landfills.

2.6.1.5 The STF will be located in the northern part of the East Lagoon, adjacent to the TTAL site for the IWMF. The proposed location for the STF is shown in **Figure 1.1.**

2.6.1.6 The construction period is anticipated to commence in 2010 for completion in 2013. The construction works for the IWMF and STF would occur concurrently.

2.6.1.7 As the operation phase of the IWMF and STF will overlap, the cumulative environmental impacts associated with the operation of the IWMF and the STF, as well as other concurrent projects, have be examined in accordance with the EIAO-TM requirements.

2.6.2 Artificial Island near SKC

Outlying Islands Sewerage Stage 2 - South Lantau Sewerage Works

2.6.2.1 The project would involve the construction of a sewage treatment works (STW) at San Shek Wan. Although the STW building would be located outside the study area of the IWMF at Cheung Sha, its associated submarine outfall would extend from the shore of San Shek Wan into the Southern Water Control Zone.

2.6.2.2 The construction works is tentatively scheduled to commence in September 2013 with a view to completion by September 2017, which may overlap with the construction of the IWMF.

Improvement of Fresh Water Supply to Cheung Chau

2.6.2.3 Under this project, a submarine water main would be constructed across the Adamasta Channel, between Northern Channel of Cheung Chau and Chi Man Wan Peninsula, to replace the existing submarine water main.

2.6.2.4 The tentative schedule of the concurrent project is 2010 to 2013, which may overlap with the construction of the IWMF for a short period of time.

2.7 Assessment Areas of the EIA Study

2.7.1.1 The assessment areas for the purpose of this EIA Study, as specified in the Brief, are specified in **Table 2.7** below.

Table 2.7 Areas Covered by the EIA Study

Type of Impact Assessment	Assessment Area	
	Tsang Tsui Site	**Artificial Island near SKC**
Air Quality & Health Impact	Affected zone defined by the territory wide scale model	Affected zone defined by the territory wide scale model
Noise	Area within 300m of the site boundary	Area within 300m of the site boundary
Water Quality & Aquatic Ecology	Area within 300m of the site boundary, and all relevant water sensitive receivers downstream of emergency bypass (if any) from the proposed sewage treatment works, including existing cooling water system of the Black Point Power Station	Southern, Southern Supplementary, Second Southern Supplementary, North Western, North Western Supplementary, and Western Buffer Water Control Zones
Waste management	Areas within the boundary of the Project	Areas within the boundary of the Project
Terrestrial Ecology	Areas within 500m from the site boundary	Areas within 500m from the site boundary
Fisheries	North Western and Deep Bay Water Control Zones	Southern, Southern Supplementary, Second Southern Supplementary, North Western, North Western Supplementary, and Western Buffer Water Control Zones
Landscape	Area within 500m from the site boundary	Area within 500m from the site boundary
Visual	Zone of visual influence defined by the visual envelope of the Project	Zone of visual influence defined by the visual envelope of the Project
Landfill Gas Hazard	Areas within the boundary of the Project	Areas within the boundary of the Project
Cultural Heritage	Area within 300m of the site boundary	Area within 300m of the site boundary

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