3 Conclusion & Recommendation

3-1 To collect garbage data

Presently the solid waste amount of every city is estimated by visual measurement, but not by actual measure of weight. Visual measurement usually involves personal error and this method is very difficult to get accurate reliable data. It is needed to collect the solid waste management data, such as collected garbage weight data, disposed garbage weight data and garbage generation data.

To make policy planning of solid waste management, not visual measurement, but measurement by a weighbridge is needed now.

- •a• To install weighbridge: At the entrance of final disposal site, a weighbridge, connected with a computer to record the data, will be installed to weigh the every truck.
- •b• The record of solid waste weight data.: The recorded data consists of truck number, weight of truck, collection area, and collection time.

- •c• The analysis of solid waste generation (collection) and composition data.

To make future policy planning of solid waste management, correct data is needed calculating capacity and lifetime of landfill site or estimating efficient numbers of collection trucks. And tracing or surveying the data, effectiveness of solid waste management can be found.

Also each year, government should carry out the study of composition of water contents, study the increase of plastic pores and large burden on collection and land filling. Recently various new products of chemicals and compound materials are generating a large share of the market.

Solid waste composition analysis should be conducted. Items of analysis are followings,

Table 3.1 Solid waste composition analysis(•)

	Area A	Area B	Area C	Area C	Area D	Area E
Waste Paper Textiles						
Plastics						
Organic Solid waste						
Glass, bottles						
Metal						
Other						
Total						
Density (Kg/m3)						

3-2 To legislate Solid Waste Management Law

The solid waste management law should legislated. The law makes clearly to any activities concerned this waste management what part citizen; enterprise and government should take of responsibilities. Factory or company should treat especially industrial waste, which generated these under governmental control. Citizen, businessman, factory owner and even government should receive a punishment for activity in violation of the law of Solid Waste Management.

Table3.2 Considerable items

Items to be described	Explanatory substance
Industrial waste	Definition of industrial waste, Industrial waste collection, transportation and treatment system controlled by local government, Responsibility of industry which generates waste, such as collection , transportation and treatment , Standardization of treatment facility, Responsibility of private industrial solid waste management company
Service area	Solid waste management service should cover whole city area.
Responsibility	Roll and responsibility of citizen, Roll and responsibility of businessman and enterprise Roll and responsibility of government.
Subsidy	Financial assistance from central government to local government for constructing solid waste management facility, such as sanitary landfill site, hospital incinerator, night soil treatment facility and transfer station.
Definition of solid waste management, collection, transportation, treatment and disposal	To make clear the definition.
Hospital waste	Definition of infectious hospital waste, Collection, transportation and disposal system of infectious hospital waste
Constructive standardization of solid waste treatment facility	To make clear the standards of solid waste treatment facility.
Punishment	Punishment for illegality of Solid Waste Management Law
Reduction, recycling strategy	Source reduction, reuse, recycling, material recycling
Solid waste management planning	Every city should make solid waste management planning for future 15years.

3-3 To minimize solid waste generation

(a) To formulate further reduction of waste source projects.

Tokyo Metropolis Special Words Area•the population of 8.0•million•succeeded in 28% solid waste source reduction from FY1989 to FY2000.i.e140million t/year•3,800t/day•

Each city should formulate solid waste reduction programs.

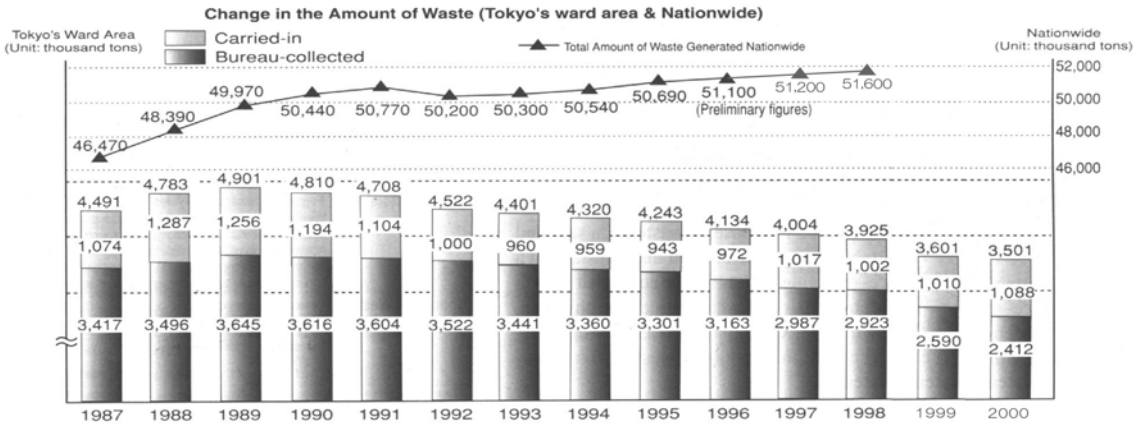


Figure3.1 Change in the Amount of Waste (Tokyo's ward area & Nationwide)

(from Statistics of Tokyo Metropolitan government)

As I introduced solid waste reduction at the work shop held on 12 March, Tokyo Metropolitan Government planed a strategy to reduce the wastes such as "the action plan on waste reduction "that was launched to promote the waste reduction and recycling in cooperation with the city residents, business man and government.

Such as "source reduction" and "resource recycling program", specifically

Waste reduction activities in cooperation with citizens

1) On site guidance for owners of large office buildings,
2) Waste separation to make an easy waste recycling,
3) My Bag campaign
4) Promotion of using recycled products

Waste reduction activities by the government

5) Reducing the waste collection frequency from 3 times a week to 2 times a week,
6) Making local recycling center,
7) Every kinds of solid waste from business areas have being charged by Metropolitan Government in Tokyo.

Since ten years before, to compare with the amount of waste decreased continuously and was around 1 million t/ year minimized

Now Pak EPA shall set the goal for waste reduction plan, that is

1) 20% reduction of the amount of waste for ten years,
2) Plastic waste shall be cut by half amount.
3) Amount of recyclable waste will be five times bigger than at present.

(b) To make the numerical goal of solid waste source reduction strategy.

The analysis of the reduction goal of each item of solid waste from every city

The target values will be set as shown in Table 3.3.

Table 3.3 The target values of waste source reduction(%).

	Area A	Area B	Area C	Area C	Area D	Area E
Waste Paper Textiles						
Plastics						
Organic Solid waste						
Glass, bottles						
Metal						
Other						
Total						

(c) Example of activities for solid waste reduction

Such products should be paid much attention on the viewpoint of this appropriate disposal. Based on the data, future garbage generation will be more scientific formed of project in cooperation with citizens..

The content of the proposal will be:

a• Plastic Solid waste Reduction.

Package Solid waste accounts 60% of total solid waste in Japan and most of them made of plastics. Local government should make how to reduce the packing plastic solid waste.

b• Direct guidance for owners of large office building, markets, schools .

To curb the amount of business-generated waste and encourage the recycling of used paper, bottles, and cans, Tokyo Metropolitan Government conducted direct guidance for owners of large office building and markets. Local government should make a strategy how to reduce the domestic solid waste from business area.

3-4 To make the final disposal site selection and screening criteria

To prevent environmental pollution or ground water contamination, it is an importance for determining the selection method of final disposal site, draft example of landfill site selection and screening criteria as followings,

Table 3.4 Example of Landfill Site Selection and Screening Criteria **(Draft)**

Criteria	Absolute	Considerations
Area Capacity • **Haul Distance**	The site area should be sufficient for a landfill with a target service life of not less than10 years.	The area should be sufficient for a landfill with target service life of approximately more than 30 years (this calculation based on 7.8 ha / 100,000 population, 0.5 kg / person / day, 0.7 t/m3 density and 10 m depth). The minimum land area depends on the total service population, waste characteristics and generation rate, and expected landfill service life. **Avoid** areas more than 25 km or 40 minutes travel time from the waste generation If the distance or travel time is more than the indicated limits, investment in either larger transfer station may be necessary
Social condition Proximity to Sensitive Land users or airports	The site should not be located in existing or proposed residential, commercial or urban development areas, and areas with archeological, cultural historical importance & an airport.	**Avoid** areas within 500 m of residential and industrial developments and within 1 km. Of memorial sites, Mosque s, schools, historical site is otherwise isolated from these sensitive receivers. **Avoid** areas encroaching boundaries of any non-participating municipality. The site should not be located within 5 km of an airport The site should be located so as to reduce bird-strike hazard to aircraft.
Geologic Conditions, Soil / Land Conditions & Topography	The site should not be located within 500 m of active fault lines. The site should not be located in soft and settling soils (sand, coarse sand, and fine sand) with a potential for liquefaction, slumping or erosion.	**Avoid** areas with sinkholes, caverns or solution channels. Avoid jointed, fractured or fissured rocks, carbonate rocks (limestone) or other porous rock formations. If the site is to be located within an area of fissured, fractured or similar rock, stringent engineering design will be required to avoid landfill gas and leachate migration to groundwater. Areas with underground mines should be avoided. **Avoid** areas with highly permeable soils (loamy fine sand, loamy sand, sandy loam, fine sandy loam and very fine sandy loam).Use of areas with high permeability soils will necessitate the use of appropriate liners and engineering measures to contamination of groundwater by leachate and landfill gas migration. **Avoid** hilly area with ground slopes. Land filling within hilly areas is feasible but steep slopes will increase the costs associated with the engineering and access inspection arrangements.
Calamity Occurrence of Flooding or Seismic Conditions		**Avoid** locating site in areas prone to Flooding. Also avoid salt lakes, swamplands. Engineering design should include protected measures, such as impervious dikes and liners to protect sites against a 50-year flood. **Avoid** areas with an average return period between 50 to 80 years for an earthquake of magnitude 6 and above. If the entire municipality is subject to this seismic risk, engineering measures may be applied to avoid the risk of groundwater contamination.

Environmental Pollution & Local Ecological Conditions Proximity to Groundwater Resources or Perennial Surface Waters.	The site should not be located in or up gradient of shallow unconfined aquifers for drinking water supply. The site should not be located within 500 meters up gradient of any surface waters used for drinking purposes.	The sites should not be located within ecologically sensitive areas proclaimed by law as national and conservations parks **Avoid** areas considered part of a 10-year recharge area for existing or future potable water sources and confined aquifers (deep wells) for drinking water supply. **Avoid** areas 500 meters up gradient of private or public drinking, irrigation or livestock water supply wells. Moreover consideration of groundwater level is needed. Existing or future drinking wells may be abandoned if alternative water supply sources / sites are readily and economically available, and the owners have given written consent to the potential risk of abandoning their wells. **Avoid** areas within 500 meters up gradient of a perennial river or stream. The conditional requirement may be adjusted if it is feasible to protect the stream from contamination through engineering measures. **Avoid** areas within 500 meters of any ecologically sensitive areas proclaimed by law.
Current and Future Land use		The site should not be located in areas with valuable mineral and energy resources, tourist destinations or across major transportation routes. **Avoid** areas classified as prime agricultural land and areas with major water, gas, electrical power or communication transmission infrastructure .The site may be located where there are existing infrastructure routes as long as their presence will not affect the landfill operation or rerouting is economically feasible.

3-5 To approach gradually semi-aerobic sanitary landfill site.

Semi Aerobic Landfill Site works as a leachate treatment facility. Inside of this landfill site, leachate is treated and quality is improved by itself at the same time of decomposition process. So the operation cost is also the least. However. The climate and natural condition of this City is of difference from that's of Japan. Small pilot project should be conducted to collect the data of design and study of the operation of landfill site.

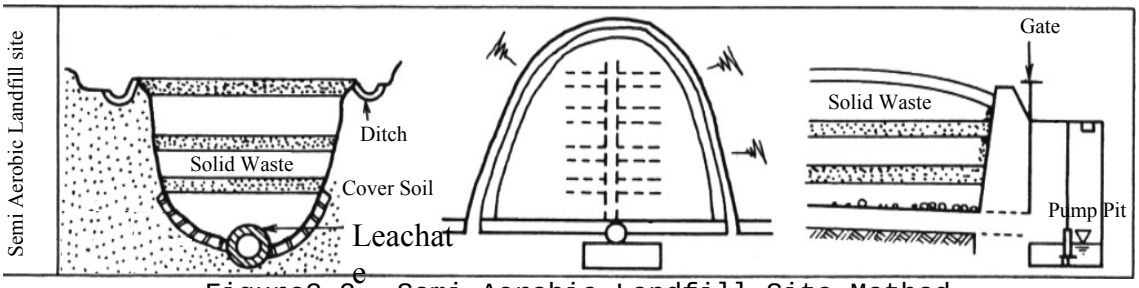


Figure3-2 Semi Aerobic Landfill Site Method

Table 3.5 Comparison among Semi-Aerobic Method and other conventional method

	Anaerobic Landfill Site •Open Dump•	Improved Sanitary Landfill Site	Semi-aerobic Landfill Site	Aerobic Landfill Site
Construction cost	•	•	•(Low)	×(High)
Operation cost	•	•	•(Low)	×
Decomposition	×	×	•(Short)	•(Short)
Stabilization	×	×	•(Short)	•(Short)
Methane Gas Generation	×	×	•(small)	•(small)

• Good, • moderate, ×negative

(a) Proposal of semi- aerobic landfill site method.

Semi- Aerobic Landfill Site has leachate collection pipes at the bottom, with a lot of small holes, covered by stones. The collection pipes remove leachate from the landfill site quickly and fresh air goes inside the landfill through the pipes and creates aerobic condition inside.

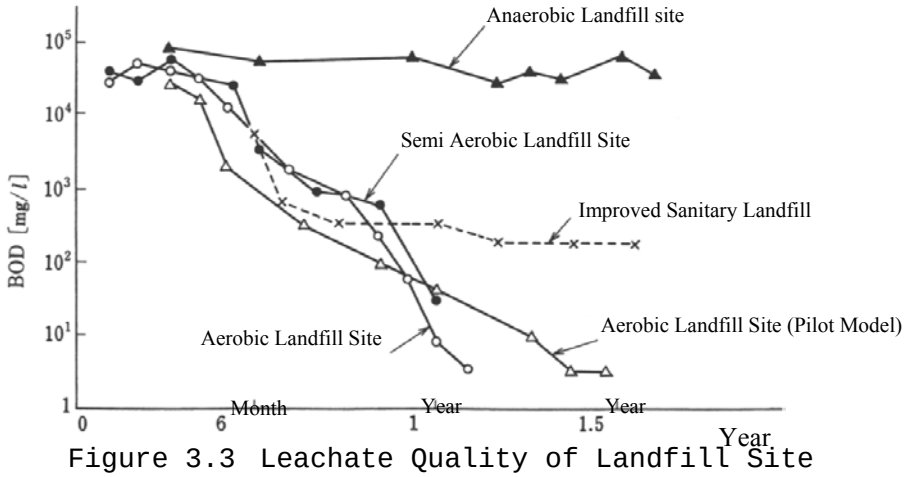
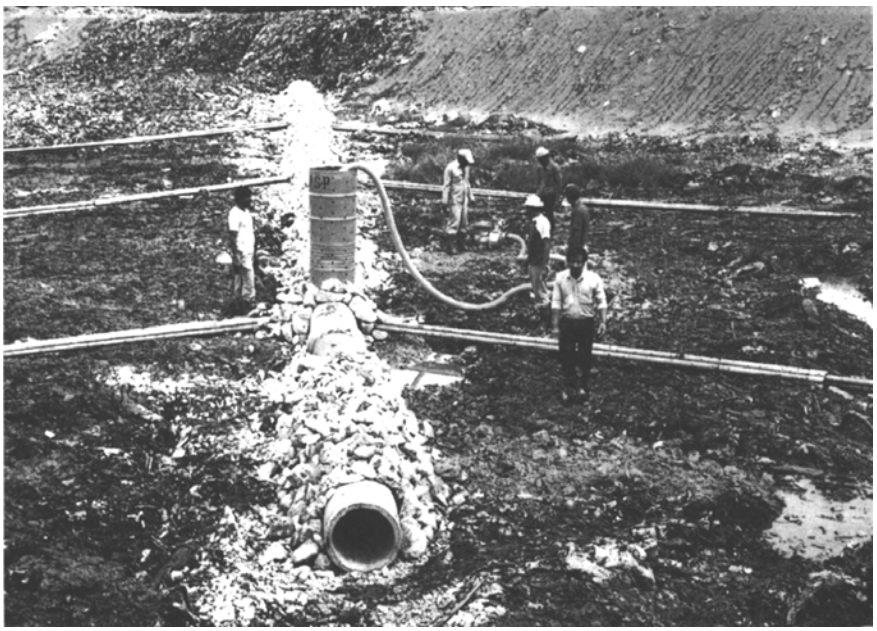


Figure 3.3 Leachate Quality of Landfill Site
(from Solid Waste Management Hand Book 2000)

The Merits of semi-aerobic landfill site.

- As Aerobic Condition makes decomposition quick, stabilization of landfill site is attained much earlier than other conventional methods.
- BOD value of the leachate becomes lower quickly by comparison with other methods. • Refer to Figure 3.3 • that means operation cost of semi- aerobic landfill site method become quite low.
- Quick leachate removal prevents ground water contamination.

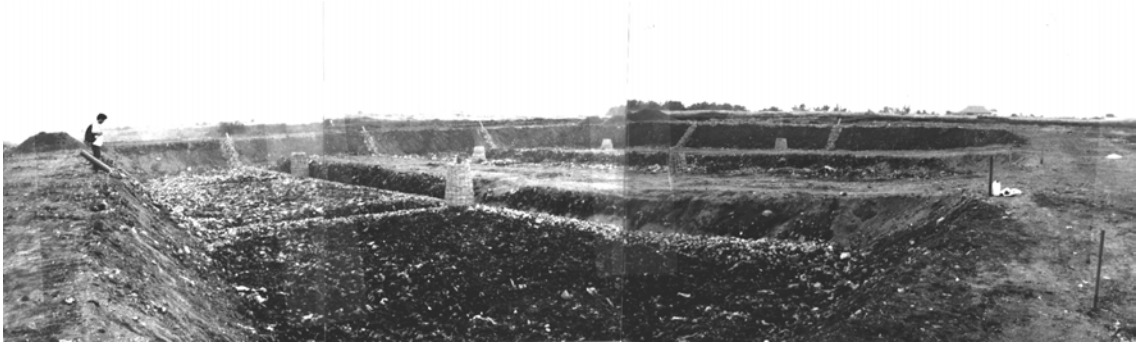
This method is already introduced or tested in Japan, Malaysia, Iran, and Indonesia.



Picture 3.1 Low cost semi aerobic landfill site in Malaysia
(From Dr. Matsufuji (Former JICA expert in Malaysia and now. Prof. of Fukuoka Univ. "Semi Aerobic Landfill Site Story" "Mizu" Jan & Feb 1998.)

Picture 3.2 Leachate collection pipes made of bamboos
(From Dr. Matsufuji. Fukuoka Univ. “Semi Aerobic Landfill Site Story” “Mizu” Jan & Feb 1998.)

Picture 3.3 Gas venting cage made of bamboo in Indonesia (JICA Study 1992)



Picture 3.4 Semi - aerobic landfill site in Indonesia (JICA Study 1992)

(b) Pipe materials using local product, such as bamboo, oil drums etc.

In Malaysia's case, leachate collection pipes were made of bamboos, and the gas venting pipes were oil drums.

It is better basically that a landfill site would be rather shown to the citizens eyes than tying to hidden from them. Generally, inadequate operation of Landfill site causes an objection by citizens to construct the final disposal site. In order to avoid the complain of citizens by occurring unsuitable living circumstance such as offensive odor, dust, crow, good operation should be needed such as

To make daily cover wastes by soil,
To check the carried garbage to landfill site
To make a plan for operation of landfill site.

Moreover to make clean the periphery of Landfill site,

To construct the boundary fence,
To plant the forest surrounded the space,
To make a clear access road inside of the landfill site is necessary.

To introduce stepwise approach to sanitary landfill, selecting subsequent operation area, the area is to construct by a sanitary landfill.

3-6 To provide infectious hospital waste management to hospital administrators

First of all,
Doctors, nurses and workers in the hospitals should be aware of how dangerous the infectious hospital wastes are.

Karachi City has a hospital incinerator; however doctors do not bring hospital waste to the incinerator. The doctors in small hospital must recognize the infectious hospital waste never reuse the category of recycling, and bring them to the incinerator.

The recycling activity of infectious hospital wastes is like to be a criminal action. Government has to crusade the recycling of infectious hospital waste, and has to start a campaign of stopping the recycle and to reconfirm those dangers for doctors, nurse, workers in hospitals and clinics.
In Lahore, Shalamar Hospital has an excellent treatment system for infectious hospital and training program.

Refer to

- ”Hospital and Biomedical Waste Management “published by Environmental Health, Health Service Academy.
- Infectious hospital waste treatment system in Shalamar Hospital in Lahore. I.e. Private sector Hospital Waste Management Program.
- ”Hospital Waste Management Rules 2002” published by Environmental Health Unit, Health Service Academy. Ministry of Health.
- Specification & Guidelines on Hospital Waste Incinerator prepared by EPA, Government of Sindh, Karachi.

3-7 To encourage the home industry in the field of solid waste management

I strongly recommend that Government of Pakistan should encourage the Home Industry in the field of Solid Waste Management.

For example, now every city in this country need to install hospital incinerator, however most hospital incinerators are imported.
Now technical development in this field is needed to establish by own countries technology.
I visited a Composting plant in Lahore and Jehlum. Their own Pakistani Technology has developed these plants. Please encourage them by and develop your own technology in this field.

Leachate treatment plant technology for construction of sanitary landfill, and Domestic Incineration technology is also needed in near future in big cities.

Table 3-6 Examples research topics concerning solid waste management.

Example of topics.	
Solid waste incineration technology	Pollution control equipment or facility Corrosion technology by exhaust Automatic control technology Exhaust heat utilization and etc.
Sanitary landfill technology	Semi-aerobic landfill site method Gas emission from landfill site Leachate treatment technology
Composting	Composting method
Hospital waste treatment method	Incinerator Medical infectious waste treatment technology
Effective collection method.	

Solid waste composition analysis	

3-8 To Develop information network on solid waste management field.

There are so many precious and good information concerning solid waste management could be obtained in Pakistan. However very limited persons know these contents of the activities.

For example

- " Guidelines for Solid Waste Management in Panjab." published by Environmental Protection Department
- "Hospital and Biomedical Waste Management "published by Environmental Health, Health Service Academy.
- Infectious hospital waste treatment system in Shalamar Hospital in Lahore. I.e. Private sector Hospital Waste Management Program.
- "Hospital Waste Management Rules 2002" published by Environmental Health Unit, Health Service Academy. Ministry of Health.
- Specification & Guidelines on Hospital Waste Incinerator prepared by EPA, Government of Sindh, Karachi.
- Composting Plant constructed and operated by Private Company "Waste Buster".
- Composting Plant constructed and operated by Green Force Project.

In order to exchange information about what is going on in the field of the solid waste management in Pakistan now, Central Government, Local Governments, private company on solid waste management services, university, institute, community, foreign donors such as JICA, ADB and World Bank, should be organized authorities to share information on solid waste management.