GUIDEBOOK FOR BEST ENVIRONMENTAL PRACTICES

Construction Waste Management at LTA Sites

Land Transport Authority

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Lastly, a big thank you to all our contractors for their continuous support and efforts in maintaining an environmental friendly site.

Land Transport Authority

ENVIRONMENTAL POLICY STATEMENT

LTA is committed to protecting our environment. We incorporate environmental protection in our strategic decisions and conduct our business in a manner that balances the environmental and economic needs of the communities in which we operate.

We will:

- Comply fully with all relevant environmental legislation and regulations and meet or exceed good environmental practices; and
- Work with our partners i.e., transport operators, contractors, interest groups and other government agencies in a concerted effort to operate in an environmentally responsible manner.

Yam Ah Mee
Chief Executive

Date: 1 July 2008

Foreword

The Land Transport Authority's Land Transport Master Plan shows that several mega infrastructure projects will be launched to keep pace with Singapore's rising transportation demand. These projects will generate waste and the challenge to LTA is to ensure that these waste are managed in a sustainable manner. If proper planning and control are not put in place, contractors may generate excessive construction waste unnecessarily or dispose the waste in a manner which affects the environment adversely.

This guidebook on construction waste management will provide contractors with useful information on good practices to reduce construction waste and help them meet the goal of sustainable construction. Practical measures to reduce, recycle and properly disposing waste from the worksites are also included.

Over the years, the National Environment Agency (NEA) has been working closely with the 3P (People, Private and Public) sectors to reduce waste. In 2008, 98% of construction and demolition (C&D) waste was recycled.

We would like to encourage contractors to further reduce the generation of C&D waste and to recycle all the waste they generate so that they can take another step towards our goal of "Zero landfill".

I congratulate LTA for the effort to address the construction waste management issue at your construction sites. I would also encourage all LTA contractors to make good use of this guidebook to better manage waste from construction activities.

Joseph Hui
Director-General for Environmental Protection
National Environment Agency

Content Page

CHAPTER 1:

Introduction

1.1 Objectives

The objective of this guidebook is to facilitate understanding and generating greater awareness in all aspects of Construction Waste Management (CWM) among our project teams and contractors. Through this, we are confident that effective CWM implementation can be achieved at all sites and thus producing minimal wastage.

1.2 Construction Waste

Environmental Public Health Act (EPHA) defines "Construction site" as:

Any premises on which works of the following descriptions are being carried out:

(a) Erection, construction, alteration, repair or maintenance of buildings, structures or roads;

(b) Breaking up; opening of; boring under, any road or adjacent land in connection with the construction, inspection;

(c) Maintenance or removal of works;

(d) Demolition or dredging works; or

(e) Any other works of engineering construction.

1.2 Construction Waste

As waste are produced during construction, a proper waste management system should be put into place to manage the waste or else potential pollution problems would arise.

Definition of construction waste

Construction waste consists of unwanted material produced directly or incidentally as a result of construction work.

It arises from activities such as site clearance, excavation, construction, demolition and road works. An example is shown in *Figure 1.1*.

Figure 1.1: Example of construction waste due to site clearance

1.2 Construction Waste

The sources of waste can come from 3 main sources as shown in *Figure 1.2*.

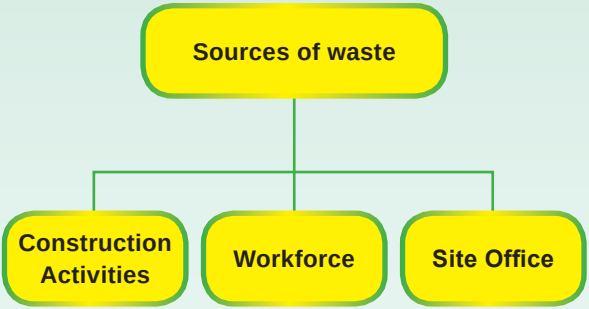


Figure 1.2: Sources of waste

1.2 Construction Waste

Waste from construction, demolition and excavation operations will normally be considered as controlled waste, and hence subjected to waste-related regulations. There are 2 environmental public health (EPH) regulations: namely EPH [General Waste Collection (GWC)] and EPH [Toxic Industrial Waste (TIW)] which handles all aspects of General waste and Toxic waste respectively.

These waste produced at LTA sites must also follow the Code of Practice for Environmental Control Officers (ECO) and the LTA's General Specification (GS). This relationship can be summarised in *Figure 1.3*.

1.3 Requirements in Waste Management

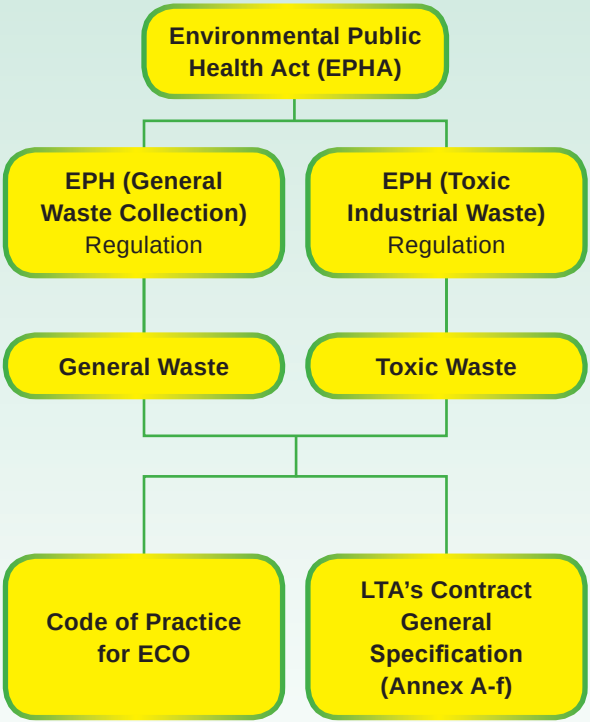


Figure 1.3: Environmental Regulations and other requirements

1.3A General Waste Regulations

EPH (GWC) Regulation 2(1):

"General Waste" means:

(a) Refuse waste, excluding any toxic industrial waste (TIW);

(b) Waste from sewerage systems, including waste from sewage treatment plants, septic tanks and water-seal latrines;

(c) Waste from sanitary conveniences not part of a sewerage system, including waste from sanitary conveniences which are mobile; and

(d) Toxic substances that have been treated and rendered harmless and safe for disposal.

1.3A General Waste Regulations

In summary, the different types of general waste can be classified into 3 different classes as shown in *Figure 1.4*.

Type of Waste	Class
Inorganic Waste Non-Incinerable waste e.g. construction debris; excavated earth; slurry; sand; stones; insulation materials; powdery materials (saw dust) Incinerable waste e.g. wood waste; waste timber; empty powdery materials bags (cement bag); packaging materials	**A**
Organic Waste e.g. food and other putrefactive waste; domestic refuse (waste paper, food containers & drink cans)	**B**
Sludge & Grease e.g. sludge from water treatment plants; waste from septic tanks; sewerage treatment plants; mobile toilets	**C**

Figure 1.4: Classification of General Waste

1.3A General Waste Regulations

It is also important to note that general waste collector must apply for a license under the different classes, depending on the type of general waste they are carrying.

EPH (GWC) Regulation 8:

Transportation of general waste under Class A: The general waste (Class A) should be transported by skip container trucks, open lorries with crane or tipper or such other vehicles as may be permitted by NEA.

Skip on a skip-carrier lorry

Full Skip

Source: http://en.wikipedia.org/wiki/Skip_hire

1.3A General Waste Regulations

EPH (GWC) Regulation 9:

Transportation of general waste under Class B: The general waste (Class B) should be transported by compaction vehicles, roll-off compactors or such other vehicles as may be permitted by NEA.

Waste Compactor

Source: http://www.directindustry.com/prod/dulevo-international/waste-compactor-15043-202898.html

Roll-off truck

Source: http://www.azhometownhauling.com/sitebuildercontent/sitebuilderpictures/main_imag_03.jpg

1.3A General Waste Regulations

EPH (GWC) Regulation 10:

Transportation of general waste under Class C: The general waste (Class C) should be transported by tanker trucks or such other vehicles as may be permitted by NEA.

Tanker truck

Source: www.daylife.com/photo/OacF7nnfGv8tr

1.3A General Waste Regulations

EPH (GWC) Regulation 20(1):

Employment of licensed general waste collectors:
Any person who produces general waste shall engage a person who is licensed under this regulation to collect and transport such waste.

EPH (GWC) Regulation 16:

Disposal of waste at disposal facility:
No licensee shall disposal off any general waste in any place except at a disposal facility.

EPH (GWC) Regulation 17:

Disposal of incinerable and non-incinerable waste:
(1) A licensee shall transport all incinerable waste to incineration plant or an appropriate refuse transfer station for disposal; or
(2) A licensee shall transport all non-incinerable waste to a refuse dumping ground for final disposal.

1.3A General Waste Regulations

EPH (GWC) Regulation 17A:

Disposal of waste for recycle:
A holder of a permit issued under Regulation 7B shall transport all waste collected by him for recycling to any recycling facility.

It is also important to note that general waste collector shall comply with the regulations and the Code of Practice (CP) on Licensed General Waste Collection.

In essence, there must be proper vehicles and equipments used for collection and transportation of refuse; proper labelling on the vehicles; refuse to be disposed of at designated disposal sites; and to renew their license annually.

1.3A General Waste Regulations

EPHA Section 19(1)a:

Prohibition against dropping certain substances in public place:
Any person who drops, spills or throw any noxious liquid, dirt, sand, earth, gravel, clay, refuse in any public place (whether from a moving or stationary vehicle) shall be guilty of an offence.

Littered public roads by construction vehicles.

EPHA Section 20:

Prohibition against dumping or disposing:
Any person who dumps any refuse or waste from a vehicle in a public place shall be guilty of an offence.

1.3B Toxic Waste Regulations

EPHA defines "Toxic Industrial Waste (TIW)" as:

Waste which by their nature and quantity may be potentially detrimental to human health and / or the environment.

It is also classified as hazardous waste.

In essence, it can be classified to be:

1. Corrosive (e.g. strong acids & alkalis);
2. Reactive (e.g. Metal hydroxides);
3. Infectious (e.g. Pathogenic);
4. Toxic (e.g. Asbestos).

1.3B Toxic Waste Regulations

Figure 1.5 shows the examples of TIW [listed under EPH (TIW) Regulations] produced in LTA sites, including their suggested method of storage.

Type of Waste	Method of storage
Paints (containing organic solvents, heavy metals)	Designated concreted area
Cables (PVC), PVC pipes, plastic films	Separate storage
Waste solvents (used acids or alkalis), thinners, paints	Labelled drums or containers; designated concreted area
Empty containers / drums (used to contain chemicals, paint, solvents, thinners, pesticide, insecticide, anti-mosquito oil, diesel)	Labelled drums or containers; designated concreted area
Oil, chemical sludge	Designated concreted area

Figure 1.5: Examples of waste produced and their proper storage methods

1.3B Toxic Waste Regulations

The TIW has to be controlled by:

1. Generators;
2. Collectors;
3. Carriers; and
4. Drivers.

EPH (TIW) Regulations 4 - 7:

In summary, the generator has to:

1. Notify the NEA when TIW exceeds permitted level; change in type or nature of TIW produced;
2. Treat or recycle the TIW produced in his premises or to provide information to the collector to enable him to deal with TIW properly and safely (storage, treatment, reprocessing, disposal);
3. Keep register of type & quantity generated; manner of disposal; date & quantity sold to TIW collector; and quantity held in stock; and
4. Submit electronic consignment note.

1.3B Toxic Waste Regulations

EPMA Section 17(1):

Penalties for discharging toxic substances or hazardous substances into *inland waters:
Any person who discharges / permits to discharge any toxic substance or hazardous substance into any inland water so as to be likely to cause pollution of the environment shall be guilty of an offence.

Area of black spot indicating the leakage of toxic chemicals

Red arrow depicts the flow of leaked toxic waste down the slope into public drains.

* Inland waters: Any river, reservoir or lake, be it natural or artificial.

1.3B Toxic Waste Regulations

EPH (TIW) Regulation 38(1)a:

Emergency action plan:
The generator shall prepare and keep up to date the emergency action plan detailing how spillage, leakage or accidents arising from transportation, storage, reprocessing or treatment of toxic waste will be dealt with.

Leakage of oil resulting in dark patches on the ground.

1.3C Code of Practice for ECO

Code of Practice (CP) for ECO

This section shall only highlight the salient points. For full details, please refer to CP for ECO.

1. The contractor shall engage a licensed waste collector for collection and removal / disposal of waste generated. A system to ensure that all waste are properly disposed at authorised sites should be implemented.
2. An adequate number of refuse bins with covers shall be provided.

C905

Adequate refuse bins that must be covered.

1.3C Code of Practice for ECO

3. Separate skips / bins shall be allocated to store construction waste / debris and organic food waste.
4. All food waste shall be contained in plastic bags before disposal into bins. They should be removed daily to prevent fly nuisance or any stench.
5. Construction waste / debris should be stored in skips placed at a location easily accessible to waste removal vehicles.

C487

Location of skips are easily accessible to waste removal vehicles.

1.3D LTA's Contract GS

LTA's Contract General Specification (GS)

This section shall only highlight the salient points. For full details, please refer to 'Annex A-f: Environmental Considerations of LTA's GS.

1. An adequate number of bins shall be provided at the site for the storage of all inorganic waste, with a separate scrap metal waste bins.
2. An adequate number of bins with covers shall be provided to store organic food waste.
3. All site waste shall be cleared regularly to prevent a build-up of waste in these bins.
4. All building debris shall be disposed of at sites directed by the NEA.
5. Any toxic waste as listed in the EPH (TIW) Regulations including used oil shall be disposed of by a licensed TIW collector.

1.3D LTA's Contract GS

6. Contractor shall carry out effective on-site sorting of construction and demolition materials to recover inert, reusable and recyclable portions.

7. The system of on-site sorting and temporary storage of construction and demolition materials shall include the following:

   a. Materials (metals, plastics, glasses, papers) recovered for collection by recycling contractors; and

   b. Cardboards and paper packaging shall be recovered and properly stockpiled in dry and covered conditions to avoid cross -contamination by other construction and demolition materials; and

   c. Excavated materials shall be sorted to recover inert portions (e.g. soil and crushed rocks) for reuse on-site or disposal to designated filling areas.

CHAPTER 2:

Construction Waste Management at LTA Sites

2.1 Construction Waste Management System

Construction waste such as timber, metal scraps and demolition waste adds on to the increasing amount of waste generated in Singapore. This will have an impact on the environment given the scarcity of land in Singapore.

Conventionally, all the waste would either be incinerated or sent to the Pulau Semakau landfill.

The incineration plants have been designed to incinerate waste safely and fitted with air pollution control equipment. They effectively reduce the volume of waste for final disposal in the landfill and also recover energy and scrap metals.

However, it is not sustainable to go on building more waste disposal facilities (incineration plants and landfill) to meet increasing amounts of waste.

2.2 True Cost of Waste

In addition to that, wastage also results in increased cost. This can be seen from the calculation of the true cost of waste in *Figure 2.1*.

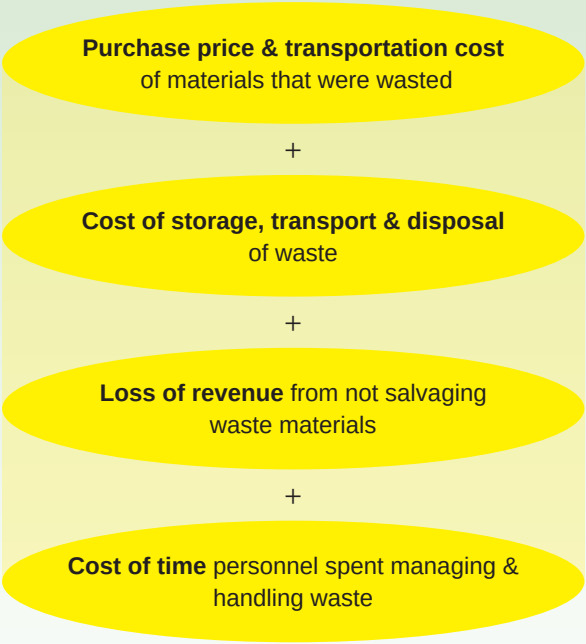


Figure 2.1: True cost of waste

2.2 True Cost of Waste

With reference to *Figure 2.1*, the factors contributing to the true cost of waste are illustrated below:

1. **'Purchase price & transportation cost of materials that were wasted':** the cost of the wasted materials that were bought and the cost of bringing them to their required location.

2. **'Cost of storage & disposal of waste':** the cost of the wasted materials that were initially stored and the cost of transporting to the disposal site.

3. **'Loss of revenue from not salvaging waste materials':** the cost of selling these wasted materials that had become obsolete or rejected.

4. **'Manpower cost for managing & handling waste':** the cost of training personnel to handle the wasted materials.

2.3 Effective Waste Management System

Thus, an effective waste management system has to be put in place to manage these wastes, hence decreasing cost. This system can be summarised in *Figure 2.2* and *Figure 2.3*.

More importantly, it requires several factors for success and they include:

1. Human factor
   - Commitment of the top management;
   - Involvement of project staff;
   - Co-operation of both main and subcontractors; and
   - Support of workers.

2. Effective communication

3. Documentation
   - Establishment of clear corporate policy; objectives and targets.

2.4 Hierarchy of Waste Management System

The hierarchy of waste management system shown in *Figure 2.2* can be used to manage the waste.

Figure 2.2: Hierarchy Diagram of Waste Management

2.4 Hierarchy of Waste Management System

The various methods shown in *Figure 2.2* are categorized in terms of preference from an environmental perspective. These methods which are considered to be more preferable (bottom of the pyramid) have the least impacts and are more sustainable in the long run.

The priority of waste management could be attained by improving processes to eliminate waste at the design stage; followed by minimising waste; reusing waste; recycling (reprocessing waste) by avoiding disposal; and lastly, treat and dispose the waste according to relevant laws and regulations (discussed in *Chapter 1*) and the good practices (discussed in *Chapter 3*).

2.4 Hierarchy of Waste Management System

This hierarchy must be used to evaluate waste management options, thus allowing maximum waste reduction and reducing cost.

Waste reduction of construction waste is best met by minimising and recycling. This is because 80% of the waste found in construction trash heaps are recyclable. Examples of these waste include wood; asphalt; concrete; bricks; metals; glass; paint; etc.

Essentially, reduction of waste would help to save the environment as it helps to reduce the greenhouse gas emission and other air pollutants.

2.5 7-Step Programme

An effective "7-step programme" in *Figure 2.3* can be established by following the hierarchy shown previously in *Figure 2.2*. The details will later be further explained.

Figure 2.3: 7-step programme

2.5 7-Step Programme

1st step: Environmentally-Improved Materials

- Consider the use of environmentally-improved materials to minimise wastage. This is normally done during the design phase.

  For example:

  A. Instead of using a timber formwork, a system formwork can be adopted. A comparison is summarised in *Figure 2.4*.

	Timber Formwork	**System Formwork**
Material	Timber & Plywood	All Aluminum
Durability	20 times	120-150 times
Wastage	Yes	No
Quality	Subject to workmanship	Good
Labour	Skilled	Unskilled
Flexibility	More	Less
Cost	$26/m^2	$34/m^2

Figure 2.4: Comparison table for formworks

2.5 7-Step Programme

B. Instead of using concrete, milled waste can be used as a temporary access on-site.

C821

Milled waste used for temporary pathway.

C. Recycling of Liquefied Soil

- Liquefied Solid Stabilization Technology was used in CCL and KPE projects, whereby liquefied soil was mainly used as a backfilling material by recycling unwanted marine clay and soil generated from earthwork projects.

2.5 7-Step Programme

D. Constructing 'Green' Roads

- It is using a mixture of recycled materials extensively in all four layers of the road structure, instead of just one layer as was used previously.
- A six-month trial had been put in place since March 2009, to construct the green road for one of the Tampines Road, just outside a heavy-vehicle park.
- If the pilot project is proven to be successful, this project will apply to future LTA construction projects.
- In addition to that, LTA's long-term aim of using 25 percent recycled materials in the construction of roads will increase to 70 percent.

2.5 7-Step Programme

E. Reusing / Recycling used concrete

C905

Using recycled precast C7 drains instead of concrete.

2.5 7-Step Programme

2nd step: Waste Assessment

- A waste assessment for potentially reusable, recyclable and disposable waste can be identified, which is normally done in the design phase.
  For example: A waste assessment is shown in *Figure 2.5*.

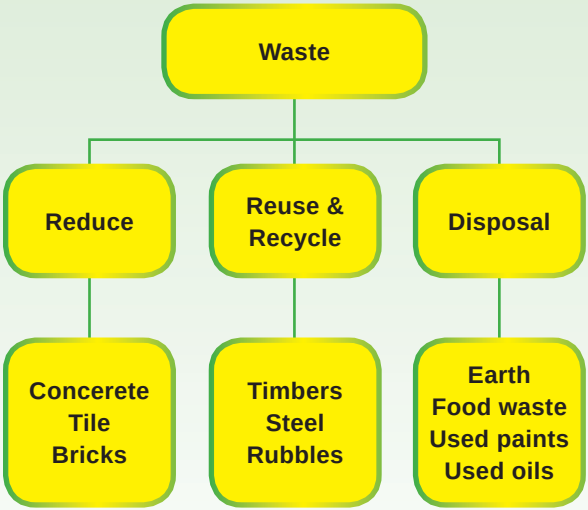


Figure 2.5: Waste Assessment

2.5 7-Step Programme

3rd step: Administer Material Wastage

- A study during the construction phase can then be done to investigate the possible causes of these waste and to administer the reduction of wastage.

For example: Two types of waste (Steel and concrete) are examined as follows.

A. Steel wastage

I. Possible causes of steel wastage

1. Not effectively using the entire length of steel
2. Lack of proper accounting of cut steel rebar

2.5 7-Step Programme

II. Administer steel wastage
   1. Use factory prefabricated reinforcement (trial project by NEA)
      → 60% reduction in processing waste
      → 30% increase in labour productivity
   2a. Site accounting and monitoring system
      → Reduce wastage
   2b. Improve work attitude of workers
      → Raising awareness on causes of wastage and the importance of waste reduction
   2c. Housekeeping at storage area
      → Tagging of steel rebars for easy retrieval
      → Proper stacking of remnant bar for easy identification
      → Grouping of fabricated steels according to size, length and beam marking

B. Concrete wastage

I. Possible causes of concrete wastage
   1. RC slab being cast thicker than designed
   2. Surplus concrete due to poor estimation
   3. Spillage during concreting
   4. Leakage in formwork

II. Administer concrete wastage
   1. Control RC slab thickness during concreting
      → Use devices to check on slab thickness
   2. Setting up site accounting system
      → Better estimation of quantity of concrete
   3. Improve concreting practices
      → Train workers in proper handling of concreting equipment such as concrete pump
   4. Preventing leakage
      → Ensuring all formworks are properly braced
      → Regular maintenance of quality of forms
      → Patching gaps in formwork with sheet metal to prevent grout loss

2.5 7-Step Programme

4th step: Waste Segregation System

- A system must be put in place to separately store the different types of construction waste during the construction phase. They must be properly stored, labelled, and properly disposed of from site.

For example:

A. Skip bins must be big and properly labelled.

C487

Well-labelled recycling skips.

B. A summary of the different methods of storage for different waste shown in *Figure 2.6a-c* can be used to ensure a standard storage method used for specific types of waste.

2.5 7-Step Programme

System to summarise the methods of storage for different waste and materials

Type of waste produced	Under cover	In secure area	On pallets	Material bound	Special Requirements
Sand, gravel, rock, crushed concrete					Store on hard standing base and in bays if its of large quantities
Cement					Avoid getting materials damp
Bricks					Store material in original packaging unit used, and protect from rain
Pipes					Slightly incline the pipes and use stoppers to prevent them from rolling off
Insulating material					Stored under polythene

Figure 2.6a: Summary of the proper methods of storage

2.5 7-Step Programme

Material stored	Under cover	In secure area	On pallets	Material bound	Special Requirements
Wood					Protect all types of wood from rain
Metal					Store in original packaging until used
Internal fitting					Store in original packaging until used
Sheet glass					Protect glass from breakage due to bad handling or vehicle movements
Paints					-
Bituminous felts					Usually stored in rolls and protect with polythene

Figure 2.6b: Summary of the different methods of storage

2.5 7-Step Programme

Material stored	Under cover	In secure area	On pallets	Material bound	Special Requirements
Ceramics tiles					Store in original packaging for reuse
Glass fibre					-
Oils					Store in tanks or drums according to quantity; protect container from damage to reduce likelihood of spillage; use a bund
Top / Sub soil					Store on hard standing base and keep segregation from potential contaminants
Precast concrete units					Store in original packaging, away from rain

Figure 2.6c: Summary of the different methods of storage

2.5 7-Step Programme

5th step: Information & Record System

- A system has to be put in place during the construction phase to record the amount of waste produced.
- A system to consolidate the information of various methods of storage for different types of materials also has to be put in place.

For example:

A. A summary of the monthly waste flow table shown in *Figure 2.7* can be used to monitor the amount of waste produced.

2.5 7-Step Programme

System to summarise the Monthly waste flow

Monthly Summary Waste Flow Table for ___ (year)

Month	Actual Quantities of Inert C&D Materials Generated Monthly					Actual Quantities of C&D Waste Generated Monthly				
	Total Quantity Generated	Broken Concrete (see Note 4)	Reused in the Contract	Reused in other Projects	Disposed as Public Fill	Metals	Paper/ cardboard packaging	Plastics (see Note 3)	Chemical Waste	Others, e.g. general refuse
	(in '000m³)	(in '000m³)	(in '000m³)	(in '000m³)	(in '000m³)	(in '000 kg)	(in '000kg)	(in '000kg)	(in '000kg)	(in '000m³)
Jan										
Feb										
Mar										
Apr										
May										
June										
Sub-total										
July										
Aug										
Sept										
Oct										
Nov										
Dec										
Total										

Notes: (1) The performance targets are given in PS Sub-clause 3(5) (c)
(2) The waste flow table shall also include C&D materials that are specified in the Contract to be imported for use at the Site
(3) Plastics refer to plastic bottles containers, plastic sheets from packaging material.
(4) Broken concrete for recycling into aggregates

Figure 2.7: Monthly waste flow

2.5 7-Step Programme

6th step: Effective Communication

- An avenue or platform for disseminating and sharing information has to be put in place. This is done during the construction phase.

For example:

A. Bulletin board at sites

→ It can be used for sharing ideas and feedbacks.

B. Environmental meeting

→ Waste prevention and recycling activities can be discussed.

2.5 7-Step Programme

C. Staff training

→ Staffs can be briefed by the senior management during inductions and the various topics that can be covered include:

D. Inspection

→ A weekly waste management inspection can be carried out to identify any problems on-site and to sort out any different opinions on the spot.

2.5 7-Step Programme

7th step: Housekeeping & Maintenance

- By having proper housekeeping and maintenance during construction, the site will always be kept clean with good waste disposal systems.

For example:

A. Embracing ideas from 5S of housekeeping

A widely regarded housekeeping management concept - 5S can be embraced at LTA sites to manage housekeeping effectively.

5S is a Japanese quality management concept based on a cyclical methodology. It is a method for organising a workplace and often referred as a housekeeping method.

This management model is based on 5 Japanese words seiri, seiton, seiso, seiketsu and shitsuke. which means organise, orderliness, cleanliness, standardise and discipline respectively.

This relationship can be observed in *Figure 2.8*.

2.5 7-Step Programme

7th step: Housekeeping & Maintenance

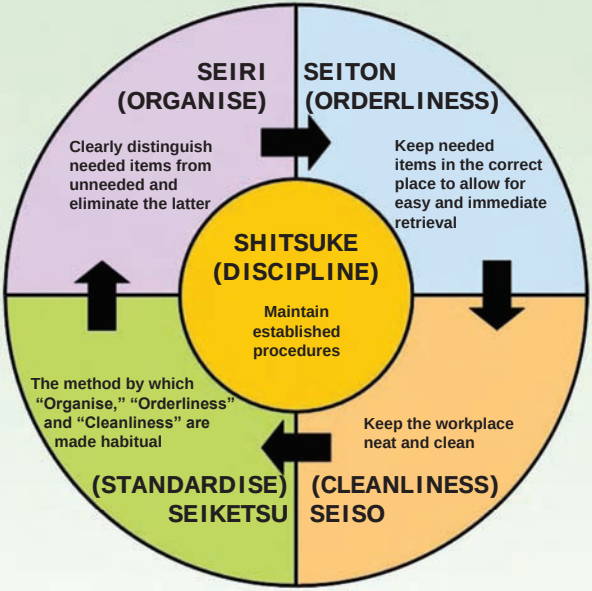


Figure 2.8: 5S concept of Housekeeping

Source: http://www.lean.state.mn.us/photos.htm

2.5 7-Step Programme

The definition of the 5s are as follows:

- **Seiri (Organise)**
  This is to focus on sorting out unnecessary items and disposing it away at site.
- **Seiton (Orderliness)**
  This is to arrange the necessary items in a neat, proper manner for easy retrieval and to return them in their original locations.
- **Seiso (Cleanliness)**
  This is to thoroughly clean and inspect the site.
- **Seiketsu (Standardise)**
  This is to maintain a high standard of housekeeping at site by keeping everything clean and orderly at all times.
- **Shitsuke (Discipline)**
  This is to train people to follow good housekeeping standards religiously, and to inculcate self-discipline through continuous practice.

Thus, by adopting this 5S model, a site with good housekeeping and maintenance will be ensured.

2.6 Benefits of Waste Management System

There are many benefits for having a construction waste management system and they are summarised as follows:

1. Provide a structured approach to management and recycling on-site
2. Improve resource efficiency and reduce cost
3. Help save natural resources
4. Help reduce greenhouse gases
5. Prolong the lifespan of our landfill
6. Increase profit margins
7. Gain better public image

CHAPTER 3:

Good Environmental Practices

3.1 Proper Waste Disposal System

Good Practice

Before actual work begins, the contractor should plan the movement of the anticipated construction waste. Thus, a sample of datasheet provided in *Figure 2.7* could be used for the consolidation of waste and the method of disposal to be used.

Other important matters to note would be:

1. All construction waste (non-hazardous & hazardous) must be disposed of at NEA's approved disposal sites via licensed waste contractors.

2. All non-hazardous wastes that are generated must be handled and disposed of in accordance with the requirements of the EPH (General Waste Collection) Regulations.

3.1 Proper Waste Disposal System

3. Any toxic / hazardous waste that are generated must be handled and disposed of in accordance with the requirements of the EPH (TIW) Regulations.

4. Do not burn waste at the worksite or dispose off the waste at any other locations, vacant lands, construction sites, etc.

   Open burning would result in a heavy penalty under the Environmental Protection and Management (Prohibition on the Use of Open Fires) Order.

3.1 Proper Waste Disposal System - Excavated sand

5. The excavated sand must be collected for disposal to NEA's registered dumping site.

C905

Slurry (excavated sand mixed with bentonite) undergoing *de-sanding process.

C905

Collection of sand in separate skip.

*De-sanding process: To separate bentonite from the sand mixture excavated and to dry the sand for easier collection and disposal of sand.

3.1 Proper Waste Disposal System - Gravels & stones

6. Gravels and stones used for silt traps can be rewashed and reused many times until they are dirty. They are then sent to the NEA's registered dumping site for disposal.

C905

Gravels and stones used for silt fence.

C905

Collection of gravels and stones for disposal.

3.2 Excavated Waste - Soil, broken rocks

1. The excavated waste collected in stockpiles must be temporary covered with canvas sheet to prevent the stockpile from being washed into the drain when it rains.

Uncovered stockpile.

C905

Good coverage of stockpile.

3.2 Excavated Waste - Soil, broken rocks

2. Some excavated materials & inert waste (soil, broken rock, etc.) shall be reused on-site for backfilling, reinstatement and landscaping wherever practicable.

Excavated materials used for backfilling purpose shall be covered with canvas sheet.

3.2 Excavated Waste - Soil, broken rocks

3. The excess excavated materials will be transported to LTA staging ground.

   Excess excavated materials are preferred to be immediately taken away as compared to being stockpiled as it may be washed away when it rains.

C823

Excess excavated materials were immediately taken away from site.

3.2 Excavated Waste - Soil, broken rocks

4. Measures must be taken to ensure that the vehicles leaving the site are properly washed, else there will be deposition of earth on the public road, violating EPHA Section 19(1)a Act.

Presence of wheel marks on public roads made by vehicles leaving the site.

Public road is covered with soil to an extent that the road markings (double yellow lines) are being obscured.

3.2 Excavated Waste - Soil, broken rocks

C905

Effective washing will not leave any wheel marks on the road.

3.2 Excavated Waste - Soil, broken rocks

5. Scrap metals (e.g. Welding rods; twisted steel wires; etc.) can be recovered and sent for recycling.

Poor storage of scrap metals.

3.2 Excavated Waste – Materials (Scrap metals)

There must be frequent removal of skip bin when it is full.

C905

Separate bin (scrap bin) that is sufficiently big is provided to store the scrap metals for recycling purposes.

3.3 Housekeeping - Storage of construction waste

1. All construction waste can be separated and stored in different skip bins, ensuring that they are properly labelled.

No segregation of construction waste in skip.

No labelling of waste collection bins.

3.3 Housekeeping - Storage of construction waste

C487

Well-labelled skips of adequate capacity are allocated for different type of materials.

3.3 Housekeeping - Storage of construction waste

2. Packing construction waste into trash bags promote easier and cleaner disposal. Covering skip bins with canvas sheet would ensure no seepage of rainwater into the bins.

ER198

Skip bin containing waste is covered using a canvas sheet.

ER198

Waste packed in trash bags.

3.3 Housekeeping - Storage of construction waste

3. Ensure frequent removal of waste to avoid overflowing of skip.

Overflowing skips.

3.3 Housekeeping - Storage of construction waste

4. Pipes that are recyclable and stored at site must be slightly inclined to prevent collection of rainwater in the pipes.

C855

Pipes are stored at a slight inclination.

3.3 Housekeeping - Litter-free sites

5. Sites must be clean and tidy, free from rubbish and litters.

Presence of empty cans on-site must be cleared.

C906 & C486

Worker on duty picking up litters on-site.

3.4 Generation of Wastewater – Surface runoff

1. Wastewater in the form of surface runoff must be directed to the water treatment plant.

Earth ditch carries extra eroded earth along the ditch, increasing the concentration of silt in the wastewater.

C905

By having concreted perimeter drain with silt trap instead of earth ditch, cleaner water flow will result.

3.4 Generation of Wastewater – Sewage

2. For mobile latrines, it must be cleaned daily and the sewage waste must also be cleared at least twice weekly to maintain good hygiene.

Dirty toilet.

C905

Portable toilet are maintained on a daily basis.

3.4 Generation of Wastewater – Washing boots

3. Wastewater generated due to the washing of boots must be sent for treatment before discharged.

Tap water used to wash the boots after site inspection are directly discharged into the public drains.

C487

Water used for cleaning boots are collected and sent for treatment.

3.4 Generation of Wastewater – Treatment

4. Silty water in the perimeter drain must undergo water treatment process before discharging into public drains.

C487

Water-treatment plant.

Before treatment
(Silty water)

After treatment
(Treated water)

3.4 Generation of Wastewater – Reuse

5. Treated silty water from perimeter drain can be reused for washing of shoe boots.

C903

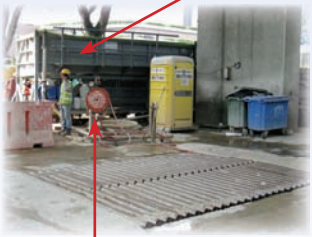
Reusing treated water for washing of boots.

3.4 Generation of Wastewater – Reuse

6. Treated silty water from perimeter drain can be reused for the washing bay.

C905

Treated silty water reused for washing bay.



C905

Washed water from washing bay is re-treated from the nearby treatment plant.

3.4 Generation of Wastewater – Reuse

7. Treated silty water from perimeter drain can be reused for controlling dust emission.

C487

Spraying treated water (vehicles containing water tank) on dusty site access.

C906

Spraying treated water while hacking the guide-wall to control the dust emission.

3.4 Generation of Wastewater – Reuse

8. Silty water can be reused for mixing of bentonite. Also, the slurry (reused silty water mixed with bentonite) could be separated for recycling of bentonite again after undergoing a treatment process.

C905

Separation of slurry for recycling of bentonite.

3.5 Toxic Waste – Generated due to leakages

1. Spill tray is required as a temporary storage in the event that leakage / spillage from chemical / oil containers occur. It will be able to prevent land contamination and water pollution.

Absence of spill tray leads to soil contamination.

ER198

Spill tray is provided beneath the containers.

3.5 Toxic Waste – Generated due to leakages

2. Empty containers / drums shall be stored in a separate toxic waste bin that needs to be cleared by a toxic waste licensed collector.

Bad storage of empty oil drum.

Bad storage of empty oil drum.

3.5 Toxic Waste – Generated due to leakages

3. Roof must be provided to prevent water from entering the spill tray. As oil floats on top of the water, the oil will be displaced off the tray, thus leading to land contamination. Also, it may end up in public drains and hence causing water pollution.

Spillage of oil even with spill trays due to overflowing of spill tray, resulting in land contamination.

Roof = protection from rain

C823

Provision of sand can absorb the oil in the event of any spillage.

3.5 Toxic Waste – Generated due to leakages

4. Apart from ensuring proper containment of oil drums, oil tank (diesel) must also be properly contained as it contains a large amount of oil:
   a. Oil tank within high bund wall that is coated with chemical-resistant
   b. Sand at the base of the bund wall to absorb any leakage in diesel

C485

Good example of proper storage of diesel on-site.

3.5 Toxic Waste – Generated due to leakages

5. Disposal of empty containers used to contain toxic or chemical substances must not be mixed with other general waste.

6. Disposal of toxic waste includes waste from the water treatment, namely the corrosive solvents; coagulated silt; flocculent; and sludge.

   The disposal of such waste must follow the EPH (TIW) Regulations mentioned earlier in Chapter 1.

3.6 Site Office

The site office also contributes to the waste generated on-site. Thus, measures must be taken into account for waste generated by the site office. These measures include:

1. Practice double-sided printing of paper
2. Reduce unnecessary printing of paper
3. Recycling of print cartridge
4. Food waste bin especially for food / organic waste

ER198

Food waste bin (covered).

3.6 Site Office

5. For sites that plant many trees, they can consider purchasing a machine to convert the food waste into *compost, thus recycling the food waste.

C905

Inputting food waste into the machine.

Compost produced as a result of converting the food waste using the machine.

* Compost: Acts as a fertiliser for plants.

3.6 Site Office

6. Recycling bins used to separate paper, plastics and cans are placed at the site office to create recycling awareness among staff and workers.

ER198

Different recycling bins (plastic, paper, drink cans) at site office.

3.6 Site Office

7. Posters can be put up at common notice boards or at construction sites to promote awareness of proper waste management.

C909

Education materials about recycling waste are put up at the common notice board.

3.6 Site Office

C905

Poster on Land Pollution - waste management are put up at construction sites.

CHAPTER 4:

Guidelines for Waste Management

4. Guidelines

The following guidelines are designed to help you prepare a waste reduction strategy for your next construction project, achieving 'meeting existing standards' and performing waste-efficient and cost-effective operations.

Opportunities for waste minimisation exist in three construction areas:

1. **Project Planning**
2. **Pre-Construction**
3. **On-Site Activities**

These guidelines are discussed in details in the subsequent pages.

4. Guidelines

1. PROJECT PLANNING

By developing a fully integrated waste management strategy, waste will be minimised, hencing increasing profit margins.

When planning your strategy, remember to:

A. Focus on the elimination of waste.

B. Identify and communicate responsibilities for waste minimisation between developer; designer; project manager; contractors and suppliers.

C. Allow inputs from all personnel.

D. Educate and inform personnel about the benefits of waste reduction and provide training.

E. Conduct an analysis of the project waste profile, using *Figure 2.7* shown in Chapter 2.

F. Integrate cost-control by reporting and monitoring of waste minimisation initiatives throughout the construction life of the entire project.

G. Make arrangements for on-site separation of materials and collections.

4. Guidelines

2. PRE-CONSTRUCTION

The pre-construction phase involves three areas (designing, estimating and purchasing) in which you can save waste and cut cost.

Designing

When designing, remember to consider elements that reduce waste, including:

- **A.** Building for deconstruction - so that when future modifications or decommissioning occurs, the entire structure can be taken apart and reused with ease and minimal waste.
- **B.** Good dimensioning and the use of modular components.
- **C.** Designed to standard material sizes.
- **D.** Building for operational waste reduction - so that once the station is operational, it generates minimal waste and is easily serviced for waste and recycling collections.

4. Guidelines

Estimation and Procurement

E. Be mindful of over-estimating the purchasing requirement.

F. Procurement policy - one of the most effective ways to avoid waste is by specifying to manufacturers and suppliers your exact requirements.

G. Buy environmentally improved materials - for example, those made from recycled content or with energy conserving features.

H. Prefabrication - by prefabricating frames and trusses, timber waste can be significantly reduced.

4. Guidelines

3. ON-SITE ACTIVITIES

On-site activities play a critical role through the operational and material handling processes in achieving the waste reduction plan.

A. Delivery and storage of materials:

- Set up appropriate storage arrangements to guard against material degradation or damage from weathering or moisture.
- Request that suppliers deliver materials when required, reducing the possibility for waste.

B. Packaging waste from building materials:

- Fittings are a significant contributor to the waste stream.
- Ensure unnecessary packaging from suppliers, or collaborate with other contractors for the collection of cardboard, plastics and metals.

4. Guidelines

C. Separation of materials to collect & recycle:

- Make arrangement with recycling contractors to provide clearly marked bins for material separation.
- Ensure subcontractors are aware of the placement of the bins and their responsibility to separate materials.

D. Litter management on-site:

It must be implemented on-site and requires the help from both your company and subcontractors:

- Outline the measures that would be taken to:
  a. minimise on-site litter during construction; and
  b. remove litter from the site.
- Methods used to minimise litter entering the water drainage system must be ensured, i.e. covering skip and stacked materials.

4. Guidelines

E. Safe disposal of unavoidable waste:

Disposal of *unavoidable waste material generated during construction.

- Outline the arrangements that will be made with waste contractors to ensure that the waste are safely recovered and disposed of to licensed landfills.
- Documentation, in the form of landfill receipts, must be kept to support the waste minimisation site review and data collection requirements.

* Unavoidable waste: Waste that cannot be recovered, reused or recycled and requires landfilling.

CHAPTER 5:

Assessment for Waste Management

5. Assessment

Project Stages		Questions to consider
Policy	1.	Has the maincontractor adopted a waste management policy?
	2.	Have the subcontractors signed the Site Waste Management Plan?
	3.	Have the subcontractors identify significant waste streams?
Procurement	1.	Has a careful evaluation of materials been made so that over-ordering and site wastage is reduced?
	2.	Has full consideration been given to the use of secondary and recycled materials?
	3.	Has unwanted packaging been arranged to be returned to the supplier for recycling or reusing?
	4.	Can unused materials be returned to purchaser or used on another job?

5. Assessment

Project Stages		Questions to consider
Project Planning	1.	Has responsibility for waste management on-site and compliance with environmental legislation been assigned to a named individual, including the relevant subcontractors?
	2.	Has a project programme been developed to include likely waste arising (how much, when, and what types)?
	3.	Has an area of the site been designated for waste management, including segregation of waste?
	4.	Have measures been put in place to deal with expected (and unexpected) toxic waste?
	5.	Has proper disposal of liquid wastes such as sewerage water and lubricants been considered?
	6.	Has the water discharge approval been obtained from PUB?

5. Assessment

Project Stages		Questions to consider
Project Planning	7.	Has approval been sought from the sewerage company for trade effluent discharge?
	8.	Have the possibilities of reusing and recycling of materials on-site explored?
	9.	Have the sites for disposal of residual waste from the project been identified?
	10.	Are there opportunities for reducing disposal cost from waste materials which may have a commercial value?
	11.	Have toolbox talks been planned for all site personnel with respect to waste management on-site?
	12.	Are selected waste materials segregated to allow best value to be obtained from good waste management practices?
	13.	Are skip bins clearly labelled to avoid confusion?

5. Assessment

Project Stages		Questions to consider
Site Operation	1.	Are Duty of Care procedures complied with, including provision of transfer notes and checking authorisation of registered carriers, registered exempt sites and licensed waste management facilities?
	2.	Is implementation of agreed waste management procedures monitored?
	3.	Is there a system to check for updated legal requirements pertaining to waste management when there are any changes?
	4.	Are reports regularly produced regarding waste quantities and treatment / disposal routes, and on the cost incurred? An example is shown in *Figure 5.1*.

5. Assessment

Process / Operation / Activity: _____

Date: _____

Profile of waste: _____

Type of Waste:	
Point of Origin:	
Quantity / month:	
Physical & Chemical Properties:	
Rate of generation (i.e. kg/month):	
Potential for contamination (e.g. mixed with other types of waste)	
Cost to manage and / or dispose:	
Why it is generated (e.g. due to frequent machine break down):	

Figure 5.1: Waste stream assessment sheet

5. Assessment

Project Stages		Questions to consider
Site Operation	5.	Has a final report been submitted? It should record the use of recycled materials, waste reduction, segregation, recovery and disposal, with cost and savings identified.
Post Completion	1.	During site operations, are challenges to good waste management practice considered and noted for incorporation into the post-completion review?
	2.	Have key waste management issues been considered for action at future projects?

CHAPTER 6:

References

6. References

Legislation

1. Environmental Protection and Management Act
2. Environmental Public Health (General Waste Collection) Regulation
3. Environmental Public Health (Toxic Industrial Waste) Regulation
4. Code of Practice for Environmental Control Officers
5. Code of Practice for Licensed General Waste Collectors
6. Environmental Protection and Management (Prohibition on the Use of Open Fires) Order

LTA Contract Specification

General Specification (Annex A-f)

Book

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