

## Appendix 6D

## APPENDIX 6D

DEVELOPMENT OPTIONS FOR PROPOSED SOLID WASTE  
INFRASTRUCTURE AND EQUIPMENT

[As submitted to Technical Committee in August 2002, Interim Report 2.]

The following technologies and infrastructure are considered to be appropriate technologies for the development of a strategic plan for solid waste management for Peninsular Malaysia to 2020: -

- Sanitary landfills;
- Transfer stations (with “bring” centres for recyclables);
- Integrated material recovery facilities (MRFs); and
- Thermal treatment plants.

### 1. DEVELOPMENT OPTIONS

The above facility types for the treatment of waste were considered by the Technical Committee in the context of three (3) proposed **Development OPTIONS - A, B and C**, as shown in **Table 1**.

The infrastructure development options are also depicted in the form of waste hierarchy as shown in **Figure 1**.

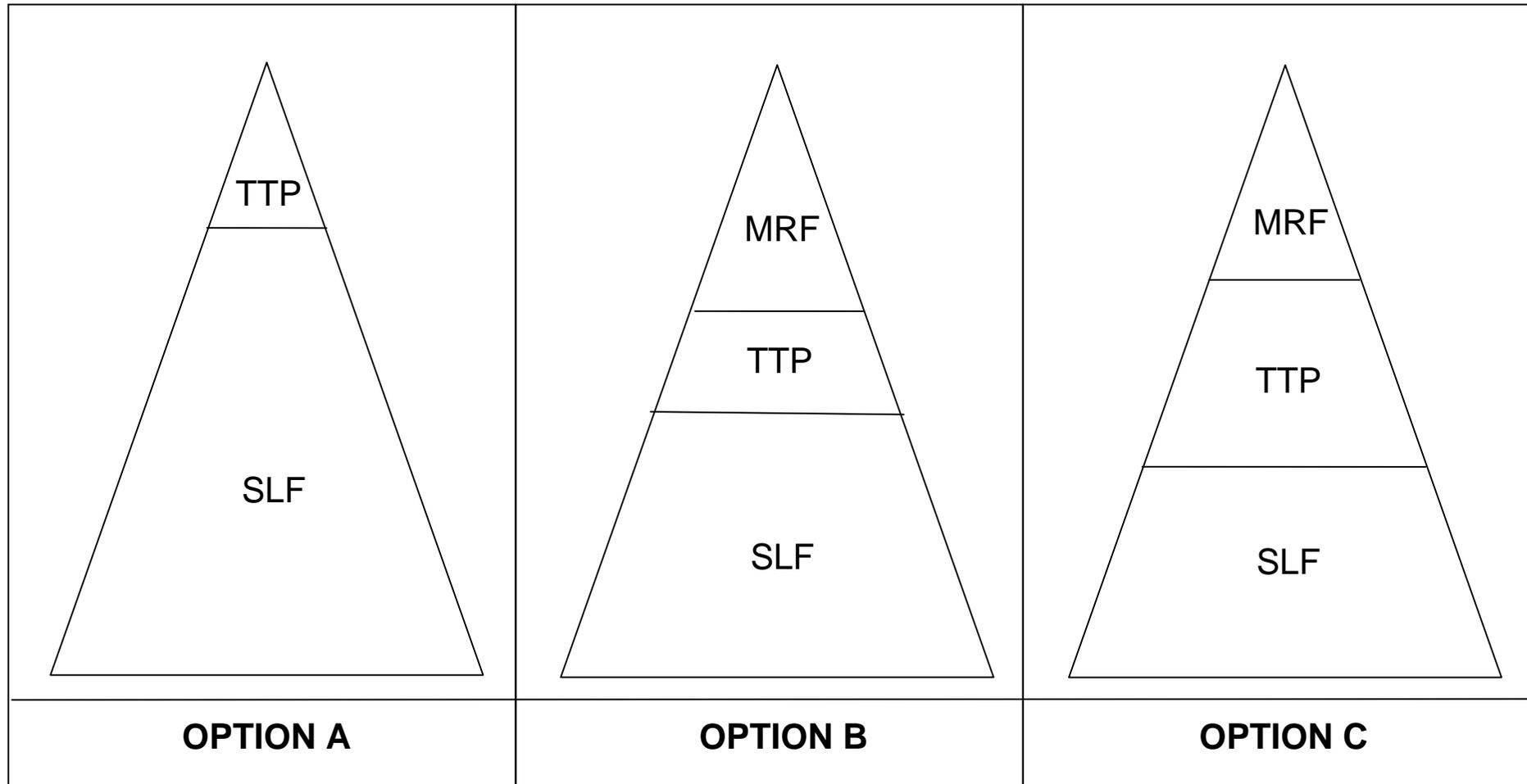
**Table 1 : Development Options for SWM Infrastructure and Equipment**

Construction and Operation of Projects during Year 2005 to 2020	DEVELOPMENT OPTIONS for Collection Equipment, Treatment and Disposal Infrastructure <i>(for each phasing alternative)</i>		
	OPTION A	OPTION B	OPTION C
Collection Vehicles	Yes	Yes	Yes
Haulage Vehicles	Yes	Yes	Yes
Government planned Projects <sup>1</sup>	Yes	Yes	Yes
Sanitary Landfills	Yes	Yes	Yes
Transfer Stations	Yes	Yes	Yes
Material Recovery Facilities	No	Yes	Yes
Thermal Treatment Plants (new)	No	No	Yes

<sup>1</sup> Government planned projects are: one thermal treatment plants (TTP) in Kuala Lumpur, one TTP on Penang island, one TTP on Cameron Highlands, one sanitary landfill at Rawang, Selangor, and one sanitary landfill at Johor.

Appendix 6D

Figure 1: Waste Hierarchy for SWM Development Options



SLF – Sanitary Landfill  
 TTP – Thermal Treatment Plant  
 MRF – Material Recovery Facility

## Appendix 6D

Waste generation and waste collection data is estimated (see **Chapter 2 of Volume 2** in Final Report) and has been modified to allow consideration of variations in waste generation in different States, and also waste generation in LA township (urban), LA non-township (urban), LA non-township (rural) and outside LA areas.

It has been related to population projections to derive total quantities of waste generated in order to establish capacities, locations and total numbers of facilities and equipment required. **Table 2** summarises the total number of infrastructure and equipment required in the three development options.

**Table 2 : Total Numbers of Facilities and Equipment by OPTION**

Infrastructure and Equipment	OPTION A	OPTION B	OPTION C
Sanitary Landfill	22	22	22
Transfer Station	51	45	45
Material recovery facility	N.A.	7	5
Thermal treatment plant	6*	6*	8 <sup>#</sup>
Collection Vehicles**	8500	8500	8500
Transfer haul vehicles**	1160	1210	1100

N.A. Not Applicable

\* Government planned projects, plus existing small incinerators on islands of Langkawi, Pangkor, and Tioman.

\*\* Total vehicles 2005-2020.

# Government planned projects, three existing small incinerators on islands, plus two new thermal treatment plants.

With specific reference to the choice of technologies for solid waste treatment the principle of the waste hierarchy has been adopted, with three primary objectives:

1. To reduce reliance on landfill;
2. To support the principles of waste reuse and recovery; and
3. To build solid waste infrastructure which is appropriate to the needs in different areas.

The development of transfer stations and other intermediate treatment facilities will reduce road movements and stabilise collection areas and allow collection vehicles to be utilised more effectively for collection. A regional approach to provision of intermediate treatment facilities does reduce the total numbers of vehicles on roads and at waste disposal sites, thus improving safety. Additionally the reduction in the total number of landfills advocated throughout the Peninsula can only be effective when haul distances for both collection and transfer haul are stabilised.

Consequently the use of intermediate treatment facilities for solid waste is a recommended strategy. The development of integrated material recovery facilities<sup>2</sup> and thermal treatment plants (which will also be waste transfer stations) provides the flexibility for waste planning, as separation of waste can be varied by material type to

<sup>2</sup> MRF – a central operation where waste is delivered, either source separated or co-mingled, and recyclable materials are sorted, mechanically or manually, to be processed into secondary material.

## Appendix 6D

suit the uncertain and often volatile secondary material market. Integrated treatment facilities are also adaptable to changes in waste collection strategy (e.g. source separation of waste). It is also recognised that recycling as a waste management alternative does rely on a number of different industrial sectors to make investment decisions.

Detailed information of the capacities for the proposed infrastructure and equipment in each development option is included in **Annex 1**. The generic location of the infrastructure is also included in **Annex 1** as **Figure A1(a), (b) and (c)** for Option A, B and C, respectively.

For comparison of cost implications for each option, three (3) **Phasing ALTERNATIVES – 1, 2, 3** were considered for the implementation of the construction of new facilities in all OPTION A, B and C. The phasing alternatives are as shown in **Table 3**.

Three (3) time phases from 2003-2020 have been determined, namely:

Phase I - 2003-2009

Phase II - 2010-2014

Phase III - 2015-2020

**ALTERNATIVE 1** requires the continued operation of the existing landfills and open dumps until completion. Existing landfill sites will be progressively closed as they are replaced with new facilities or their capacity is no longer required as a result of the success of the campaign to reduce, re-use, recycle and recover wastes. As new sites are needed due to the volume of waste generated then these sites will be engineered landfills constructed to level 4.

**ALTERNATIVE 2** comprises the upgrade of existing sites which will continue to be used, (the level of upgrade will be dependent on remaining lifespan), and the construction of all new sites to level 4.

**ALTERNATIVE 3** proposes the closure of all existing sites before 2010, and their replacement with new sanitary landfills constructed to level 4.

However, there are financial implications depending on the technologies adopted in terms of capital and operational expenditure and these have also been considered in recommending a **preferred option and alternative**.

## Appendix 6D

**Table 3 : Phasing Alternatives for the Procurement of Collection Equipment and Construction of Infrastructure**

Phasing ALTERNATIVES	Phase I (2003-2009)	Phase II (2010-2014)	Phase III (2015-2020)
<b>ALTERNATIVE 1.</b> <b>Government planned Projects First –</b> undertake only those projects currently planned during Phase I of the Strategic Plan period <sup>3</sup> .	- Construction of Government planned projects only.	- Procurement of collection equipment; - Construction of some infrastructures	- Procurement and replacement of collection equipment; and - Construction of some infrastructures.
<b>ALTERNATIVE 2.</b> <b>Technical Considerations –</b> undertake infrastructure development in a phased manner in accordance with technical evaluation of requirements.	- Procurement of collection equipment; - Construction of Government planned projects and some infrastructures.	- Procurement and replacement of collection equipment and - Construction of some infrastructures.	- Procurement and replacement of collection equipment and - Construction of some infrastructures.
<b>ALTERNATIVE 3.</b> <b>Total Provision –</b> undertake all proposed works during Phase I early in the Strategic Plan period.	- Procurement of Equipment; - Construction of Government planned projects and ALL other infrastructures.	- Procurement and replacement of collection equipment	- Procurement and replacement of collection equipment

<sup>3</sup> Strategic Plan period 2005-2020.

## Appendix 6D

2. Capital Investment and Operating Costs<sup>4</sup>

Total costs of each option (years 2003 –2020) are tabulated in **Table 4**.

**Table 4 : Total Capital and Operational Costs for Development Options**

Development Options	Capital Cost (billion RM)	Operational Cost (billion RM)
OPTION A	11.5	13.0
OPTION B	13.5	13.2
OPTION C	15.9	13.9

Assumptions used to determine the capital and operational costs are itemised in **Appendix 6G of Volume 3**.

The costs take account of economies of scale in construction and operation of the various facilities and in the case of vehicle requirements assume a 7-year lifespan for all mobile vehicles.

In recognising the level of financial investment required, it is proposed the three phases of capital expenditure could be distributed as shown in **Table 5** (except in the case of Alternative 3 - Total Provision, where investment is made in one phase only).

**Table 5 : Phasing of Capital Expenditure for Alternatives**

Development Options	Phasing Alternatives		
	ALTERNATIVE 1	ALTERNATIVE 2	ALTERNATIVE 3
OPTION A	<u>Scenario 1</u> Phase I – 35% Phase II – 42% Phase III – 23%	<u>Scenario 2</u> Phase I – 60% Phase II – 21% Phase III – 19%	<u>Scenario 3</u> Phase I – 100%
OPTION B	<u>Scenario 4</u> Phase I – 28% Phase II – 52% Phase III – 20%	<u>Scenario 5</u> Phase I – 66% Phase II – 18% Phase III – 16%	<u>Scenario 6</u> Phase I – 100%
OPTION C	<u>Scenario 7</u> Phase I – 23% Phase II – 60% Phase III – 17%	<u>Scenario 8</u> Phase I – 71% Phase II – 15% Phase III – 14%	<u>Scenario 9</u> Phase I – 100%

The technical considerations for phasing are based on an assessment of available facilities (landfills and dumpsites) and a consideration of vehicle and plant condition.

<sup>4</sup> Cost implications of land and revenue from recyclables are excluded from this appendix. Details of these are included in **Chapter 7 of Volume 2**, for the selected infrastructure development.

## Appendix 6D

For example - available void space for waste deposition is limited and many sites are full or nearing capacity.<sup>5</sup> 20% of waste compactors owned by Local Authorities are over 15 years old, and 90% are older than 6 years.<sup>6</sup>

### 3. Assessment of Options and Alternatives

The options and alternatives have been considered in relation to perceived requirements during the period to 2020 and as a consequence the facilities and equipment in each option A, B and C, are the same in each alternative<sup>7</sup>. They relate directly to facility and equipment provision.

**Table 6** indicates key considerations and ranking for the selection of an appropriate option, including current environmental requirements and waste hierarchy considerations.

**Table 6 : Considerations for Selection of Appropriate Options**

Considerations	OPTIONS		
	A	B	C
1. Waste Hierarchy application	Low	Med	High
2. Balanced development of SWM throughout the Peninsula - Cost Implication	High	Med	Low
3. Social Acceptability	Low	Med	Med
4. Ease of Implementation (technical difficulty, siting considerations, existing standards, etc.)	High	Med	Med

Flow diagrams of the three options depicting estimated quantities for treatment and disposal at the various facilities in shown in **Figure 2(a), (b) and (c)** for Option A, B and C, respectively.

In **Option A** waste direct to landfill is 26% (33 million tonnes) of the total waste collected during the period 2005-2020 and 93% of waste collected goes to landfill (either via intermediate treatment or direct).

In **Option B** waste direct to landfill is 17% (22 million tonnes) of the total waste collected during the period 2005-2020, and 87% of waste collected goes to landfill (either via intermediate treatment or direct).

In **Option C** waste direct to landfill is 16% (21 million tonnes) of the total waste collected during the period 2005-2020, and 80% of waste collected goes to landfill (either via intermediate treatment or direct).

The possibility for waste material recovery is greatest where MRFs are constructed, particularly as they will be in areas of significant waste generation. Recovery rates can be further enhanced if source separation is used in conjunction with MRFs to

<sup>5</sup> 46% of landfills in Peninsular Malaysia have a total lifespan of less than 5 years (MHLG Information and Status of Waste Disposal Sites at Local Authorities 2002).

<sup>6</sup> Analysis from returned L.A. questionnaires (see **Appendix 3E of Volume 3** for types of vehicles owned by LAs).

<sup>7</sup> Note however that in Alternative 1 the total capital expenditure varies from Alternatives 2 and 3 because in Phase I no new collection or transfer haul vehicles are procured.

## Appendix 6D

reduce contamination of potential recyclable material, together with the contribution of energy from waste from landfill gas and thermal treatment plants.

A key consideration for the options is the phasing of development, and its relationship to cost implications.

### **ALTERNATIVE 1 – “Government planned Projects Only in Phase I”**

If phased according to **Table 5** the Government planned projects only could be undertaken in Phase I, thus relieving the burden of financing for other infrastructure. However this alternative is not considered practical because:

1. There are significant and urgent requirements for new disposal facilities in the next five years;
2. Vehicles and disposal facilities in many LA's are very old and in poor condition, and affect the efficiency of service, particularly waste collection, and require to be replaced;
3. Progressive improvement in solid waste management would not take place until 2010 or when finance was allocated.
4. Environmental degradation would continue (particularly in areas where dumpsites predominate).<sup>8</sup>
5. Previous lack of investment would be compounded, and would result in the requirement for greater investment later.
6. This alternative does not provide a rational and sustainable national strategy for solid waste management.

### **ALTERNATIVE 2 – “Technical Considerations”**

This alternative considers the needs of Peninsular Malaysia, with technically based rationale derived from best available information and desktop studies. It considers what is required to improve the environment and service provision, but takes account of the existing facilities and equipment,<sup>9</sup> which may be used for varying period's dependant on condition. Some of these facilities are dumpsites, but could be upgraded to varying standards by considering economic life and overall benefit obtained. In addition, it considers the practicality and financial implications of providing nationwide infrastructure for all facilities and new plant and equipment within a time frame of 6-7 years. This option would allow for effective financial planning and institutional development within the ensuing Malaysia Plans (9<sup>th</sup>, 10<sup>th</sup> and 11<sup>th</sup>) to 2020. Similarly, technology transfer could be introduced progressively during the Strategic Plan period.

### **ALTERNATIVE 3 – “Total Provision”**

In this alternative all capital investment for new facilities and equipment is provided within one phase (suggested 2003-2009), with consequent financial implications in the early years. This is, of course, the “ideal” situation to improve solid waste management services and infrastructure in a short time, but involves substantial capital investment and significant short term planning.

The implications on activities in **Phase I** (2003-2009) of the three phasing alternatives is summarised in **Table 7**.

---

<sup>8</sup> 43% of landfills are open dump sites (MHLG Information and Status of Waste Disposal Sites at Local Authorities 2002).

<sup>9</sup> From MHLG survey, LA questionnaires and interviews with Government officials.

## Appendix 6D

Table 7: Implications on Activities in Phase I of the Three Phasing Alternatives

Activities in Phase I	Phasing ALTERNATIVES			Remarks
	1	2	3	
1. Collection Improvement	N	Y	Y	
2. Transfer Haul				
- TS serve Government planned projects	N*	Y	Y	*Existing transfer stations only (3 no).
- TS serve above + new SLF	N	Y	Y	
- TS serve above + upgraded sites	N	Y	N**	**No sites upgraded
3. Intermediate Treatment				
- Government planned TTP projects	Y	Y	Y	Kuala Lumpur, P. Pinang & Cameron Highland
4. Sanitary Landfill				
- Government planned SLF projects	Y	Y	Y	Rawang SLF, Seelong SLF
- Upgrading existing disposal sites (age > 5 years)	N	Y	N	In Alt. 3, all existing sites to be closed.
- Construction of New SLF	N	Part	All	

**THE DEVELOPMENT OF THE STRATEGIC PLAN SHOULD BE BASED ON PRACTICAL, TECHNICAL AND ECONOMIC CONSIDERATIONS AND THUS OPTION B, ALTERNATIVE 2<sup>10</sup> IS CONSIDERED TO BE THE MOST FEASIBLE AND IS RECOMMENDED.**

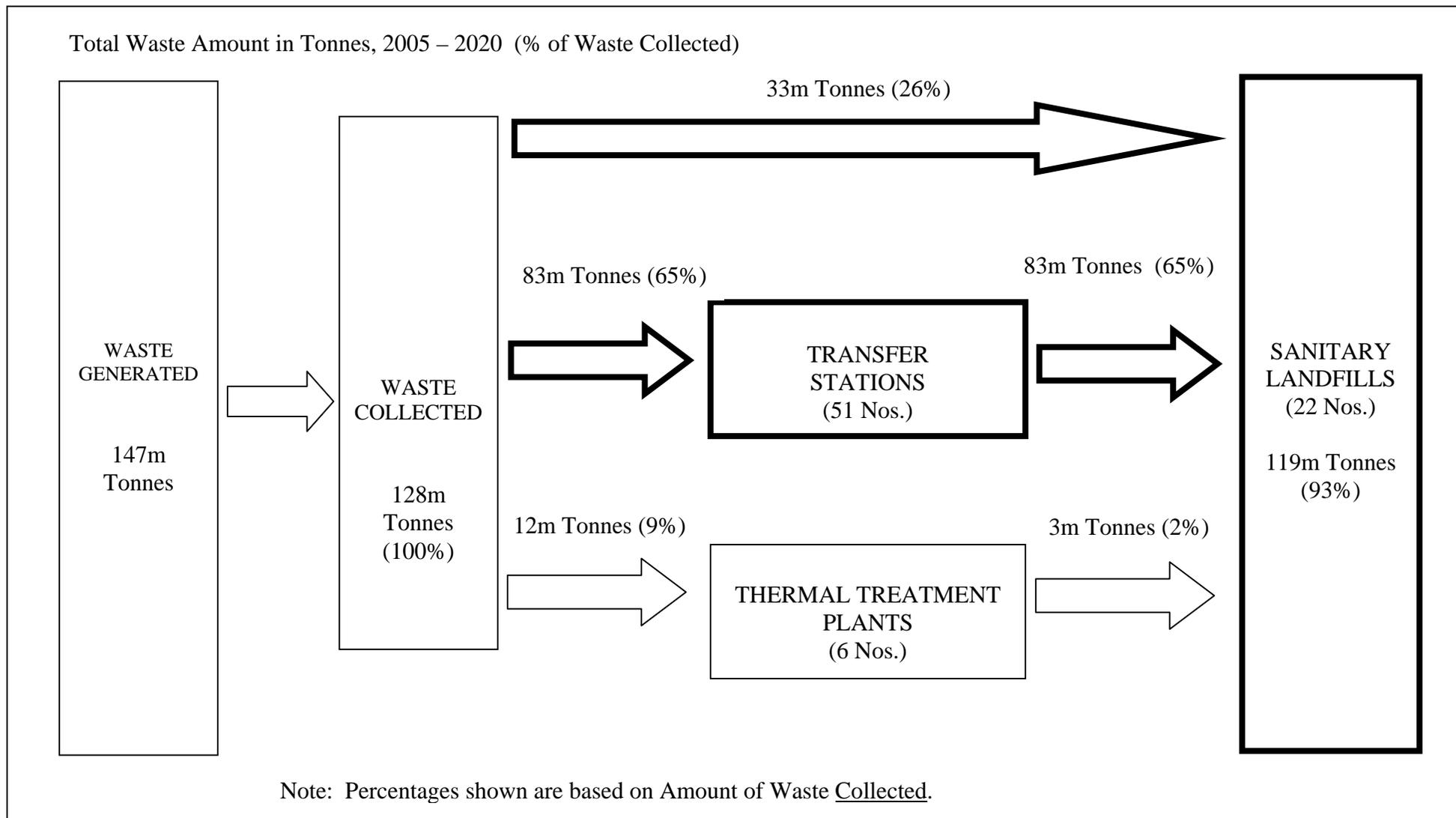
**IN SUMMARY, Option B, Alternative 2, Scenario 5 is (with reference to Table 5):**

- To construct and operate: Sanitary landfills, transfer stations, material recovery facilities and Government planned projects during 2005 and 2020.
- To undertake infrastructure development in a phased manner in accordance with technical evaluation of requirements.
- Phase I development involves 66% of capital cost, phase 2 development consists of 18% of capital cost, and phase 3 development consists of 16% of capital cost.

<sup>10</sup> As Scenario 5 in Table 5 of Phasing of Capital Expenditure for Alternatives.

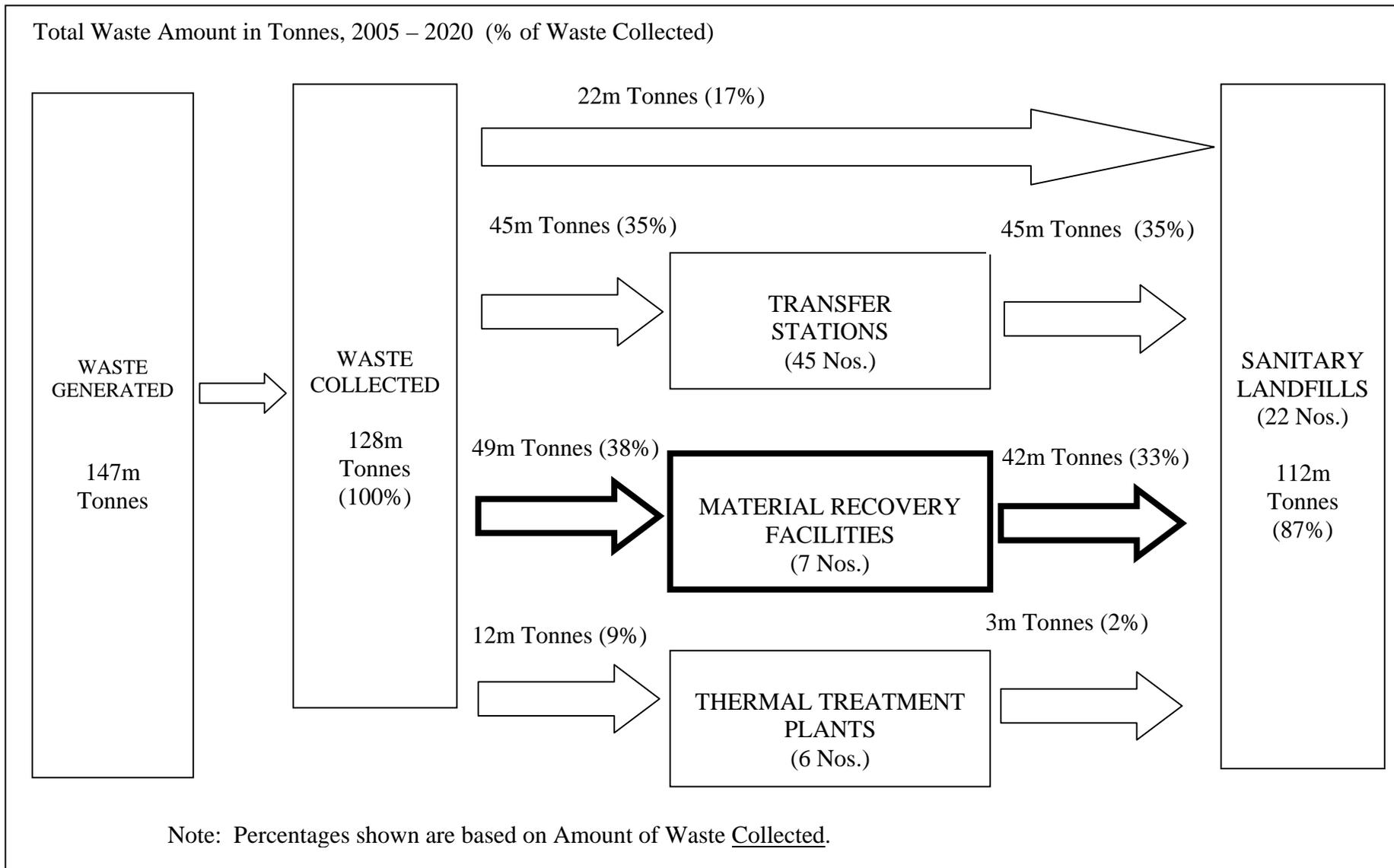
Appendix 6D

Figure 2 (a) : Waste Diversion for OPTION A (2005 - 2020)



Appendix 6D

Figure 2 (b) : Waste Diversion for OPTION B (2005 - 2020)



Appendix 6D

Figure 2 (c) : Waste Diversion for OPTION C (2005 - 2020)

