b) Disadvantages

- Requires very sophisticated technologies.
- Investment and operational costs are high.
- Requires a large area for construction of a smelting plant.
- Requires specialized engineers and skilled operators.
- Requires coke and oxygen as supporting fuel.

c) Critical points

- High rate of supplement fuel, such as coke and oxygen
- High operational cost
- Limited size of waste to be charged into the furnace
- Capacity of smelting furnace

2) Evaluation

For evaluation the following factors will be examined.

a) Recovered materials

All materials in waste can be treated and will be recovered as slag.

b) Main system

It is almost the same as the incineration system, but requires supplementary fuel facilities for coke and oxygen, slagging facilities for its handling and a different type of furnace.

c) Maturity of technology

The technology is basically similar to that for the blast furnace steel industry in general use today, however that for waste treatment is at the beginning stage for practical application.

In this sense it could be said that this technology for waste is still premature.

d) Recycling effect

Nothing will be recovered from the smelting system except for heat energy, but substances in the form of slag that are chemically changed will be produced and will be reused.

e) Quality of recovered material

Only fully molten slag will be reused.

f) Marketability of recovered material

Refer to item number e).

g) Volume reduction

The most important feature of this system: the original waste volume is reduced to about 1/98.

h) Environmental aspects

Environmentally no analytical data on slag have showed any harmful chemical content. On the other hand, the flue gas from the smelting furnace will contain approximately the same pollutants as an incineration system.

i) Acceptability by the public

This is difficult to evaluate now, acceptability might be achieved in the future, in particular from an environmental viewpoint.

This system is the best environmentally and for minimizing final disposal site area, however, it is presently uneconomical.

(7) RDF (Refuse Derived Fuel)

An RDF system is a mechanized waste volume reduction method on a relatively small scale.
This system separates wastes into the combustibles such as paper and plastic, and the incombustibles by a mechanical means, for producing fuel from the combustible fraction of waste.

The combustibles will be formed to a specific shape as fuel, and the remaining incombustibles will be processed for recovering the valuable materials. Remained non-reusables will be disposed of at the final disposal sites.

1) Advantages and disadvantages

a) Advantages

- Performs as an entire system from resource recovery to recycling.
- Makes waste usable as fuel.
- Stores waste as fuel.
- Recovers and recycles glass, ferrous metals and non-ferrous materials.

b) Disadvantages

- Requires relatively high investment cost.
- Requires a large area for construction.
- Requires environmental protection equipment.
- Requires engineers and operators.
- Requires a stable market.
- Relatively small scale facility will be possible for one plant, so many plants will be necessary for a huge amount of waste.

c) Critical points

- Content of the light fractions, such as plastic and paper, in the waste.
- Market price of products in competition with other fuel

2) Evaluation

For evaluation the following factors will be examined.

a) Recovered materials

Mostly paper and plastic will be treated to produce fuel.

b) The main system consists of the following equipment.

- Receiving and feeding equipment
- Separating and sorting equipment
- Thermal treating equipment
- Storage facility

c) Maturity of system

In terms of big mass treatment with thermal processing, the technologies for this system are premature.

d) Recycling effect

For the case with good marketability the recycling effect by RDF would be considerable.

e) Quality of recovered materials

Products as fuel by RDF would be in the range of 2,500-3,500 kcal/kg, heating value. Accordingly the products could be used as supplemental fuel for existing thermal facilities.

f) Marketability of recovered materials

It is likely to be difficult to establish a stable market because no computable price will be possible.

g) Volume reduction

Because of the plastic's ability to bind other fractions in a thermal process, the amount of recovered materials depends on the quantity of plastic content in waste.

About 1-2% of the total amount of waste can be recovered as fuel in maximum.

h) Environmental impact

No environmental impacts will be caused to the outside, but inside odor, dust and noise problems need to be solved.

i) Acceptability by the public

In principal this would be acceptable merely from the environmental viewpoint.

RDF in general will not be adopted. This is because of a lack of enough space for construction of waste handling facilities and of the expenses for making RDF from the MSW which already contains combustibles in it. This is not suitable for the situation in Hungary.

3) Conclusion

C/P and the JICA Study Team agreed not to plan the RDF system as a component of the M/P.

(8) Matrix-Evaluation of intermediate treatments

All components evaluated in the Section 4.3.4. as the possible intermediate treatments are summarized in a matrix for comprehensive evaluation in the Table 4-5. For evaluation, a scale of four is used (excellent, good, fair and poor).

In the environmental evaluation the type of potential impact is shown. The overall evaluation indicates that the preferable component is an incineration system. Second is a resource recovery and recycling system, followed by composting and shredding.

Mechanical waste compaction is evaluated as inadequate, and smelting treatment and RDF are technically premature.

Table 4-5 Matrix-evaluation

Component of M/P	Recovered material	Main system	Maturity of technology	Recycling effect	Quality of recovered material	Marketability of recovered material	Site volume reduction	Volume reduction %	Environment			Acceptability by the public	Remarks	Evaluation (in order)
									Harmless	Stability	Impact element			
Resource recovery and recycling	Second raw materials	Separate collection	A	A	Depends on system	C	Large	Depends on market-ability	A	A		Depends on system	Difficult from economic view point	Difficult from economic viewpoint
Green waste composting	Compost	Simple Windrows	A	A	A	B	Large	70	A	B	Odor waste-water	B	Use for own purpose	Further experiment is required
Shredding	Combusti-bles and metal	Shredding and rough separating	A	B	B	C	Large	20	B	A	Noise vibra-tion	B	Installation in the incineration plant	Possible
Mechanical waste compaction	No recovered material	Mechanical compactor. conveyor	A	C	-	-	Small	-	C	C	Noise vibration	C	Useful only for long distance transport	Inadequate
Incineration	Energy (Electric-ity, steam hot water)	Mass high temperature combustion	A	A	A	A	Large	90	A	A	Effluent gas. water and noise	A	Reduction effect in long term opera-tion is extremely great. Waste heat is recycled.	Most preferable
Smelting treatment	Energy and slag	Mechanical melting furnace with coke and O_2	C	A	A	B	Large	98	A	A	Ditto	B	Questions are investment and operational cost	Premature
RDF	Fuel and metal	Shredding separating sorting and thermal	B	A	A	C	Large	40	B	B	Odor noise	B	Expectation will be big in the future	Premature

E: Excellent A: Good B: Fair C: Poor

4.3.5 Municipal Solid Waste Final Disposal

The function of the final disposal site is to store the MSW and to make it harmless by applying natural metabolism without any environmental problems to surroundings of the site.

In order to obtain the above functions, the following components must be considered.

a) Methods
b) Structure of landfilling
c) Monitoring systems for environmental problems

There are the four final disposal sites operating in the Budapest city. Today's situation of the above three components of these sites is presented in the Section 3.7.

In this Section, the alternatives for the above three components are discussed with consideration of local natural conditions and with reference to the Hungarian technical final disposal guidelines, named Guide for Systematic Disposal of the MSW.

(1) Methods

In this field there are basically three disposal methods as below.

- Open dumping method
- Controlled landfilling method
- Sanitary landfilling method

1) Open dumping method

The open dumping method is the lowest grade method with a number of environmental problems. This method is quite primitive. The collected waste is just dumped into a site without use of heavy machines or soil covering.

The collected waste is just dumped into the site, therefore, many kinds of environmental problems may occur, like air pollution caused by spontaneous combustion, and bad hygiene caused by harmful insects and beasts. Some kinds of waste are scattered by wind blowing long distances.

Ground water and superficial water from the site may be contaminated by leachate. Leachate is generated by interaction between dumped waste and rain fall on dumping site.

2) Controlled landfill

This method is an open dumping using heavy machines to control the dumped waste. However, even if this method is employed, most of environmental problems will remain.

3) Sanitary landfill

This method uses heavy machines to cover waste with soil to prevent environmental problems.

There are two covering methods: the cell method and sandwich method. The cell method is to cover the dumped waste after shoving by a heavy machine wrapping the waste with soil at the end of daily work.

The sandwich method is to cover the dumped waste, which has been flattened out by heavy machines, with a soil layer. These methods are shown in the Figure 4-11. Generally, to cover the dumped waste with soil can reduce the environmental problems.

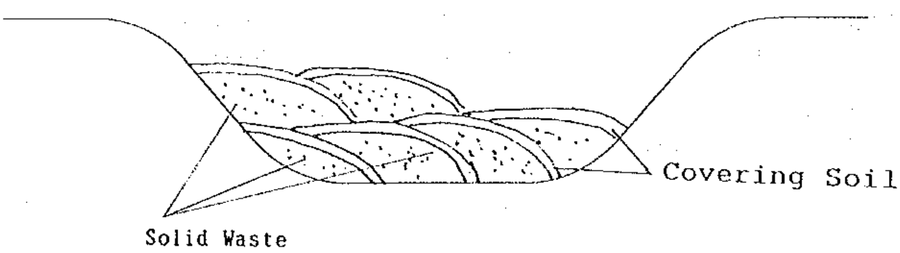
Covering waste with soil reduces many kinds of environmental problems which are discussed above.

Comparison of the three disposal method is presented in the Table 4-6.

Financially, sanitary landfill is the most costly method but the first priority from technical and environmental points of view.

Figure 4-11 Covering Methods

Cell Method



Sandwich Method

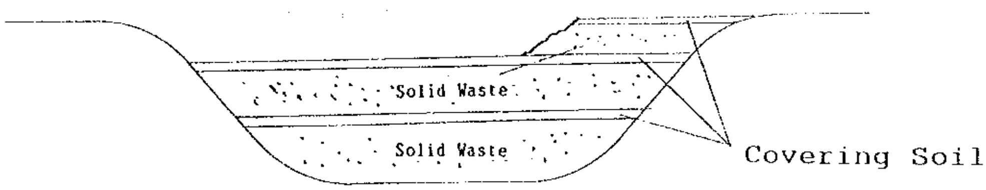


Table 4-6 Comparison of Three Landfilling Methods

	Open dumping	Controlled landfill	Sanitary landfill
A. Operation			
1. Necessity of heavy machines	No need	Need	Need
2. Necessity of soil for covering	No need	Need	Need
B. Environmental Aspect			
1. Air pollution	Heavy	Heavy	Negligible
2. Soil contamination	Possible	Possible	Negligible
3. Ground water contamination	Highly possible	Highly possible	Preventable
4. Superficial water contamination	Highly possible	Highly possible	Preventable
5. Quantity of generated leachate	Much	Much	Less
6. Bad odor	Yes	Yes	Negligible
7. Harmful insects & beasts, etc.	Yes	Negligible	Negligible
C. Financial Aspects	Negligible	Medium	High
Evaluation	x		o

o: Good
: Acceptable
x: Inacceptable

Note: Financial Aspects are only for operational costs.

(2) Structure of landfilling

Generally, structure of landfilling is classified into five types as shown in the Figure 4-12.

1) Anaerobic landfill:

Solid waste is dumped into an excavated hole or a valley, and dumped waste is flooded in an anaerobic environment.

2) Anaerobic sanitary landfill:

Condition of landfilling is basically anaerobic but covering soil is used for a sandwich method.

3) Improved anaerobic sanitary landfill:

On the bottom of anaerobic landfill, leachate collecting pipes are installed to drain out of the site.

But, situation of solid waste surroundings is still anaerobic environment.

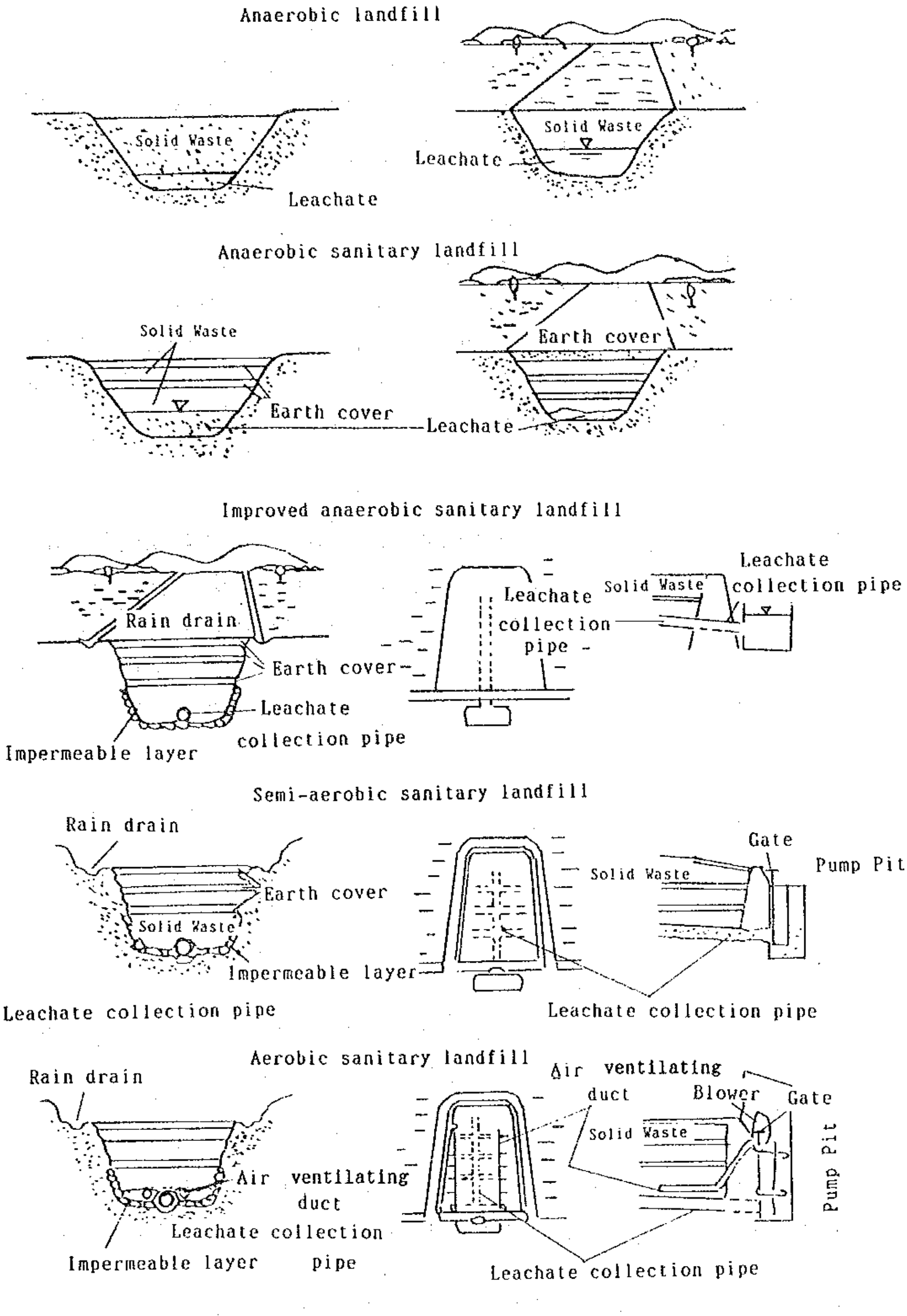
4) Semi-aerobic sanitary landfill:

The leachate collecting pipes installed in an improved anaerobic sanitary landfill will have enough sectional area and its open end reaches to the air, and the pipes are wrapped with cobblestones. The collecting pipe's function is to drain water out of the solid waste and to supply oxygen to the waste, so that the surroundings of the pipes may be aerobic.

5) Aerobic sanitary landfill:

By setting up the additional pipes for supplying air in the semi-aerobic sanitary landfill site, air shall be sent in by blowers so that the waste layer can be more aerobic sanitary

Figure 4-12 Classification of Structure for Landfill



Source: Japan-United States Governmental Conference on Solid Waste Management
Oct. 1976 by Dr.Masataka Hanashima

At present, there are the four anaerobic sanitary landfills in Budapest.

In the past, the anaerobic sanitary landfills have been in acceptable condition because of meteorological and financial conditions.

Environmental problems in connection with a final disposal site are bad odor, water contamination including ground water, and air pollution caused by spontaneous waste combustion, etc. These are influenced by decomposition of dumped waste which is affected indirectly by precipitation and temperature.

In this sense, water balance between supply and evaporation in a final disposal site is important. In a final disposal site, the main sources of water are rain fall and ground water; the main sinks are evaporation and capacity of waste to keep water in voids of waste.

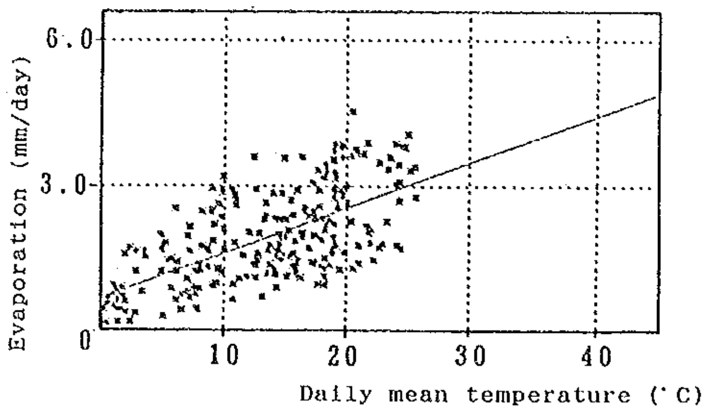
Meteorological data for Budapest are given in the Tables 2-3 and 2-4.

In the past 10 years, the maximum precipitation was 671 mm in 1980 and minimum precipitation was 414 mm in 1986. As for monthly data in 1990, the maximum was 60 mm in September, and the minimum was 4 mm in March.

Concerning temperature, in the past 10 years, the maximum was 36.6°C, the minimum was -18.1°C and the yearly mean for the past 10 years was 11.3°C. Monthly temperature data in 1990 show that maximum, minimum and average of yearly mean for the past 10 years were 34.6°C, -9.7°C and 12.0°C respectively. According to the Study on Forecast of Leachate

Quantity followed time series, there is some correlation between possible evaporation quantity and mean temperature, as shown below.

Figure 4-13 Correlation between Evaporation and Daily Mean Temperature



Source: Sapporo Meteorological Observatory in 1989.

When daily mean temperature is 12°C, the possible evaporation is approximately 1.5 mm/day, according to the above Figure 4-13.

Therefore, yearly possible evaporation will be 365 day x 1.5 mm/day = 547.5 mm/year. This quantity is almost equal to yearly precipitation. This means that if it rains steadily at the average rate through a year, leachate will not be generated in the case of Budapest.

As for the capacity of the MSW to keep water in voids of the MSW, this capacity will be 10% of the reclaimed MSW volume in the final disposal site.

From the above reasons, even anaerobic sanitary landfills might be performed acceptably. However, it does not rain steadily and in order to establish further improved sanitary landfilling in the future, an improved anaerobic sanitary landfill structure is desirable.

4.4 System Alternatives

Prior to the selection of a M/P, the alternatives corresponding to each system component constituting a MSW management system were selected. Then, the alternatives for each system component were carefully evaluated, mainly from technical, economic and environmental view points, to determine the adequate system components for Budapest.

The system components are listed below.

. MSW discharge and storage
. MSW collection and transportation
. MSW intermediate treatment (Matrix-evaluation was performed for: resource recovery and recycling, green waste composting, shredding, mechanical waste compaction, incineration, smelting treatment and RDF (Refuse Derived Fuel))
. MSW final disposal

Based on the evaluation, the conventional system was selected for discharge and storage; a transfer station system was selected for southern districts (9 districts of district number IX-XII and XVII-XXI) of the city with collection vehicles purchased for T/S and transportation; an incineration with a shredding system was selected for intermediate treatment; and a sanitary landfilling method was selected for the final disposal.

Summary of system alternatives

The selected components for the M/P are summarized as follows.

- Construction of T/S
- Purchase of collection vehicles, case 1
- Purchase of collection vehicles, case 2
- Operation of HHM1

- Construction of HHM2
- Plan of the final disposal sites

In the plan for T/S and new collection vehicle purchase as in case 2 connected with the HHM2 construction, these will have a technical relationship to each other; the HHM2 construction will be a premise for planning of T/S and new collection vehicle purchasing. New collection vehicle purchasing can be planned in consideration of increase of the MSW in the future and locations of new final disposal sites.

In this Chapter, two system alternatives which were formed by means of combination of the selected components will be examined to form the M/P for the MSW management in Budapest.

For convenience the components are expressed by abbreviations as follows.

- Construction of T/S, (T/S):	Covers the MSW from southern part of Budapest.
- Purchase of collection vehicles, (P_1):	Case 1: Vehicle purchasing without T/S
- Purchase of collection vehicles, (P_2):	Case 2: Vehicle purchasing with T/S
- Operation of HHM1 (existing incineration plant), (I):	Consists of 4 combustion units of a 300 t/day capacity each, with heat supply for district and electric power generation system.

- Construction of HHM2 (new incineration plant), (I_2): Consist of 2 combustion units of 480 t/day capacity each, with electric power generation system.

- HHM1 + HHM2, (Is): Both plants

- Plan of the final disposal sites, (L): MSW, harmless industrial waste, construction wastes and combusted residues (including ash) are to be disposed of at the final disposal sites.

The two system alternatives, accordingly, are as follows.

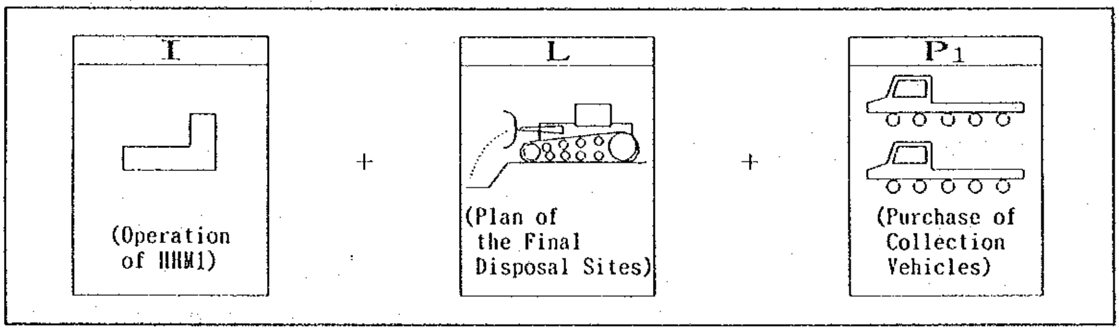
(1) Alternative-1

The Alternative-1 consists of operation of HHM1 (I), plan of the final disposal sites (L) and purchase of collection vehicles (P_1).

In this case, the treatment capacity of incineration, after modification of the HHM1 boilers, was fixed at 310,000 t/year. However, since another modification of boilers will be needed during the three years from 1998 to 2000, the fixed capacity will be adjusted as shown in the Table 4-12. It will obviously be necessary for the main equipment of the plant to be maintained or renovated in order to keep the capacity as much as possible up to 2005, and to satisfy the new environmental requirements.

Formation is as below.

Alternative-1 = I + L + P_1

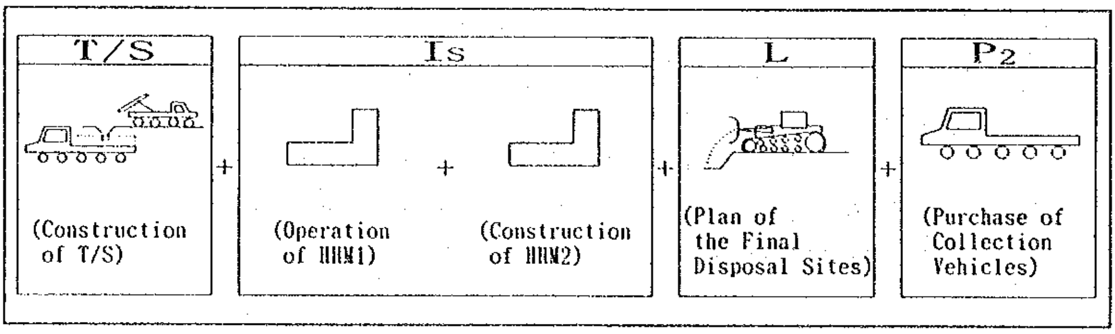


(2) Alternative-2

The Alternative-2 consists of the Alternative-1 plus HHM2 and T/S including P_2. The location of HHM2 is to be at the same site with HHM1, in district-XV. The capacity of HHM2 will be determined according to the Table 4-12. T/S to be located at the Akna site will be responsible for transporting the combustible MSW collected in southern districts of Budapest to HHM2.

Formation is as below.

Alternative-2 = T/S + Is + L + P_2



4.4.1 System Alternative Evaluation

(1) Methodology

1) Procedure

The procedure adopted for evaluation of the system alternatives is shown in the Figure 4-14 in which the following three steps are applied.

a) Formulation of alternatives
b) Evaluation of individual alternative basing on five evaluation criteria
c) Synthetic evaluation of all evaluated results

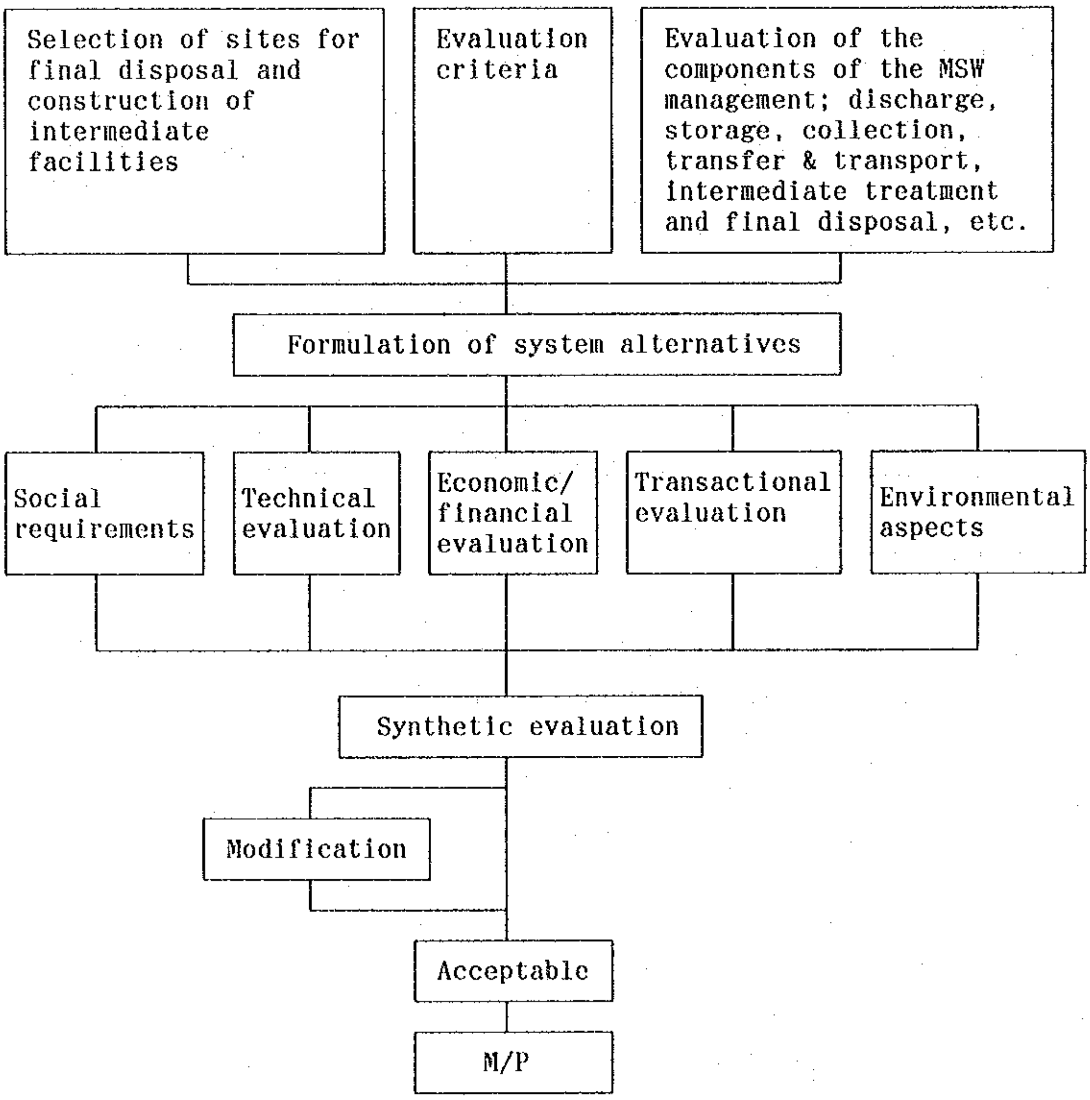
2) Evaluation criteria

The five evaluation criteria used for the evaluation of the system alternatives are:

a) Social requirements,
b) Technical evaluations,
c) Economic and financial evaluations,
d) Transactional evaluations, and
e) Environmental aspects.

The system alternatives identified are ranked on the basis of qualitative and quantitative examinations of each of the above-mentioned evaluation criteria.

Figure 4-14 Procedure for Evaluation of the System Alternatives



Note:

- Selection of the site for final disposal of the MSW was performed and is shown in the Section 5.3, and the site for the HHM2 construction was selected by Hungarian side.

- Evaluation of the components of the MSW management was performed and is shown in the Section 4.3.

(2) Social requirements

The public has come to pay much attention to environmental issues in Budapest through becoming aware of worldwide information concerning the environment through the mass media.
This phenomenon was confirmed in the JICA Study Team's public opinion survey.

The social requirements for the MSW management in Budapest were determined in our public opinion survey, and summarized as follows.

- The first requirement is to reduce the MSW volume generated.
- To recover reusable materials for recycling
- As one of the ways to reduce the MSW volume generated, an MSW incineration system is required.
- In any case, environmental protection is required.
- 1/3 of people require minimizing the number of the final disposal sites. Obtainability of the new disposal sites is very difficult in any case.

In this regard the Alternative-2 satisfies the requirements in the following ways.

- T/S system will be acceptable, because the numbers of collection vehicles will be reduced, and eventually air pollution problems in Budapest will be relieved to a certain degree.
- Construction of HHM2 will also be acceptable.
- In connection with the HHM2 construction, the necessity of obtaining the new final disposal sites in the future will remarkably be curbed, particularly in terms of long term operation.
- Electric power will additionally be generated in HHM2 as recycling.

(3) Technical evaluations

The technical evaluation of each system alternative will be examined in terms of the following five requirements.

Requirements	Break-down
Maturity of technology	- reliability - operational stability - operational efficiency
Degree of operational difficulty	- operational requirements - continuous operation
Required level of engineers and operators	- qualification for engineers and operators - license of operators - special education or training for engineers and operators
Present state of art	- employment of technology used in the world
Future trends	

1) In case of the system Alternative-1 ($I+L+P_1$)

- Maturity of technology to integrate the system Alternative-1 is definitely satisfied, but HHM1 does not fully satisfy reliability, operational stability and efficiency, even after modification due to insufficiently designed equipment.
- In the present worldwide situation of the MSW management systems, incineration systems are widely employed and considered the most appropriate type to reduce the generated MSW volume, landfilling is also still much in use.
- In the future, incineration systems will be kept in use widely, while landfilling systems will be minimized due to a lack of available land.
- Flue gas emission conditions of HHM1 will be improved to satisfy the new regulations.

- The Alternative-1 requires 4.5 million m^3 more of the final disposal sites than the Alternative-2 in terms of total system operational efficiency.
- The Alternative-1 requires 12 more collection vehicles than the Alternative-2.

In case of the system Alternative-2 ($T/S+Is+L+P_2$)

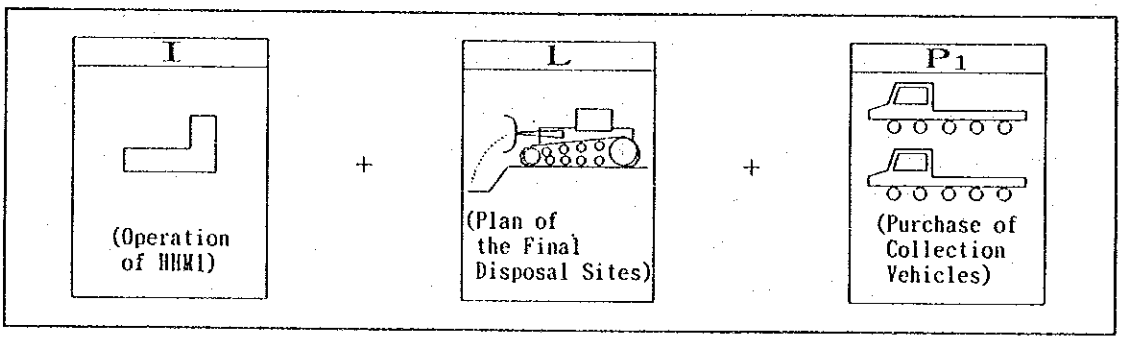
- With the sophisticated technologies of special boilers and flue gas cleaning system, the system Alternative-2 will ensure high operational efficiency of the compounded plants HHM1 and HHM2.
- For required level of engineers and operators to handle boiler, flue gas cleaning facilities and electrical and control equipment, special qualifications and license for HHM2 are required, but not for others. However, some training on site will be necessary.
- In the present worldwide situation of the MSW management systems, incineration systems are widely employed and considered the most appropriate type with the sufficient environmental protection facilities to meet the national legal conditions.
- T/S is also widely employed, particularly in the United States of America and Europe.
  In view of a lack of the final disposal sites in Budapest, a T/S system will be of much importance in the future from environmental and economic view points.
- In the future, incineration systems will be kept in use widely, while landfilling will be minimized due to a lack of available lands.
- With the effect of reliability and operational efficiency, the Alternative-2 can reduce much more combustible MSW than the Alternative-1.
- HHM2 can back up the lack of HHM1's capacity.

(4) Economic and financial evaluations

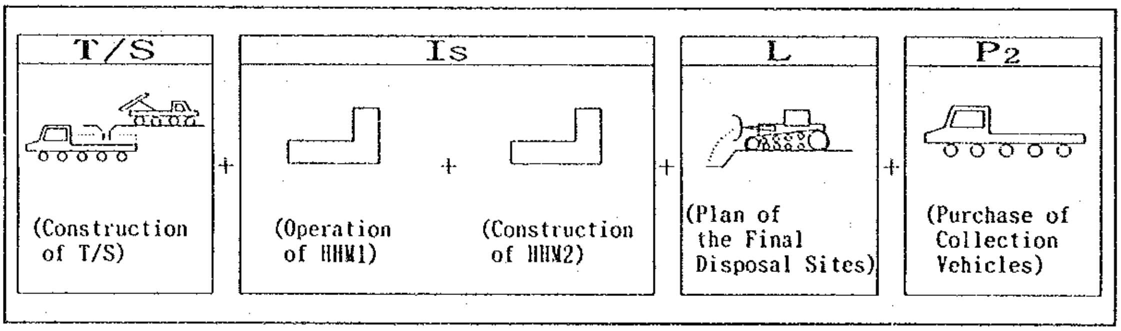
1) Definition of alternative scope

The scope of the two alternatives is defined as follows. The capital requirements for both are based on these scopes. The cost is estimated only for new investment and operation. Similarly, revenue is calculated only for new investment.

Alternative-1 $= I + L + P_1$



Alternative-2 $= T/S + Is + L + P_2$



a) Collection vehicles

New collection vehicles consist of two types of collection trucks namely trucks having a minimum of $12m^3$ and container trucks. Vehicles will be purchased depending on demand for the projected period (1994-2005).

b) Transfer station

The construction work of T/S will commence from 1997, and operation will start from the beginning of 1999 in accordance with the operation of HHM2. The cost estimate items for T/S consist of the following.

- Land acquisition
- Civil work
- Building construction
- Truck scale
- Compactor (50 HP/unit x 2)
- Dollying facility for container service
- Press container (24 m^3 x 15 sets)
- Container - trailer trucks (7 trucks)

c) New incineration plant

The specifications and conditions for the new incineration plant are defined in the Section 5.3.

d) New disposal site

The new final disposal sites are calculated based on the mass balance of the MSW, in case of the Alternative-1, the total of 20.2 million m^3 of the new disposal sites are needed, while in case of the Alternative-2, 15.8 million m^3 are needed for the project period.

2) Conditions used for estimate

The cost estimation is based on the following method and conditions. These conditions are also applied for cost estimation for the financial evaluation of the first priority project in the Chapter 10.

a) The estimated cost is presented in US Dollars.

b) The price level of the estimate is the beginning of 1993.

c) The exchange rate used is 1US$=84Ft=1.65DM=¥120.

d) The estimated cost for newly installed facilities, operation and maintenance are according to Hungarian data and quotations collected by the JICA Study Team during the third field survey.

e) The cost, insurance and freight, and local handling charges, account for 5% of Free On Board (FOB) prices.

f) The cost of imported machinery and goods includes 10% customs duty, 2% of customs clearance fee, and an average 3% statistical fee.

g) The cost of locally purchased machinery and material is estimated as including delivery to the site.

h) In utility cost, the public utility supplies such as water, natural gas and oil are charged 5% VAT, the chemicals and others are charged 25%.

i) All needed chemicals for the project are supplied by domestic manufacturers.

j) In the estimated personnel cost social security cost of 44% and 7% for unemployment insurance fee are included.

k) The projected site of HHM2 is located within the existing HHM1 site that belongs to the Budapest municipality so that land acquisition incurs no cost.

l) No new final disposal sites have been determined yet as contract basis. Therefore the construction cost for the final disposal sites is estimated on a unit price per cubic meter basis and all necessary land is assumed to be rent.

m) The engineering services fee (Consultant engineering fee) is estimated only for HHM2. This fee includes licensing or purchasing manufacturing drawings of the boiler and overhead cranes in HHM2.

n) The revenue consists of incineration fees, final disposal fees and sales revenues from power supply. The estimation for each item is shown in the Table 4-9.

o) As for revenue, the container leasing fee and collection fee are assumed to be the same in both cases, and these are not new revenue sources, so they are not compared in the Table 4-9.

p) The service fee in the estimate is assumed to be the 1993 fee tariff including 6% VAT.

3) Cost estimation and financial comparison

The Tables 4-7 to 4-9 summarize main cost and revenue items. On the basis of comparing the cost and revenue of both alternatives, the following advantages and disadvantages are noted (Table 4-10).

a) There is more than a seven-fold difference in investment costs between the Alternatives. In the Alternative-1, only the investment costs for the new final disposal sites and purchasing new vehicles are needed, while in the Alternative-2 the costs for several new items are incurred. Especially. the investment cost for a new incineration plant makes a big difference between the estimates.

b) The cost difference in operation and maintenance is narrower than the investment cost, however, there is still a 1.2-fold difference. The Alternative-2 costs more than the Alternative-1.

c) In terms of revenue, however, the Alternative-2 is slightly higher (1.25-fold) than the Alternative-1. The main factor is that the service fee, for final disposal, is higher than the incineration fee under the present service fee system.

d) Revenue from energy sales contributes little to the profitability of the project.

Table 4-7 Cost Estimation for Fixed Capital Investment (1994 - 2005)

Unit: Thousand US$

	Alternative-1	Alternative-2
Transfer Station	-	4,311
Incineration Plant	-	257,763
Final Disposal Sites	33,080	24,233
Collection Vehicles	6,994	4,536
Total	40,074	290,843

Note: The above investment cost includes Import Duty and VAT, but excludes Interest During Construction (IDC).

Investment Schedule for the Alternative-2

Unit: 1,000 US$

Items	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Transfer Station	-	-	-	1,724	2,587	-	-	-	-	-	-	-
Incineration Plant (HHM2)	-	24,441	77,774	77,774	77,774	-	-	-	-	-	-	-
Final Disposal Sites	10,714	-	-	-	-	-	9,543	-	-	3,976	-	-
Collection Vehicles	1,695	848	445	445	445	212	-	-	-	-	-	446
Total Investment Cost	12,409	25,289	78,219	79,943	80,806	212	9,543	0	0	3,976	0	446
Financial Burden to Municipality (%)	1.63	3.33	10.31	10.54	10.66	0.02	1.26	0	0	0.52	0	0.06

Note: Financial burden to the municipality bases on the case that the municipality totally finances and manages the master plan project.

Table 4-8 Cost Estimation for Operation and Maintenance (1994 - 2005)

Unit: Thousand US$

	Alternative 1	Alternative 2
Transfer Station (1999-2005)	-	290
Incineration Plant (1999-2005)	-	11,967
Final Disposal Sites *1	19,271	14,288
Collection and Transportation	13,139	11,991
Total	32,410	38,536

Note: *1 including covering soil cost and bulldozers.

Table 4-9 Revenue Estimation (1994 - 2005)

Unit: Thousand US$

	Alternative-1	Alternative-2
Incineration Fee		
(A) = MSW collected by FKFV Total incineration volume at HHM2 x 90% x 1.4US$/m3	-	14,112
(B) = MSW collected by others Total incineration volume at HHM2 x 10% x 1.90US$/m3	-	2,128
Sales Revenue from Power Supply Total power generation - own power consumption x 2.72Ft/kwh	-	14,282
Final Disposal Fee *1		
(A) = final disposal volume x 0.90 x 1.4US$/m3 (brought by FKFV)	45,304	31,960
(B) = final disposal volume x 0.10 x 3.15US$/m3	11,327	7,992
Total	56,631	70,474

Note: *1 Fee for disposing residue and ash from incineration plant is included in Incinaration Fee.

Table 4-10 Financial Comparison for the Alternatives (1994 - 2005)

	Alternative-1	Alternative-2
Total Investment Cost (Million US$)	40.1	290.8
Total Operation Cost (Million US$)	32.4	38.5
Total Revenue (Million US$)	56.6	70.5
Landfill Saving Effect (thousand cub.m)	0	-4,450

e) In comparison between operation/maintenance cost and revenue over the projected period, the revenue exceeds the operation/maintenance cost by a great margin in both cases. That means the operation/maintenance cost is within the present revenue structure.

f) The Alternative-2 will have a cash shortage after 1999 (started operation of HHM2) due to inbalance between the investment cost plus operation cost and revenues.

In this case, however, the economic, social factors for the project and socioeconomic benefits as well as political backgrounds in connection with the decision of the Budapest City General Assembly, which agreed with the necessity of HHM2 should be taken into account for making judgement. First of all, there is the major premise of considering the Master Plan of the MSW management system in Budapest, that is the acquisition of the new final disposal sites is in practice very difficult for the municipality.

Newly required final disposal sites in both cases for the project period are 20,250 million m^3 in the Alternative-1 and 15,800 million m^3 in the Alternative-2 respectively. It is more natural to judge that the municipality will find it rather difficult to get all of the necessary sites. As a matter of fact, the effect of reduction of final disposal volume (that is, area of sites needed) should be regarded as the first priority even from a financial view point.

The benefit of executing the MSW management by the municipality is considered as equal to the cost which will occur if the municipality does not execute the MSW management work. In this case, the Budapest citizens have to rely on private companies (if there are any) for the MSW management or they have to manage it by themselves.

The main cost to individual households to dispose of solid waste by themselves is the cost of acquiring the land to do it. In case of the Alternative-1, if disposal sites are not acquired at all, the total 20.250 million m^3 disposal sites would be acquired by citizens anyhow. 20.250 million m^3 can be converted to 20.250 million m^2 for 1 m landfill-depth. (The conversion factor from landfill volume to landfill area varies according to the depth of the landfill but, in this case, the depth is assumed to be 1 m so the conversion factor will be 1.)

The average land cost in Budapest was estimated as 2,500 Ft/m^2 in 1992, so that it could be calculated the total land cost is 50,625 million Ft (602.6 million US$). This does not include the operation cost of waste disposal. The amount of the total land acquiring cost much surpasses the project investment cost of the alternatives. (The Budapest citizens live mostly in public apartment houses so that to materialize the above idea is difficult practically.)

Regarding the effects of reduction of the final disposal site volume in the alternatives, for the Alternative-2 there could be a saving of a capacity of 4.450 million m^3 but this is only calculated up to the year 2005. Taking the lifetime of an incineration plant into consideration, the equivalent of two more same capacity disposal sites can be saved.

In the same way as above, reduction of the necessary disposal site area (4.450 million m^3 x 3

= 13.350 million m^3) can be converted, to 13.350 million m^2, and it can be calculated that the total land acquisition cost is 33,375 million Ft (397 million US$). This cost estimation is a multiple of 1.3 of the Alternative-2 project investment cost.

This cost estimation and preliminary economic analysis are made on the basis of various assumptions, but the above-mentioned premise, namely that the acquisition of the new final disposal sites is in practice very difficult for the municipality, is one of the most important factors for selecting new countermeasures for the future MSW management in Budapest.

If the municipality cannot secure the necessary capacity of the final disposal sites, the MSW management cannot be carried out.

On the other hand, the cost of waste treatment by individual households is higher than the projected investment cost. From these viewpoints, the Alternative-2 is more realistic. This is because the land acquisition cost is taken into consideration; the Alternative-2 has the least cost in preliminary economic analysis.

Further economic evaluation of the incineration plant project is examined in the Chapter 10.

(5) Transactional evaluations

1) Steps to put a system into practice

Whatever the most appropriate system alternative is, nothing will happen without effective step to put the system into practice.

Special circumstances in Hungary, such as the shift to a free economy and economic instability, should be taken into account.

2) For both system Alternatives-1 and Alternative-2

a) Transfer station system for the system Alternative-2

In order to make a success of this system, the following steps should be taken.

- To purchase the land to construct the T/S facilities at a closed final disposal site such as the Akna site as the first priority
- To carry out the EE for the T/S construction site
- To take into account necessary countermeasures for environmental protection
- To obtain public understanding and cooperation by adopting environmental protection measures in the planning of T/S

The public should participate in the planning, particularly in the EE stage.

b) Final disposal

Prior to discussing final disposal, it is very important to recognize today's situation.
There is an absolute lack of the final disposal sites in Budapest city, and the Budapest Capital City Government has recently been driven to obtain the new final disposal sites not only in but also outside the city.

In view of this fact the following should be carried out to implement the M/P effectively and on schedule, and to improve the MSW management in Budapest.

The Budapest Capital City Government has the responsibility for the MSW management in all city areas, and local district governments and land owners are asked to be involved in planning for obtaining the new final disposal sites as a matter of first priority for Budapest.

In this, the Budapest Capital City Government has to put into practice the following as common concepts for both alternatives.

- To show the absolute necessity of the final disposal sites in the MSW management system in the city in the long term
- To let other interested parties participate in the planning from the initial stage, for example in an EIA study
- To consider an environmental monitoring system not only during an operational period but also after accomplishing the disposal for a few years
- To plan to reuse closed sites in a way which will be favourable to the public and land owner
- To strengthen the present organization of the Budapest Capital City Government

3) Incineration system

Although incineration systems for the MSW have widely been put into practice all over the world, the environmental protection measures in some cases are not adequate because of poor technology or insufficient financing.

In this respect it will be absolutely necessary to obtain public consent by taking into account the technologies and facilities needed to satisfy the environmental conditions that are legally specified.

Prior to the detailed design of all facilities for HHM2, the result of the EE carried out will be fed back to the detailed design to ensure good performance of the facilities.

(6) Environmental aspects

In the MSW management, the main environmental impacts to be discussed are air (including odor), soil and water pollution, noise and vibration. The present situation as well as the environmental issues are listed in the Chapter 3. In this Section, the two alternatives are compared from the environmental point of view with the results of the EE Study. The environmental effects, related to the construction phase, or related to the location of future plants (landscape, fauna, flora), will be described in the Chapter 11 on the EE study.

The main difference between the two alternatives can be found in the intermediate treatment and consequently in the need for the final disposal site capacity.

It seems more convenient to study one by one the elements included in two alternatives and to finally summarize the environmental evaluation in a matrix.

In both system Alternatives-1 and Alternative-2

1) Transfer Station for the system Alternative-2

It is very clear that environmental effects from traffic due to the rational functions of T/S for HHM2, by reducing the number of collection vehicles between T/S and HHM2, will be of considerable importance in comparison of both alternatives.

2) Incineration plant HHM1

In the present state, HHM1 does not comply with the requirements concerning air and water pollution. The flue gas treatment system will be improved in the near future.
HHM1 has the special permission to exceed the salt concentration in the effluent discharged into the public sewage system, given by the local environmental authority. Actually, there is no planned schedule for the improvement of this situation.
It is necessary to consider in the evaluation that, in the future, HHM1 will comply with the regulations. In that case, the impacts on the air, the water and consequently on the soil will be extremely reduced, since the regulations are very severe (compared to the EC standards for example). Not only the flue gas, effluent water, noise and vibration but also particularly the disposal of ash to be generated from the incineration process may cause adverse effects on the environment. Actually ash and residues are not considered by the legislation as hazardous waste; the residues and ash are disposed of at the final disposal site now.

Actually no noise or odor problems seem to occur in the neighborhood of the plant.

3) Incineration plants HHM1 and HHM2

The construction of HHM2 in addition to HHM1 will have a good effect on the overall environmental situation because it will decrease substantially the amount of the MSW to be landfilled and it will be designed to comply with the regulations (air, water, noise).

By the construction of HHM2, the environmental impact sources such as incineration residue and ash from HHM1 will also be treated in HHM2, when the regulations concerned are established in Hungary, and the treated water from HHM1 will be reused in HHM2 by means of a closed system.

4) Landfilling

The major problems related to the final disposal sites are explained in the Section 3-7.
Depending on the final disposal site soil conditions, the contamination of the ground water and of the soil is the main element to be considered.

In case such contamination is clearly caused by the residues and ash from incineration, this kind of problem can be reduced with the use of soil instead of incineration ash and residues as covering material.

At present protective layers on all the surfaces of the final disposal sites and leachate collectors are not installed, except for a clay layer on the bottom.

A minimum requirement is needed to improve the present situation related to the HHM1 operation and the operating final disposal sites by complying with the legal and social requirements. In this respect HHM2 is designed to be free by reducing environment impacting sources. In consideration of further improvement for the future, legal regulations on handling of incineration ash in particular, will be legislated because it is likely to contain heavy metals and harmful materials.

(7) Synthetic evaluation

On the basis of evaluation results carried out according to the procedure of the Figure 4-14, a synthetic evaluation is performed in the following manner. In this evaluation the results of the decision of the Budapest City General Assembly, which agreed with the necessity for the HHM2 construction was considered as well for selection of the most favorable alternative. The evaluation results are indicated in the Table 4-11.

<u>The Evaluation of the Two Alternatives</u>

1) Evaluation Criteria
   i) Social Requirements
   ii) Environmental Aspects
   iii) Economic and Financial Evaluations
   iv) Technical Evaluations
   v) Transactional Evaluations

2) Examination and Setting of Priorities for Evaluation Criteria

(i) Necessary Items of Examination

- The items that need to be examined in this Study concern the effective improvement of present and future issues of the MSW management system of Budapest. That is, the top priority is to improve the present MSW management system and establish a system that will meet the requirements of the society in the future.
  Measures that should be given a top priority in this Study are the following.
  * incineration of the combustible MSW
  * final disposal of the MSW at the sanitary final disposal sites

- Environmental protection measures are socially demanded as a measure for prerequisite of each measure.
- Financial burdens are inevitable for the realization of improvements in the MSW management system.
- Since the technology required to solve the issues of the MSW management system is already established, no technological difficulty would be existed.

Taking consideration on the order of importance as stated above, the order of evaluation criteria should be determined.

(ii) Prioritization

In view of the above considerations, the order of priority of evaluation criteria was decided as shown below.

1 Social Requirements
2 Environmental Aspects
3 Economic and Financial Evaluations
4 Technical Evaluations
5 Transactional Evaluations

The qualitative evaluations of the Alternatives-1 and Alternative-2 to the evaluation criteria given above were performed as shown in the Table 4-11.
Qualitative evaluations were made for more specific subcriteria of the above each evaluation criteria.

The evaluations were performed by the JICA Study Team with the cooperation of Hungarian side according to the following procedure.

Four evaluation ranks, A, B, C and D were used, with A presented the best, B presented the better, C presented the worse and D presented the worst.

D signifies a critical factor for the implementation of the alternative and when an alternative has an item evaluated as D, the implementation of that alternative is deemed extremely difficult.

(iii) Results of Evaluation

14 items in the Alternative-2 were ranked A while seven items were ranked A and one item was ranked D for the Alternative-1. Taking into account of the decision of the Budapest City General Assembly, which agreed with the necessity of HHM2 in addition to these results, the Alternative-2 was selected as the M/P.

Table 4-11 Evaluation of the Two Alternatives for the MSW management

Evaluation Criteria	Evaluation Subcriteria	Alternative 1	Alternative 2	Remarks
Social Requirements	1. Obtaining of the new final disposal sites	D	B	- By the year 2005, the Alternative 1 (Alt-1) will require approximately 4.5 million more m³ of reclaiming space than the Alternative 2 (Alt-2). - This means that, if the Alt-1 is adopted reclamation sites must be sought outside the Budapest city area and a regional waste disposal system will become necessary by the year 2005. - It is therefore expected that many social, political and technical issues will be encountered for the Alt-1. - Although the Alt-2 provides a larger time margin than the Alt-1, consideration of similar measures will still be necessary. - From the above, the Alt-1 is given D evaluation and the Alt-2 is given B evaluation
	2. Land efficiency in terms of the MSW disposal volume per m² of site area to be utilized for the MSW disposing $\frac{\text{MSW disposal volume (m}^3\text{)}}{\text{Required area for final disposal and incineration (m}^2\text{)}}$	B	A	- The quantity of the MSW treated or disposed (m³) per site area (m²) required by the MSW management facility (incineration plant or final reclaiming disposal sites) is: For the Alt-1: Final disposal + BY HHM1 $\frac{40,587,000}{3,218} + \frac{8,033,000}{30,000} = 815.9$ m³/m² For the Alt-2: Final disposal + By HHM1 + By HHM2 $\frac{31,057,000}{2,547} + \frac{7,830,000}{30,000} + \frac{5,090,000}{22,000}$ = 1,304 m³/m²
	3. Social acceptance	C	A	- Since there is a possibility that the final disposal sites outside the Budapest city will be required in the future, the execution of wide area cleaning activities is required. - Agreement with neighboring municipalities and residents will be necessary for regional waste disposal activities. Political and administrative difficulties may arise in this case.
	4. Resource Recovery	B	A	- The waste energy recovery for the Alt-2 is bigger than that of the Alt-1.

Evaluation Criteria	Evaluation Subcriteria	Alternative 1	Alternative 2	Remarks
Environmental aspects	1. Quantity of air pollutants and CO_2 in flue gas	A	C	The Alt-1 is superior to the Alt-2, because air pollutants and CO_2 in flue gas will increase with increasing amounts of the combustible MSW incinerated.
	2. Quantity of CH_4 generated from the final disposal sites	C	A	The Alt-2 is superior to the Alt-1, because CH_4 generation is proportional to the amount of the combustible MSW to be disposed at the final disposal site.
	3. Ground water contamination	B	A	Possibility of ground water contamination chiefly depends on the amount of the MSW to be disposed at the final disposal site.
	4. Odor from the final disposal sites	B	A	Possibility of odor generation chiefly depends on the amount of the MSW to be disposed at the final disposal sites.
	5. Pollution due to collection and transportation	B	A	Possibility of pollution due to the collection and transportation vehicles chiefly depends on the number of the vehicles required after construction of the transfer station, therefore the Alt-2 is superior to the Alt-1.
	6. Spreading of environmental impacts	B	A	Spreading of environmental impacts depends on the number of the final disposal sites, therefore, the Alt-2 is superior to the Alt-1.
	7. Residue and fly ash	A	B	Quantities of residue and ash depend on the capacity of an incineration plant, therefore, the Alt-1 is superior to the Alt-2.
Economic and financial evaluation	1. Total investment costs of each alternative	A	C	Necessary expense for the Alt-1 is 40,074 x 10^3 US$. Necessary expense for the Alt-2 is 290,843 x 10^3 US$.
	2. Total operational costs (1994-2005) of each alternative	A	C	Operational cost for the Alt-1 is 32,410 x 10^3 US$. Operational cost for the Alt-2 is 38,536 x 10^3 US$.

Evaluation Criteria	Evaluation Subcriteria	Alternative 1	Alternative 2	Remarks
Economic and financial evaluation	3. Effect in creating opportunity of employment and economic effect due to the construction of the facilities.	B	A	The Alt-2 will provide more employment opportunities.
	4. Burden on individuals in preserving good environment	A	B	If, in the future, collection fees are to be collected from the residents in order to secure revenue increases for the municipality, the influence to residents will be greater for the Alt-2 due to the higher investment cost.
	5. Total revenue (1994 - 2005)	B	A	Revenue of the Alt-1 will be 56,631 x 10^3 US\$. Revenue of the Alt-2 will be 70,474 x 10^3 US\$.
Technical evaluation	1. MSW disposal technology	A	A	Adequate technologies can be used for both alternatives.
	2. Effect for reducing the MSW volume to be hauled to the final disposal sites up to 2005	C	A	The Alt-2 has a better reducing effect.
Transactional evaluation	1. Intricacy of administration and organization required for implementation of Alternative	A	B	This is proportional to the technologies to be applied.
	2. Necessity of EIA Study and its cost	B	A	EIA is required for the construction of each final disposal site and each incineration plant.
	3. Necessity of countermeasures for the public in the vicinity of the facilities	C	A	The Alt-1 is disadvantageous in that a greater number of the final disposal sites will be required.
Results		A = 7 B = 9 C = 4 D = 1	A = 14 B = 4 C = 3 D = 0	

4.4.2 Municipal Solid Waste Mass Balance of Each Alternative

Explanation

(1) Generation of waste

During the JICA Study Team's field survey it is found that 69% of the generated MSW is a potential object for incineration, and the remaining 31% of the incombustible wastes to be directly disposed of at the final disposal sites. (Table 4-12).

(2) Final disposal

The factor 0.85 is the compaction ratio of the residues and ash and similar materials, and 0.5 is that of the MSW which consists mainly of organic combustibles.

Table 4-12 MSW Mass Balance

Alternative - 1 (I+L)

Unit: 1,000 m^3

	YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Generation	(A) Total amount	4423	4246	4323	4323	4323	4409	4498	4588	4679	4773	4868	4966	5065	5166	5270	5375
	(1) waste for the purpose of incineration (69%)	3045	2923	2976	2976	2976	3035	3096	3158	3221	3286	3351	3419	3487	3556	3628	3700
	(2) waste not to be hauled to incineration (31%)	1378	1323	1347	1347	1347	1374	1402	1430	1458	1487	1517	1547	1578	1610	1642	1675
Volume Reduction	HHM1	1040	1710	2100	2100	2100	2100	1900	1700	1700	1000	1000	2100	2100	2100	2100	2100
	HHM2																
	Recycle	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2
	(B) Sub. Total	1043	1713	2103	2102	2102	2102	1902	1702	1702	1002	1002	2102	2102	2102	2102	2102
Final Disposal	(C) Residue and Ash	104	171	210	210	210	210	190	170	170	100	100	210	210	210	210	210
	(D) (A)-(B)	3380	2533	2220	2221	2221	2307	2596	2886	2977	3771	3866	2864	2963	3064	3168	3273
	(E) Covering soil	1	1	2	84	84	87	96	104	107	130	134	105	109	112	116	119
	(F) Sub. total After disposal (compaction) C×0.85+D×0.5+E	1779	1413	1291	1373	1373	1419	1556	1692	1740	2101	2152	1716	1769	1823	1879	1934
Balance	(G) Free vol. of operating Site																
	(1) Existing Site	6463	4684	3271	1980	1307	8934	7515	5959	4267	2527	426	3074	1358	4039	2216	2337
	(2) New sites				700	9000						4800		4450		2000	
	(3) Renovate Site																
	(G)-(F)	4684	3271	1980	1307	8934	7515	5959	4267	2527	426	3074	1358	4039	2216	2337	403
	+: enough site cap. -: not enough site cap.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

Table 4-12 MSW Mass Balance (continued)

Unit: 1,000 m^3

Alternative - 2 (Is+L)

		1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
	YEAR	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Generation	(A) Total amount	4423	4246	4323	4323	4323	4409	4498	4588	4679	4773	4868	4966	5065	5166	5270	5375
	(1) waste for the purpose of incineration (69%)	3045	2923	2976	2976	2976	3035	3096	3158	3221	3286	3351	3419	3487	3556	3628	3700
	(2) waste not to be hauled to incineration (31%)	1378	1323	1347	1347	1347	1374	1402	1430	1458	1487	1517	1547	1578	1610	1642	1675
Volume Reduction	HHM1	1040	1710	2100	2100	2100	2100	1900	1700	1700	1000	1100	1819	1887	1956	2028	2100
	HHM2										1600	1600	1600	1600	1600	1600	1600
	Recycle	3	3	3	2	2	2	2	2	2	2	2	2	2	2	2	2
	(B) Sub. Total	1043	1713	2103	2102	2102	2102	1902	1702	1702	2602	2702	3421	3489	3558	3630	3702
Final Disposal	(C) Residue and Ash	104	171	210	210	210	210	190	170	170	260	270	342	349	356	363	370
	(D) (A)-(B)	3380	2533	2220	2221	2221	2307	2596	2886	2977	2171	2166	1545	1576	1608	1640	1673
	(E) Covering soil	1	1	2	84	84	87	96	104	107	85	85	68	69	71	72	73
	(F) Sub. total After disposal (compaction) C×0.85+D×0.5+E	1779	1413	1291	1373	1373	1419	1556	1692	1740	1392	1398	1131	1153	1177	1200	1224
Balance	(G) Free vol. of operating Site																
	(1) Existing Site	6463	4684	3271	1980	1307	8934	7515	5959	4267	2527	1135	4537	3406	2253	3076	1876
	(2) New sites				700	9000						4800			2000		
	(3) Renovate Site																
	(G)-(F)	4684	3271	1980	1307	8934	7515	5959	4267	2527	1135	4537	3406	2253	3076	1876	652
	+:enough site cap. -:not enough site cap.	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+

CHAPTER 5 MASTER PLAN

5.1 Goals, Targets and Policy of the Master Plan

5.1.1 Goals of the Master Plan

The goal is to ensure a beautiful and clean living environment by overcoming the present issues of the MSW management in Budapest.

The goal of the M/P will be achieved practicing the following matters.

- As a rule, to contain management of all the MSW generated in Budapest within the city

- To establish an adequate MSW management system in consideration of environmental protection

- To reduce the MSW volume before collection (by means of separate collection, etc.)

- To reduce the MSW volume after collection

- To minimize potential environmental impact in the MSW management system

- To strengthen present organization to enable it to set up the most suitable MSW management system to cope with various environmental changes in the future

5.1.2 Targets of the Master Plan

- To secure and construct the new final disposal sites as follows:
  By 2005, the disposal sites of 16,500 x 10^3 - 20,950 x $10^3 m^3$ are to be secured in accordance with a system alternative to be selected.

- To introduce a new fee collection system to strengthen the financial capacity for the MSW management activities of the Budapest Capital City Government

- To establish a suitable intermediate treatment system to reduce about 70% of the combustible MSW volume generated in 1999 and 90% in 2005

- To establish a Transfer Station (T/S) by the end of 1998 and secure collection vehicles to cope with the increase of the MSW in the future

- To continue experimentation with separate collection in order to establish a resource recovery and recycling system by the year 2000

- To establish the technical guidelines for the disposal of incineration residue and ash by 1994, and to review the present disposal system based on the guidelines to be established

- To adopt a sanitary landfill method for the new final disposal sites by purchasing bulldozers after 1994

- To set up a specific section, to strengthen the present organization of the Department of Communal Matters, with ten experts to manage the following matters by 1995

  1) Implementation and supervision of the M/P
  2) Control of information and data concerning the MSW management
  3) Research and development of the MSW management system by separate collection, recycling, treatment by composting and a new fee collection system, etc.
  4) Strengthening of cooperative relationships between the residents and the Budapest Capital City Government in the MSW management system
  5) Supervision of FKFV

- To strengthen the present organization of FKFV particularly related to general management for the public relations and the technical department by 1998

5.1.3 Planning Policy of the Master Plan

In order to formulate the M/P the following concepts will be integrated into the policy.

(1) To create the cleaner and environmentally better Capital City of Budapest in association with:

- Identification of issues in the present MSW management in Budapest,
- Formulation of alternatives to improve the present situation, and
- Implementation of the selected system alternative (M/P).

(2) To respect the nature and environment of Budapest with the adequate MSW management system technologies, for which the following should be considered

- Environmental evaluation
- Establishment of guidelines and regulations

(3) To consider the positive participation of the public to create their better environment, for which the following should be very essential

- In Budapest, the environment surrounding the MSW disposal management is becoming increasingly difficult. Under such circumstances, it is necessary that the NIMBY (Not In My Backyard) syndrome be eradicated in order to solve the issues for the MSW management. Positive and responsible actions for public education and public relations by the Budapest Capital City Government, FKFV, etc. are necessary.

- People have to participate in the MSW management. For example, people should be involved in implementation of a system of resource recovery and recycling as well as the separate collection of hazardous wastes in the future.

5.2 Municipal Solid Waste Collection and Transportation

In order to deal with the increase of the MSW generation by 25%, approximately one million m^3 in 2005, it is necessary to increase the number of collection vehicles in connection with the establishment of T/S.

(1) Transfer Station (T/S)

The MSW to be generated in the southern part of the city has to be handled by T/S where the collected MSW by the existing collection vehicles in use with capacity (i) over 12 m^3, (ii) 12 m^3 and (iii) less than 5 m^3 will be transshipped to detachable specifically designed containers with a capacity of 24 m^3.

A compaction machine with a compaction ratio of 1:5 will be installed for transferring the pressed MSW to the container (Figure 5-1).

(2) Location of T/S

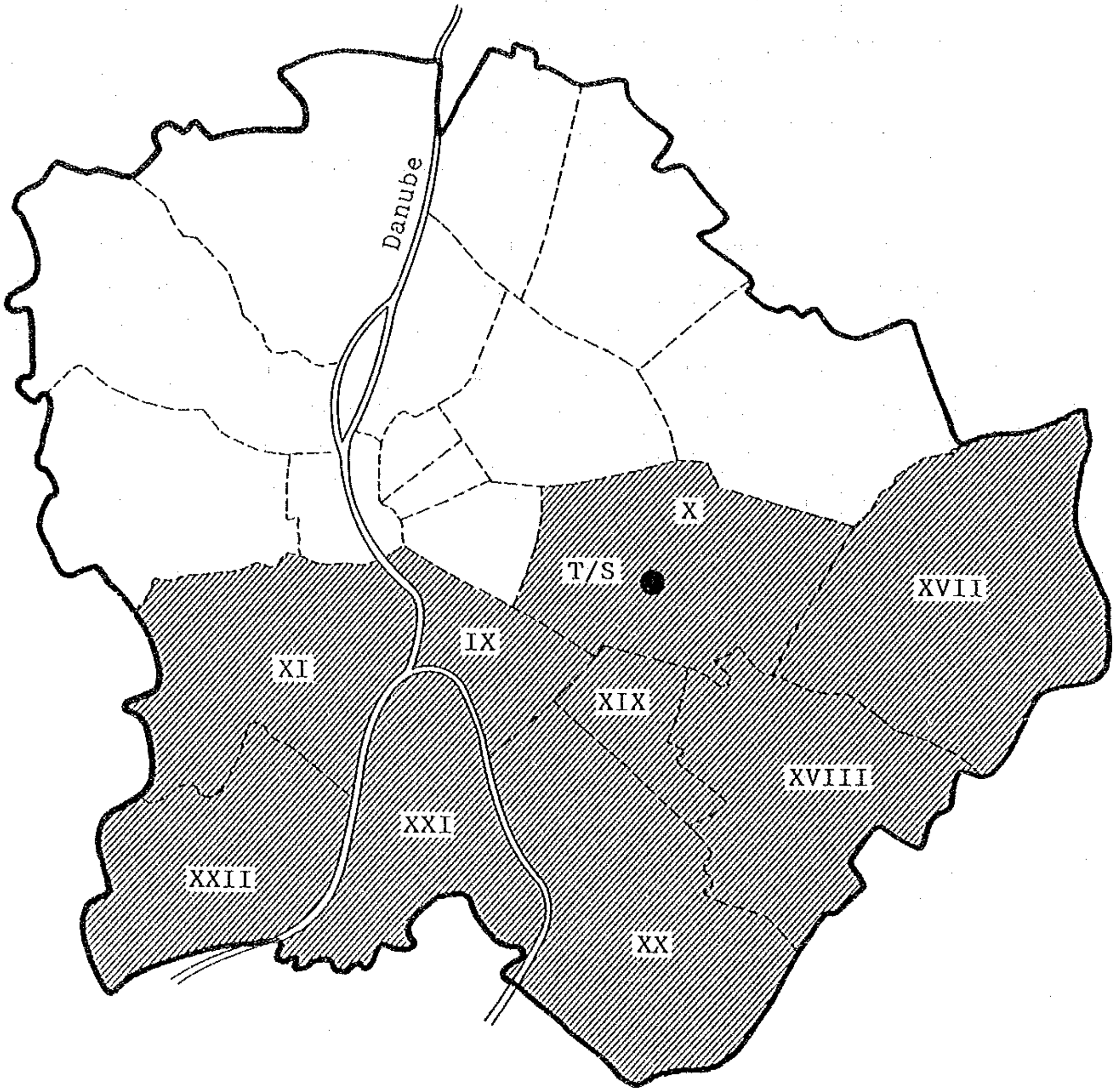
According to FKFV's report, the MSW to be generated in the southern area is 1,350,000 m^3/year (200,000 t/year) in 2005, which will be hauled to the Akna final disposal site if HHM2 is not constructed.

For selecting the location of T/S the following factors were taken into account and evaluated.

- No traffic disturbance and good accessibility
- Location to be as equal distance as possible from each southern district
- Easy acquisition of land
- Less environmental effects
- Less cost for land purchasing
- Enough space for construction of T/S

With the precise evaluation of the factors the Akna final disposal site was selected by the Budapest Capital City Government as the most suitable location with an additional advantage in terms of land reuse after the completion of the MSW disposal.

Figure 5-1 Location of T/S with Collection Areas



Note: The MSW from shadowed areas is hauled to T/S.

(3) Capacity of T/S

As mentioned in sub-section (2), 200,000 t/year of the MSW will be dealt with by T/S in 1.4 ha area with 260 working days for the MSW collection schedule in 2005; 770 t/day will be the capacity.

T/S will reduce the number of the MSW transport trips, between T/S and HHM1 and HHM2 by container trailers trucks. Only 49 trips will be enough for this press-containers with 18-ton payload container-trucks. Capacity of 18 tons will be legally allowed in terms of traffic load. With an assumption of seven trips per day for each container trailer truck, seven trailer trucks in total will be enough to transport the MSW to HHM1 and HHM2. However, in consideration of operational fluctuation and unexpected happenings the final numbers of containers and container trailer trucks should be decided.

(4) Plan of T/S with seven operators

Major equipment of T/S will be as follows.

- 2 lines of compactors
- 2 hoppers
- Container moving facility
- 15 containers
- 7 container trailer trucks
- 1 truck scale
- Civil engineering works and building for administration
- Wastewater treatment system
- Miscellaneous

(5) Implementation

Construction will be completed by 1998 after starting in 1997 and operation will be commenced from the beginning of 1999, jointly with the start of HHM2 operation.

(6) Number of collection vehicles

Two major strategies can be considered in deciding on the number of collection vehicles needed in 2005.
One is to increase the number of vehicles to meet a demand for the increasing MSW generation volume; the other is to purchase new vehicles for replacing aged ones to ensure transporting efficiency. In the evaluation of the two, increasing the number of collection vehicles with capacity over 12 m^3 and purchase of new vehicles for replacing the aged ones will obviously be important, economically and functionally.

FKFV has already decided to purchase 15 collection vehicles with a capacity over 12 m^3 in 1993.
This was discussed in the Section 4.3; purchasing plan of collection vehicles is presented in the Table 4-3.

5.3 Plan for the Municipal Solid Waste Intermediate Treatment

The municipal solid waste incineration plant in terms of mass-burning of the MSW will contribute to remarkable volume reduction and neutralization of the MSW and utilization of waste heat to be generated in the plant, resulting in improvement of the environment with installation of adequate equipment.

An incineration system can be friendly to the environment and economical if properly designed and operated.

Flue gases will be a source of potential air pollutants from incineration, so that prudently selected technologies and measures for environmental protection must be employed to satisfy the environmental regulations and standards of Hungary.

<u>Objectives</u>

- By means of incinerating the MSW to be generated in Budapest, the life of the present and future final disposal sites should be increased.

- Through the fully continuous operation of HHM1 and HHM2, electric power will be effectively generated and sold for contribution to economical operation.

- Minimal impact on the environment. In order to comply with the Hungary's emission standards, the flue gases will be cleaned with a semi-dry type system consisting of a quenching reactor by means of chemical reaction with $Ca(OH)_2$ and activated carbon, followed by bag filtering for removing dust and other pollutants. In addition, two 80m height stacks with nozzle effect will assure adequate gas dispersion.

- An effluent water free type plant is planned with the following measures.

  . Recycling the treated wastewater to the ash discharging system

  . Adopting a semi-dry type system for flue gas cleaning

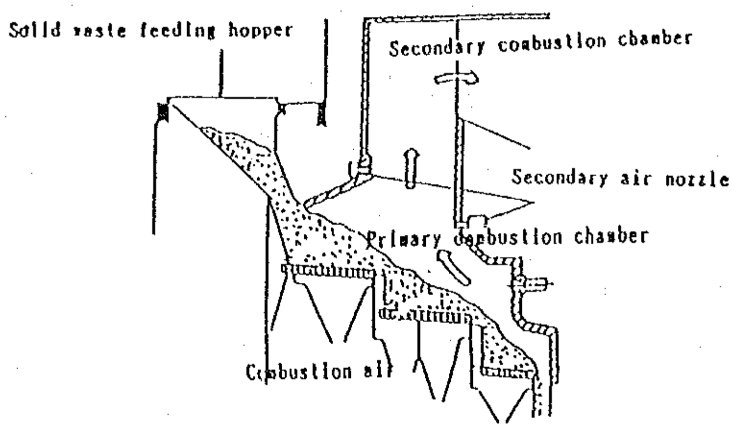
  . Adopting the air-cooled type steam condenser

In this Chapter the major related equipment and methods presented as several alternatives are examined below.

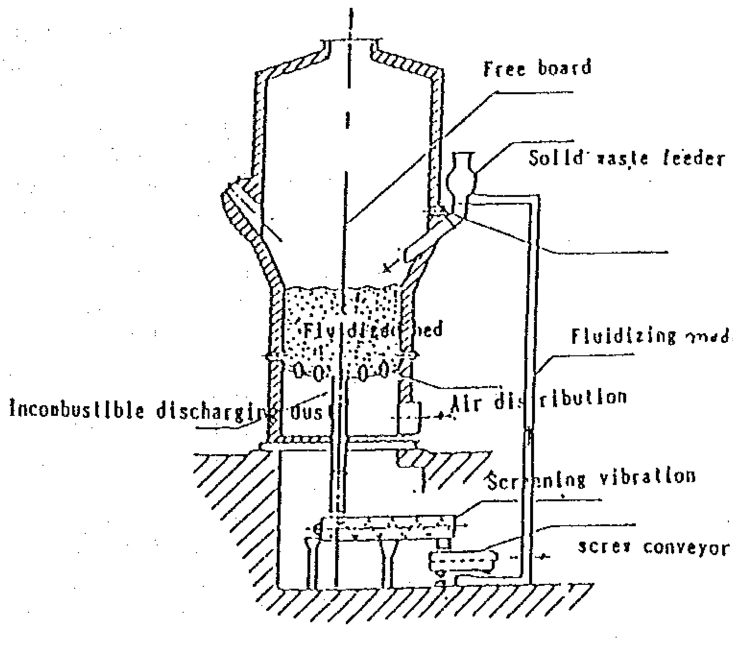
(1) Comparison of type of furnaces

There are, in general, three types of waste combustion furnaces in use now. They are the stoker type (ST), fluidized bed type (FB) and rotary drum type (RD). Comparative evaluation of these types of combustion furnace is summarized in the Table 5-1. From a technical viewpoint, the stoker is the best with a wide applicable range for different kinds and characteristics of the MSW. In addition, the capacity of the stoker type furnace allows variation of the load from a few tons per day to over one thousand tons per day. Therefore, in selection of the type of combustion furnace, especially in case of the capacity over 300 t/day, the stoker type furnace should be considered. Each type furnace is shown in the Figure 5-2.

Figure 5-2 Type of Furnace



Stoker type furnace



Fluidized bed type furnace

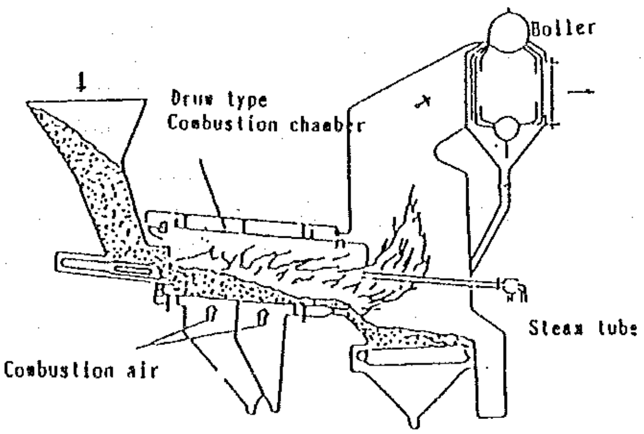


Table 5-1 Comparative Evaluation of Combustion Furnaces

Comparison item		Type of combustion furnace ST	FB	RD	Remarks
Feeding system		o	x	△	FB needs preseparation of waste by size
Furnace	Furnace capacity	o	x	x	FB and RD do not have capacity of over 200 t/24 h
	Combustion efficiency	△	o	x	FB's combustion speed is the highest, ST's is middle and RD is low
	Operational ease and adaptability to fluctuation	o	x	△	ST is superior in starting and shut down of the furnace and easy adaptability to fluctuation; RD is next; FB is superior in starting up after a short period shut down.
	Fluctuation of heat load in combustion chamber	o	x	o	Quick temperature change in FB, followed by ST and RD.
	Flexibility to change of waste quality	o	x	x	Refer to remarks of furnace capacity.
	Ignition loss	o	o	x	FB is the best with minimum ignition loss followed by ST and RD.
Generation of pollutant	Dust	o	x	△	FB is likely to produce much dust
	HCL, SO_x				Almost same
Waste heat utilization		o	△	△	According to furnace capacity

ST=Stoker type, FB=Fluidized bed type, RD=Rotary drum type

- continued -

Operation and mainte-nance	Operational characteristics	o	△	△	ST is easy to operate.
	Administrative personnel	o	x	x	FB and RD need more due to the number of furnaces for same plant capacity
	Repairing cost	o	x	x	Same as above
Economy	Construction cost	o	x	x	ST is cheapest due to the number of furnaces for same plant capacity
	Annual operation cost	o	x	x	ditto
Reliability and degree of perfec-tion of technology		o	x	x	FB and RD are inferior in the range over a capacity of 300 t/24 h.

o: Superior   △: Good   x: Inferior

(2) Comparison of flue gas treatment systems

In general combustion flue gases from furnace contain noxious matter, dust, sulphur oxides, nitrogen oxides and hydrogen chloride, as well as some heavy materials.
These pollutants including dust shall be controlled by means of adequate systems to meet the Hungarian emission standards for incineration plants, which were legislated in May, 1991.

Besides the pollutants stated above, the most crucial pollutants are dioxins and dibenzofurans that are much more severely regulated in Hungary than the EC's standards.
A comprehensive evaluation of the cleaning systems in consideration of dioxins and dibenzofurans should be conducted.

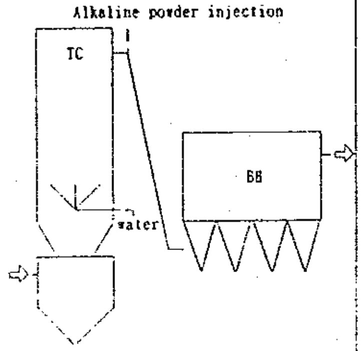
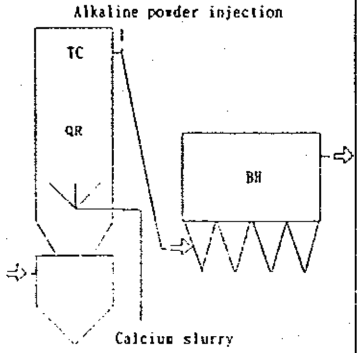
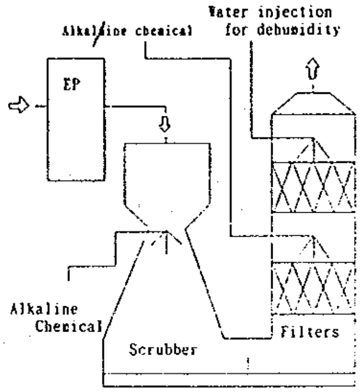
There are, generally, three types of flue gas cleaning systems which are in use now. They can be classified into the following three types in terms of pollutant removing process.

- Wet type scrubbing with alkali
- Semi-dry type absorption with alkali followed by bag filter
- Dry type absorption with alkali followed by bag filter

Three types of system are presented in the Figure 5-3.

In the Table 5-2 all aspects of technology, economy and operation are evaluated.
In this respect the dioxins and dibenzofurans are the most dangerous pollutants to be eliminated by a cleaning system after thermal treatment under high temperature combustion in the primary and secondary

Figure 5-3 Type of Flue Gas Cleaning System

	Dry Type	Semi-dry type	Wet type
① Description	System flow = TC + BH Out line Flue gas is cooled down to about 180℃ in the TC by water spray injection and Alkaline power. Ca(OH) . is injected in the flue gas duct before BH to react with harmful acid contents. The reacted contents are removed by BH and the remaining not reacted Ca(OH) deposited on the filters will be reused in the BH ensuring reacting efficiency more higher.	System flow = QR + BH Out line By using QR in which calcium slurry is injected a removing efficiency of acid harmful contents in the flue gas is highly increased. Further more Dioxine is also efficiently reduced by means of quick temperature decreasing in QR. Reacted contents are removed by BH.	System flow = EP + WS After EP the flue gas is washed by scrubber with a quick temperature reducing effect and reacted with Alkaline chemical injected. After scrubber the gas is entered the filters chamber continuously. Basically acid harmful contents are dissoluted in Alkali-water and removed by wastewater treatment. Alkali-water has to be circulated in the scrubbing system and certain amount of Alkali-water should be taken out to the wastewater treatment to control a concentration of salt in the circulation water in a range of 5 %. After WS the flue gas temperature should be reincreased up to 160℃ to avoid white plume generation.
② Schematic flow			

Note TC: Temperature Control QR: Quenching Reactor WS: Wet Scrubber BH: Bag-House
EP: Electrostatic Preciptator

combustion chambers.

As a conclusion, the semi-dry type system is proposed.

Table 5-2 Comparative Evaluation of Flue Gas Cleaning Systems

Items \ Type		Dry type	Semi-dry type	Wet type
Removing availability to HCl, SOx, Dust, Heavy metals, Dioxin		△	◎	○
Removing efficiency %		60-70	90-99	90-99.5
Chemicals to be used		$Ca(OH)_2$ $Mg(OH)_2$	$Ca(OH)_2$, activated carbon, accelerator	NaOH
Consumption	Water	less	less	a lot of
	Elect. power	◎	○	△
Area requirement		◎	○	△
Effluent water		nothing	nothing	a lot of
Construction costs		0.6-0.8	1	1.5-2.0
Operational costs		1.04-1.06	1	1.3-1.5

Note: ◎ : Best, ○ : Good, △ : unrecommendable

(3) Comparison of steam condensers

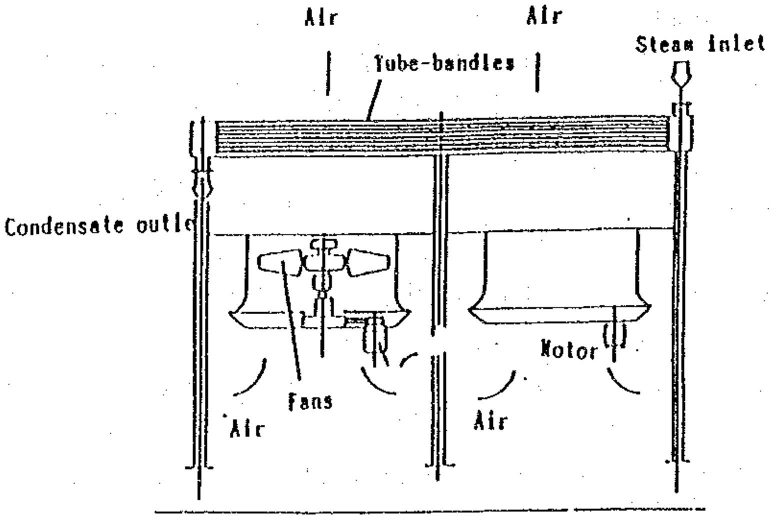
In a waste incineration plant, it is necessary to install a heat exchanger (also called a steam condenser) by which all the generated steam will be condensed after being used in the plant and steam turbine.
The condensates are pumped back to the boilers.

There are generally two types of steam condenser which have been widely in use. They can be classified into the water-cooled type and the air-cooled type. (Figure 5-4)
The Table 5-3 shows a comparison of water-cooled and air-cooled condensers.
The air-cooled condenser, in which only natural air is used for steam condensing, is now widely adopted in the MSW incineration plants, particularly in inland areas for saving water consumption, investment and operation costs.

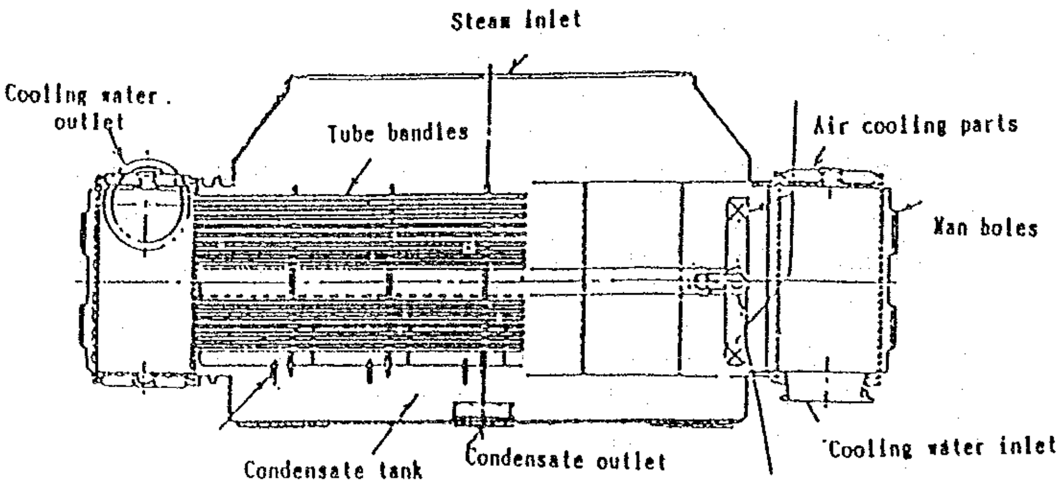
According to the comparison in the Table 5-3, the air-cooled type is preferable in cases where water is short; it also offers lower operational cost and less environmental impact with noise protection measures.

Common use in Hungary is Heller-Forgo condenser where the cooling medium for steam condensation is water that is cooled by air.

Figure 5-4 Type of Steam Condenser



Air cooling type steam condensor



Water cooling type steam condensor

Table 5-3 Comparison of Water-Cooled Type and Air-Cooled Type Condensers

Description		Water-cooled type	Air-cooled type
Construction cost		1	1.3
Maintenance and operational costs		1	0.8
Installation space		1	3
Environmental problems		. Scattering of water from the cooling unit . White plume by water evaporation . Water consumption is large	. Noise generation . No water consumption at all
Adaptability for the MSW incineration	Can be used as condenser	Ditto	
	Flexibility for load change	o	o
	Antifreezing measures	. For the cooling tower, necessary during winter.	. Not necessary

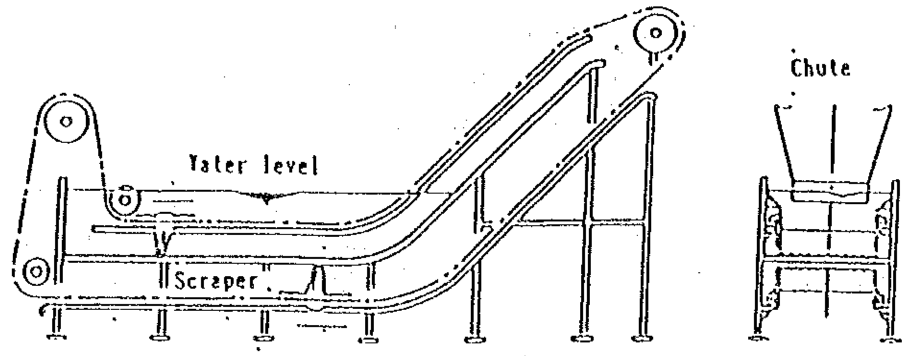
(4) Comparison of residue discharge system

Residue removal equipment has to be installed under the furnace and used for residue discharging after quenching, as illustrated in the Figure 5-5. There are two types of residue discharging equipment in use now. The wet type residue discharging equipment and the semi-wet type residue extractor.
In the wet type residue discharging equipment, a scraper conveyor is installed in a channel filled with water. The semi-wet type residue extractor has the following characteristics, compared with the wet type residue discharging equipment:

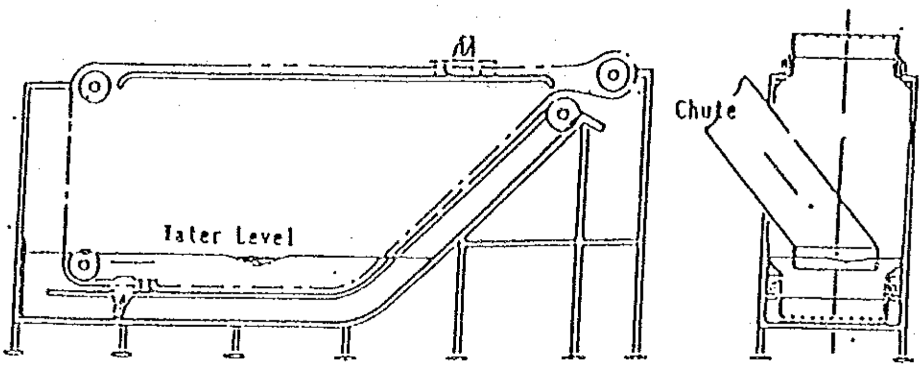
a) The system is completely sealed. Therefore, there is no gas or pressure leakage out of the furnace.

b) The residue contains less water than the wet type, almost dry residues will be produced, therefore no pollution by wastewater is likely.
Water content will be between 15 and 20%.
Automatically, water consumption will be less than the wet type which may have over 35%.
Supplementary water is needed to compensate for water evaporated into the furnace from the extractor and water removed with residues. The consumption of supplementary water can be minimized with the semi-wet type; furthermore, boiler drained water and effluent water from the demineralizer can be reused for this purpose.

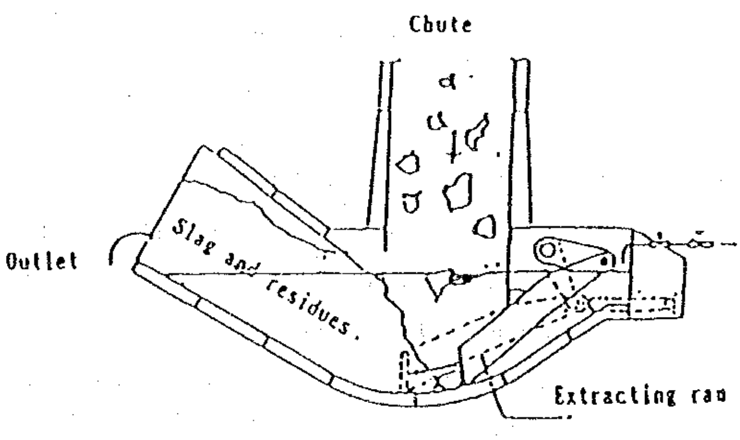
Figure 5-5 Type of Residue Discharging Equipment



Under-return motor-driver type residues conveyor



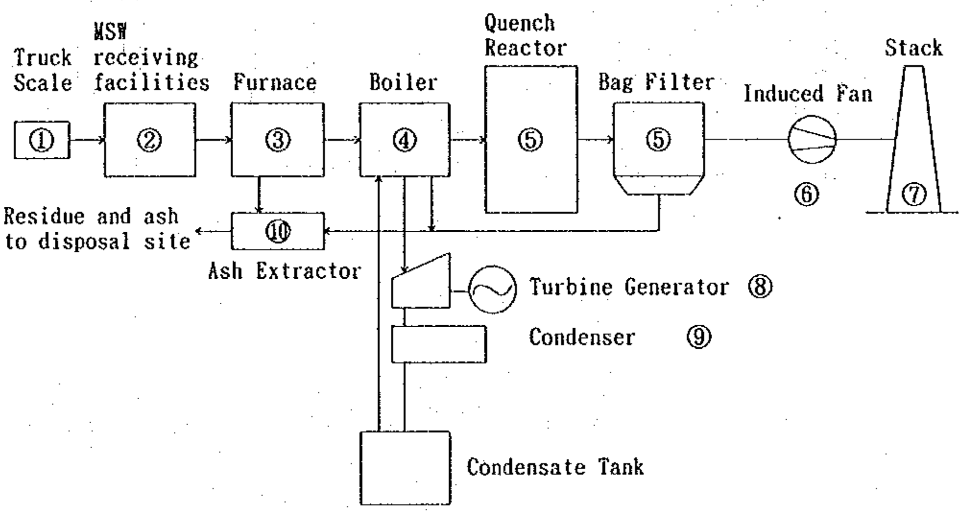
Upper-return motor-driver type residues conveyor



Semi-wet type residue extractor

(5) Main process flow

As the result of technical examination of incineration process components, a main process flow is structured as shown below.



Specification :

① Truck scale : Automatic scaling type

② MSW receiving facilities : Pit and overhead crane system

③ Furnace : Stoker type, water-cooled tube wall, Automatically programmed combustion control

④ Boiler : Natural circulation type

⑤ Flue gas treatment system : Semi-dry, bag filter type

⑥ Induced draft fan: Motor driven turbo fan

⑦ Stack : Two steel made inner stacks with 80m height and one concrete made outer stack,

⑧ Turbine generator: Steam turbine - condensing extraction turbine Max. power capacity; Approx. 35,000kW (at 212 ton/hour)

⑨ Condenser : Air-cooled type condenser

⑩ Ash extractor : Semi-wet type extractor

5.4 Plan for the Final Disposal Sites

In the discussion on the final disposal sites in the Chapter 4, the present issues were identified chiefly as follows.

- Lack of the operating final disposal sites
- Difficulty of obtaining the new final disposal sites
- Sanitary landfill method is not applied.

Since a plan for a final disposal site should include obtaining a new site along with technical details, first of all methods of site selection will be discussed and then technical details will be examined in this Chapter.

5.4.1 Methods of Obtaining, Construction and Operation

According to the Table 4-12, the capacities of the new disposal sites during the period of 1993 - 2005 require 20,950,000 m^3 for the Alternative-1 and 16,500,000 m^3 for the Alternative-2. In both cases a capacity of 700,000 m^3 will be obtained in the Akna site and 9,000,000 m^3 will be obtained in the Bajna site. At present the 14 potential sites will be given first priorities to fulfill the remainders.

Detailed methods of site selection can be found in the Progress Report (II), in which three major steps in a site selecting procedure are presented. They are "Selection of Potential Sites", "Selection of Candidate Sites" and "Final Site Selection".

In view of the issues identified in the Chapter 4, 14 potential sites have already been selected; however, the following steps are still under execution.

- Land acquisition
- Consensus by neighboring residents

- Compatibility with regional plan
- Economic feasibility study
- Environmental acceptability

Land acquisition, obtaining consensus from neighbors and environmental acceptability have proven difficult so far. Hungary presently has serious social issues connected with privatization, so land acquisition is partly a complicated legal matter. On the other hand, obtaining the consensus of neighbors and reducing environmental damage will be solved technically by means of sanitary landfilling.

(1) Improvement of landfilling structure

Generally, in a sanitary disposal site the following facilities should be provided.

a) An embankment to prevent the MSW from flowing out

b) A liner to prevent leachate from permeating through the bottom of the site

c) An open channel system to prevent rainwater from flowing into the site and a leachate collection pipe system to drain out of the site

A leachate collection pipe system leading to the leachate pond

1) Equipment

a) Truck scale

b) Heavy machine to shove and compact the MSW

The specific compactor is better than other kinds of heavy machines to compact the MSW.

c) A sprinking truck to prevent dust due to wind blowing

2) Other facilities and necessary materials

a) Administrative house to check the quality and quantity of the MSW and to handle the truck scale

b) Washing pond to wash the tires of collection vehicles

c) Electric power line, supply water line and sewer system

d) Fence to keep people out

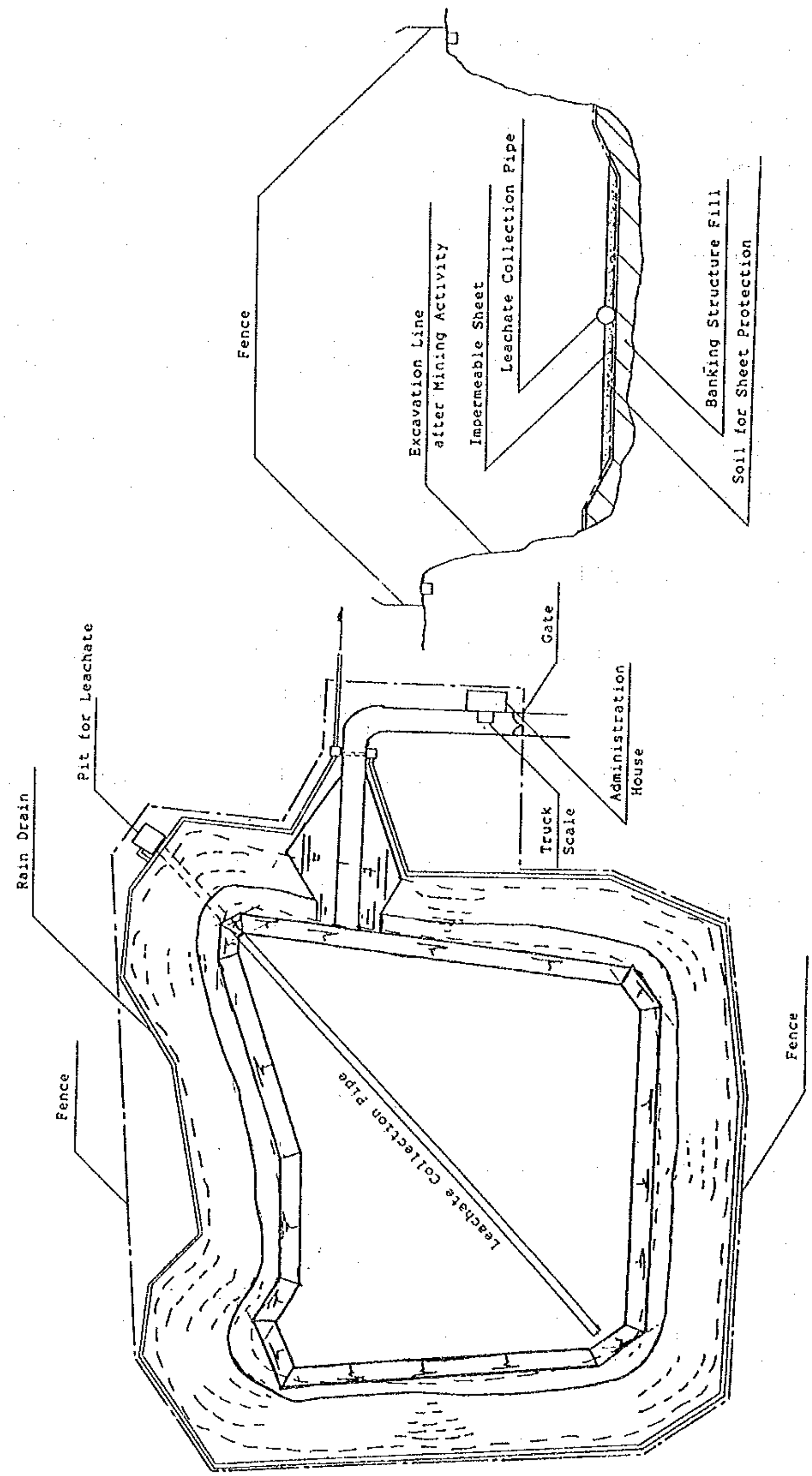
e) Covering soil

3) A monitoring system to check environmental condition during and after landfill operation

a) Observation wells for ground water contamination

An improved sanitary landfill structure is shown in the Figure 5-6.

Figure 5-6 Plan of Improved Anaerobic Sanitary Landfill



(2) Landfill operation

A landfill operation involves not only shoving and compacting the MSW, but also reclaiming it safely and hygienically. Moreover, the landfill operation should be economical. To achieve these goals, the following daily work should be done.

1) In order to operate safety, the site supervisor should indicate the place where the collection vehicles should unload the MSW.

2) Before the vehicle is unloaded, the MSW should be checked whether it is appropriate or not for disposing.

3) The unloaded MSW should be shoved and crushed by a heavy machine; at the same time, compacting work should be well done.

4) Covering with soil should be done after the daily landfill operation; additionally, when wind blows, water should be sprinkled by the trucks to prevent the MSW from blowing.

5) Before the covering operation, disinfectant should be sprayed. Especially, during summer this work is indispensable.

   When the same disinfectant has been used for a long time, it can lose its effectiveness. It is recommended that the disinfectant should be changed.

6) After daily landfill work, covering soil work should be done. This work also should be done well so that the MSW is well compacted. Sandy soil is recommended for daily covering work. Soil which contains organic matter should not be used. There

are two kinds of covering, the cell method and the sandwich method explained in the Section 4.3.5. Generally, as this method will wrap the MSW with soil, the cell method is adopted in Japan. The sandwich method is adopted usually for small sites. This method does not wrap the MSW; then, as the slope of the shoved MSW is open to air, it may cause environmental problems.

5.4.2 Plan for Machines for the New Final Disposal Sites

In proportion to the increase of the MSW in the future, the quantity of the MSW to be hauled to the final disposal sites will also increase. In order to deal with this increase, additional bulldozers will be necessary.

Calculation conditions

The following calculating conditions are considered.

(1) Specific weight of the MSW at the final disposal site

When the MSW is hauled to the sites, its specific weight will change. When the MSW is unloaded at the site, its specific weight is assumed to be approximately 0.25 t/m^3.

Therefore, the following correlation can be written.

$$V = Vw \times 0.6 \quad (1)$$

where:

V : Necessary volume of the MSW to be shoved by bulldozer

Vw: Generated MSW volume of which specific weight is 0.15 (in 2005).

In other words, the volume of the hauled MSW will be six tenths the volume of the original MSW.

(2) Necessary quantity to be shoved by bulldozers at the final disposal sites

By the equation (1), the necessary volume to be shoved per year is shown on the top line in the Table 5-4 for the case of the system Alternative-1. The volume to be shoved per day is shown on the second line.

(3) Capacity of bulldozers for the future

Number of operating bulldozers and their specifications are presented in the Table 3-9. Theoretically, a shoving capacity per bulldozer is calculated from the following equation,

$$Vb = (60/Cm) \times q \times E$$

where:

Vb: Shoving capacity per bulldozer
(cubic meters per hour)

q : Excavating capacity of one cycle operation per bulldozer

Cm: Time for one cycle excavation
Cm is calculated from the following equation.
Cm = 0.027 + 0.79
: distance of one cycle=40m is assumed in this case.

E : Coefficient of operational efficiency=0.9 is assumed in this case.

Results of calculation

Capacity of 240 H.P. bulldozer = 133.71 m^3/h

Capacity of 130 H.P. bulldozer = 49.96 m^3/h

Capacity of 110 H.P. bulldozer = 36.97 m^3/h

Table 5-4 Calculation for Additional Bulldozers

Alternative-1

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Necessary shoving quantity/Y (×1000m3)	2091	1623	1459	1509	1509	1562	1729	1896	1952	2401	2460	1907	1969	2032	2096	2161
Necessary shoving quantity/D (m3)	8042	6242	5612	5804	5804	6008	6650	7292	7508	9235	9462	7335	7573	7815	8062	8312
Present capacity of heavy machine/Y (×1000m3)	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407
Present capacity of heavy machine/D (m3)	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412
Necessary supplement Capacity (m3)	2630	830	200	392	392	77	483	606		1694	210					
Additional cap.					519	236	519	855		1711	236					
Total cap.	5412	5412	5412	5412	5931	6167	6686	7541	7541	9252	9488	9488	9488	9488	9488	9488
Balance		-	-	-	+	+	+	+	+	+	+	+	+	+	+	+

Alternative-2

	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005
Necessary shoving quantity/Y (×1000m3)	2091	1623	1459	1509	1509	1562	1729	1896	1952	1510	1513	1173	1196	1221	1245	1270
Necessary shoving quantity/D (m3)	8042	6242	5612	5804	5804	6008	6650	7292	7508	5808	5819	4512	4600	4696	4788	4885
Present capacity of heavy machine/Y (×1000m3)	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407	1407
Present capacity of heavy machine/D (m3)	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412	5412
Necessary supplement Capacity (m3)	2630	830	200	392												
Additional cap.					519	236	519	855								
Total cap.	5412	5412	5412	5412	5931	6167	6686	7541	7541	7541	7541	7541	7541	7541	7541	7541
Balance		-	-	-	+	+	+	+	+	+	+	+	+	+	+	+

Operating time is assumed to be:
8 hours x 0.8 = 6.4 hours/day.

Therefore, the capacity of bulldozer at each site is as follows.

Akna

Capacity of 2 bulldozers with a capacity of 240 H.P.
$= 2 \times 133.71m^3 \times 8 \times 0.8 = 1{,}711.48m^3/day$

Capacity of 1 bulldozer with a capacity of 150 H.P.
$= 1 \times 49.96m^3 \times 8 \times 0.8 = 319.74m^3/day$

Capacity of 1 bulldozer with a capacity of 110 H.P.
$= 1 \times 36.97m^3 \times 8 \times 0.8 = 236.61m^3/day$

Total $2{,}267.83m^3/day$

Micsurin

Capacity of 1 bulldozer with a capacity of 240 H.P.
$= 1 \times 133.71m^3 \times 8 \times 0.8 = 855.74m^3/day$

Capacity of 1 bulldozer with a capacity of 150 H.P.
$= 1 \times 49.96m^3 \times 8 \times 0.8 = 319.74m^3/day$

Capacity of 1 bulldozer with a capacity of 110 H.P.
$= 1 \times 36.97m^3 \times 8 \times 0.8 = 236.61m^3/day$

Total $1{,}412.09m^3/day$

Peteri Major

Capacity of 1 bulldozer with a capacity of 150 H.P.
$= 1 \times 49.96m^3 \times 8 \times 0.8 = 319.74m^3/day$

Capacity of 1 bulldozer with a capacity of 110 H.P.
$= 1 \times 36.97m^3 \times 8 \times 0.8 = 236.61m^3/day$

Total $556.35m^3/day$

Dunakeszi

Capacity of 1 bulldozer with a capacity of 240 H.P.
$= 1 \times 133.71m^3 \times 8 \times 0.8 = 855.74m^3/day$

Capacity of 1 bulldozer with a capacity of 150 H.P.
$= 1 \times 49.96m^3 \times 8 \times 0.8 = 319.74m^3/day$

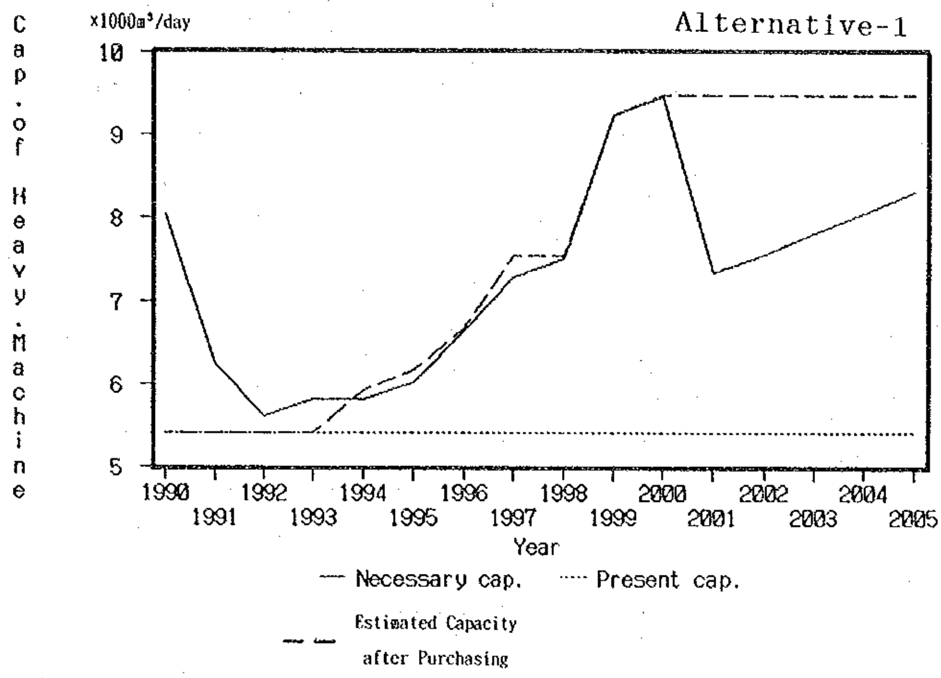
Total $1{,}175.48m^3/day$

Present total capacity at the four sites is 5,411.75 m^3/day

It is presumed that this capacity will remain up to 2005.

(4) Comparison between the necessary capacity and present capacity is given in the Figure 5-7 and the Table 5-4. From this result, for the system Alternative-1, four bulldozers should be purchased from 1994 to 1997 and three bulldozers should be purchased in 1999 and 2000. For the Alternative-2, four bulldozers should be purchased from 1994 to 1997. The purchasing plan is shown in the Table 5-5.

Figure 5-7 Comparison between Present Capacity and Necessary Capacity of Bulldozers



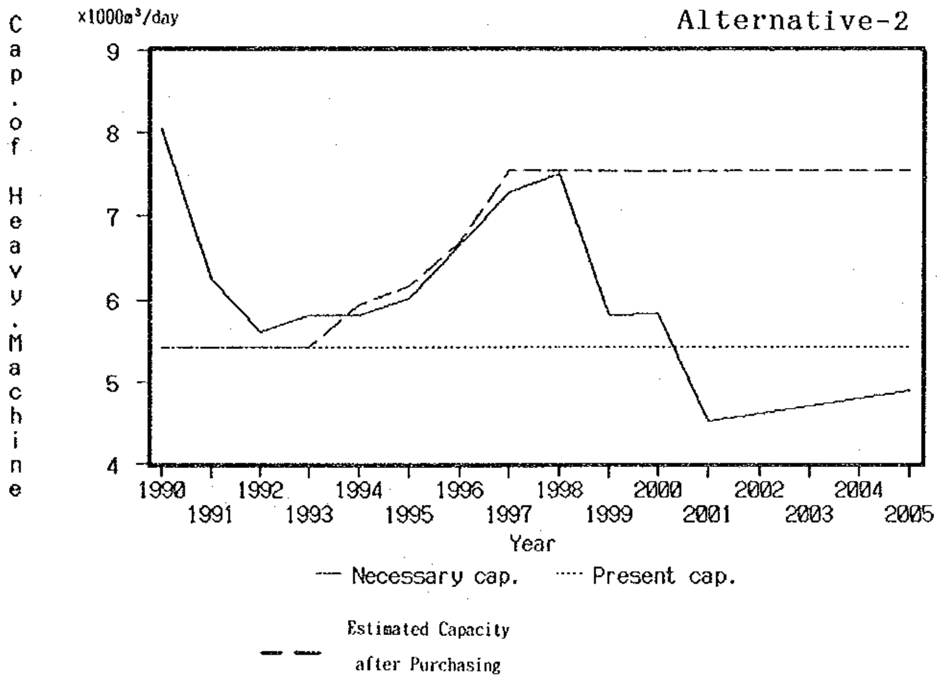


Table 5-5 Purchasing Plan of Bulldozers

Alternative-1

	1994	1995	1996	1997	1998
Spec. of bulldozer	210HP 1 unit	110HP 1 unit	210HP 1 unit	320HP 1 unit	—

	1999	2000	2001	2002	2003
Spec. of bulldozer	320HP 2 units	110HP 1 unit	—	—	—

	2004	2005
Spec. of bulldozer	—	—

Alternative-2

	1994	1995	1996	1997	1998
Spec. of bulldozer	210HP 1 unit	110HP 1 unit	210HP 1 unit	320HP 1 unit	—

	1999	2000	2001	2002	2003
Spec. of bulldozer	—	—	—	—	—

	2004	2005
Spec. of bulldozer	—	—

5.5 Plan for Organization, Administration and Management

In order to achieve the goals and targets stated in the Chapter 5, strengthening the present municipality's organization for dealing with the MSW management is very important and urgent.

In addition, although a system of resource recovery and recycling as well as composting were not included in the M/P this time, those will be another main subject in the future.

In view of those facts and expectations it is necessary to establish a new special sector consisting of ten experts which will belong to the Department of Public Utility Works independently from the other three departments.

This sector has to take responsibility for the following matters.

- To implement the M/P effectively and successfully
- To control all information and data concerned
- To plan and elaborate schemes for future management systems and developing technical systems
- To organize companies and local district authorities to concentrate their tasks and targets in the right direction
- To study a methods to increase revenue levels
- To study an integrated MSW management system of a large region including other surrounding cities

It is recommended that this department be set up before the end of 1993.

5.6 Plan for Education and Training

The objective of public education is to strengthen citizens' cooperation in the following aspects.

- Reduction of the MSW generation
- Proper storage and discharge
- Separate collection for experiment to be continued
- Necessity of land for final disposal and construction of intermediate treatment facilities
- MSW transportation
- Necessary costs for the MSW management

The Budapest Capital City Government, local district governments and FKFV should be responsible for public education.

For resource recovery and recycling, FKFV should positively collaborate with MEH and private recycling companies for public education.

(1) Public (children) education by the Budapest Capital City Government

Public education on the MSW management in the city can be given by the Budapest Capital City Government by means of school education and mass-media. In addition to cleanliness and public health connected to the MSW management, it is recommended that some programmed education on the MSW management should be given at primary and secondary school levels. Educational contents would be expected to include the following:

- Waste and public health
- Necessity for proper the MSW discharge and storage
- Structure of the MSW management and environment
- Kinds of wastes

- Importance of resource recovery and recycling
- Public responsibilities, duties and cooperation

In public education, each district government should cooperate with the Budapest Capital City Government.

(2) Public (adult) education by the Budapest Capital City Government

Principally the following items should be taught by the Budapest Capital City Government in cooperation with local district governments and FKFV. Without these effective activities the ultimate target of the MSW management in the city will not be achieved. Mass-media and/or pamphlets would be useful in these activities.

- Necessity for the proper MSW discharge and storage
- Structure of the MSW management
- Importance of resource recovery and recycling
- MSW generators responsibilities and duties
- Necessary costs for the MSW management, environment in other words
- How to treat organic matter by means of compost
- Use of vinyl bags for separate discharge
- Necessity of land for final disposal and construction of related facilities
- Participation in visits to related facilities, such as HHM1
- Open door actions

(3) Public (adult) education and instruction by FKFV

Through mass-media and/or the distribution of booklets and pamphlets FKFV should educate the public.
The following subjects should be covered.

- Separate discharge and storage
- Collection schedule for separate discharge and storage
- Composting
- How to minimize the MSW generation
- Cooperation for separate collection

(4) Personnel who should receive training

Since the present technical and administrative level of personnel running the MSW management system in the city is already sufficient, only personnel who will be involved in the future administration or operation of intermediate facilities will require training which composes of classroom lecture and On the Job Training (OJT).

(5) Types of knowledge and experience required

The knowledge and experience required are as follows:

- Relationship between the MSW management and intermediate facilities
- System and process of each intermediate facility
- Theoretical structure of sophisticated system to eliminate environmental impacts
- Details of control system
- Mechanism between kinds of waste and chemical components in gases and wastewater
- Relationship between metal and corrosion, chemicals and harmful gases, chemicals and harmful elements in wastewater
- Sanitary engineering

5.7 Implementation Schedule of the Master Plan

In order to make the implementation schedule of the M/P, it is necessary to plan the schedule for each component of the selected M/P respectively, and then its individual schedule should be integrated into a comprehensive schedule.

According to the system Alternative-2 as the selected M/P, first of all T/S has to be planned so that its construction will commence from early 1997 and be completed by the end of 1998, including commissioning to meet the commencing schedule of HHM2, from 1999.

Along with T/S construction, the containers and container trucks should also be purchased by the end of 1998.

Next, the number of collection vehicles planned in the Table 4-3 should be purchased.

Since the planning of collection vehicle purchases depends upon the locations of the new final disposal sites to be obtained in the future, it is necessary to reconfirm the planned numbers of vehicles before actual purchasing.

Next, the construction of HHM2 should be started in accordance with the schedule presented in the Figure 8-1.

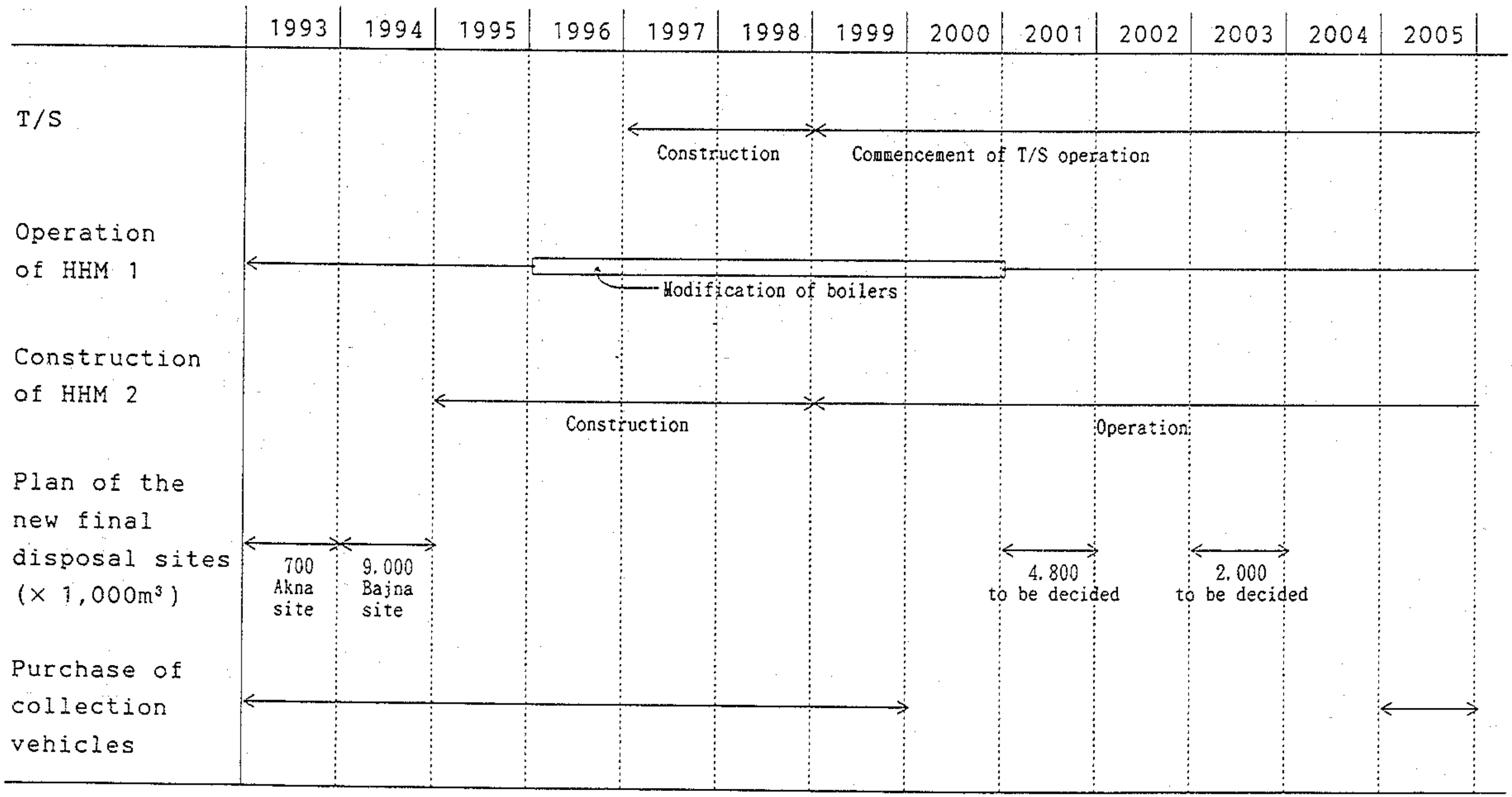
In order to integrate the individual schedule, the schedule to obtain the new final disposal sites, and sites' capacities will be very important factors to link the individual schedules with each other. At the present time, in addition to the operating final disposal sites two new sites in Akna and Bajna areas will be in operation in 1993 and 1994 respectively. Before closing the Akna and Bajna disposal sites in 1998, other 14 new sites selected as potential sites should be obtained in accordance with the MSW mass balance for the Alternative-2 presented in the

Table 4-12.

According to the Table 4-12, at least 4.8 million m^3 and 2.0 million m^3 of the new final disposal sites should be obtained by 2000 and 2003, respectively.

The implementation schedule is shown in the Figure 5-8.

Figure 5-8 Implementation Schedule of the M/P



5.8 Cost and Financial Plan

5.8.1 Cost Estimation

The costs of investment and operation in implementing the Alternative-2 are estimated as shown in the Tables 4-7 and 4-8. For the convenience of this Chapter the project investment cost for the Alternative-2 can be summarized as follows.

Table 5-6 Investment Cost for the Alternative-2 (M/P)
(Fixed price basis in 1993)

Unit: Thousand US $

	Local	Foreign	Total
Transfer Station	4,311	-	4,311
Incineration Plant	152,696	105,067	257,763
Final Disposal Sites	24,233	-	24,233
Collection Vehicles	4,536	-	4,536
Investment Cost	185,776	105,067	290,843

Note: The above investment cost includes Import Duty and VAT, but excludes Interest During Construction (IDC).

5.8.2 Preliminary Financial Plan

(1) Affordability to the municipality

Even though it may be possible to realize the Master Plan alternatives, the financial affordability to the Budapest Capital City Government is another point that should be considered. The total investment amount of the Alternative-2 is about 40% of the municipality's budget for 1993 and greater than the municipality's MSW management budget by a factor of 13.

In the municipality's budget, funds for the facility construction such as an incineration plant are appropriated as an item for "development and construction expenditure". The budgeted amount for these items in 1993 is 135 million US$ in total and it covers all kinds of facility construction in the city.

Thus, under the present financial condition of the municipality, it seems to be difficult for it to finance all of the investment independently for this project.

Regarding the operation cost for the present MSW management, equilibrium between income and outgo has been almost maintained. Income comes mainly from consignment fees from the municipality, waste container leasing fees and general service fees which are charged for the MSW collected and transported by private companies.

Of these, the consignment fees are the largest; they are calculated on the basis of the MSW management cost by FKFV. The management cost consists of operation cost and administration cost, but capital investment cost is excluded. That is, revenues cover only flow but not the stock portion of costs.

As long as the present tariff system continues there will never be capital funds generated from ordinary management work for new investment. Other means of raising capital must be considered. There are three possible ways to raise capital funds for a new project: one is support by the central government, the second is use of a concessional loan, and the third is to introduce a new tariff system on the basis of the "Polluter Pays Principle" or "Burden Share Principle".

(2) Financial support by the central government

As for financial support by the central government, the following three schemes are assumed to be available for this project: namely "Targeted Support" (CELTAMOGATAS), "Special Support" (CIMZETT TAMOGATAS) disbursed from the government's special account, and the Central Environmental Protection Fund (CEPF) handled by the Ministry of Environment and Regional Policy.

1) "Targeted Support"

The government assists the municipalities to implement specific projects or develop specific areas. The municipalities have to submit applications which describe the outline of the project to the Ministry of the Interior before April 15 every year. The final decision is made by the government.

2) "Special Support"

The scheme concept and procedure is the same as the "Targeted Support" but the project scale is smaller than the above.

3) Central Environmental Protection Fund (CEPF)

CEPF originally aimed at serving as an important financial tool for accomplishing state tasks in the area of environmental protection and nature conservation. Applicants must submit project proposals which are evaluated and ranked by an inter-ministerial committee. The final decision is made by the Minister for Environment and Regional Policy.

Out of three types of government support, the first two schemes are preferable for the project and quite within the bounds of possibility, while the total annual amount of CEPF support is rather small (about 14 million US$ in 1991). In any case, these forms of government financial support should be considered as the first priority in raising funds for the project.

(3) Use of concessional loans

As secondary financial sources, a loan from a bank or the flotation of municipal bonds could be considered. In general, the conditions of available loans in the local market are quite severe for the project; the interest rate is assumed to be more than 20% per year. It is more recommendable to borrow from a foreign financial institution such as the International Bank for Reconstruction and Development (IBRD), European Bank for Reconstruction and Development (EBRD) or a foreign governmental financial institution that can offer concessional conditions.

There is also a possibility to float a municipal bond; the government will be the main subscriber, however the Budapest citizens also could be subscribers. The present interest on the national bonds is around 20%, so that from the interest viewpoint the flotation of municipal bonds are not recommended, however, from the viewpoint of raising funds widely from the local market it is the preferable means.

In any case, a loan from a foreign financial institution or governmental institution, and the flotation of a municipal bond, require government approval. Also as a general rule in Hungary, a project for which the investment cost is more than

0.002% of the state budget (equivalent to approx. 2.5 billion Ft) requires official approval by parliament.

(4) Introduction of new tariff

The third financial source is collecting the cost directly from the Budapest citizens. As mentioned above, the present tariff system can only cover the flow cost portion, and also, FKFV now does not charge any service fee except to some rich households. In a sense the consignment fee is regarded as the equivalent of the Budapest citizens indirectly paying a fee to FKFV. But not only from the view point of raising funds but also management, to ensure that the investment cost for the MSW is fairly shared by the generators of waste, and to keep people aware of the importance of the MSW management, it is recommended to introduce a new "Fee Collection System" for the project.

It is necessary to revise "City Council Degrees on public hygiene and activities relating to the MSW management" in order to introduce the new tariff system and this requires approval by the Municipality's General Assembly. It means that time is needed for political debate so that this can be considered as a financial source in the future.

Besides the above financial sources, the utilization of leasing system of facilities and equipment is one possible idea; however, the leasing system is not so popular in Hungary so far. Therefore it should be considered as one possibility, but within the scope of partial investment.

As a result, it is concluded that the raising of funds for the project should rely mainly on government financial support, with use of concessional loans and a new tariff system to be examined as finance sources over the long run.

A detailed financial plan for the construction of HHM2 is studied in the Chapter 10.

5.9 Environmental Evaluation of the Master Plan

5.9.1 Municipal Solid Waste Collection and Transportation

(1) T/S

An EIA study has been done by Hungary for the construction of T/S at the Akna site. The conclusion of this study is that the effect on the air pollution and on the noise load due to both the operation of T/S and truck traffic can be considered negligible. The only point is to construct T/S as far as possible from the neighbouring residential area to avoid noise complaints. The effect of the MSW compacting ratio (1:5) will decrease the traffic of transportation vehicles from this area to HHM2.

(2) Access roads

Now and in the future, noise emission from vehicle traffic can be considered the main problem for neighbours along the access roads to HHM2. The construction of T/S has a favorable effect on this topic, along with the construction of a new road that is investigated in the city's development plan, presently under study. The traffic conditions on existing and possible access roads to HHM2 site have to be considered in the Environmental Impact Assessment (EIA), in evaluating the noise load due to the transportation vehicles and in the possible countermeasures in accordance with the noise control standards.

5.9.2 Plan for the Municipal Solid Waste Intermediate Treatment

The main environmental problems caused by HHM1 are described in the Chapter 3. The potential impacts from HHM2 are similar, but the present state of the art of incineration technology can assure compliance with the environmental regulations, even with the strict limitations in force in Hungary. In this Section, the different components of HHM2 are described in order to identify the preferable solutions from the environmental viewpoints.

(1) Stack

The height of the stacks is the parameter which determines the concentration of pollutants around the plant in given conditions for the following data.

- Concentration of these pollutants in the exhaust flue gas
- Speed and temperature of the exhaust flue gas
- Meteorological situation in the area

The so called dispersion study is done in order to determine the height of the stack by means of calculation of the immission levels corresponding to the stack height and emission levels from HHM2. If necessary, in case of exceeding of immission limit values, these calculations are done several times, by increasing the initial height of the stack. In such a way the minimum height of the stack can be found. The result of a preliminary calculation, according to the standards in force in France and Switzerland, taking into consideration the Hungarian limit values, is a minimum height of about 44 to 66 m.

The dispersion study started with a height of 80 m.

A more detailed explanation of this topic is given in the Chapter 11.

(2) Flue gas treatment system

The objective of the Flue Gas Treatment System (FGTS) is to meet the limit emission values for the pollutants in the exhaust flue gas. Presently, HHM1 is equipped with an electrostatic precipitator (EP). This system is not adequate to comply with requirements and, according to the regulation, a new FGTS should be implemented.

Basically, the three following processes could be considered:

- Dry system,
- Semi-dry system,
- Wet system.

A technical comparison of these systems is given in the Section 5-3. From the environmental viewpoint, the semi-dry system is preferable because it is not producing any wastewater. However, a large quantity of ash is collected in the bag filter. The same FGTS should be implemented in both HHM1 and HHM2 for technical and economical reasons.

(3) Ash and residue handling and treatment

The incineration process produces residues which are:

- Residue from incineration, which contains a small quantity of heavy metals,

- Ash from the boiler and the FGTS; the latter contains heavy metals and a few dioxins.

The residue can be removed by a wet or semi-wet discharging system as described in the Section 5-3. The water from the handling facility has to be treated; consequently the semi-wet system is preferable for its almost nothing of wastewater produced.

According to the Western European standards, residue and ash have to be treated separately, as their toxicity degrees are different. The residue can be used as a construction material for roads or airport runways, or disposed of in a normal final disposal site, separately from the organic waste. The ash cannot be discharged in a normal final disposal site without treatment. Different processes for ash treatment are described in the Chapter 7. An additional possibility is to wash the ash, which allows storage of the ash in a normal final disposal site. Only the sludge produced by the washing process, in much smaller quantity, has to be disposed of in a controlled final disposal site and wastewater should be chemically treated.

The operation of HHM1, disposing of residue and ash together with organic waste in the final disposal site will have to be changed, according to a new regulation to be legistlated in Hungary. HHM2 will dispose of the residue in the existing or future final disposal site and the ash in a controlled final disposal site if necessary.

(4) Wastewater treatment

Presently, wastewater treatment is one of the weak points of HHM1. The quantity of salt in the effluent water is much higher than the limit value, but the local authorities have given special permission to HHM1. An atomization unit should be installed to solve this problem, by evaporation of the water. The salt separated by this atomization process can be discharged in a normal final disposal site or recycled for industrial purposes. This atomization unit could be designed in order to treat the total amount of wastewater from HHM1.

(5) Noise protection

In this evaluation, noise protection for the neighbourhood of the plant is studied. The noise exposure to the workers is regulated by work regulations. Obviously, outside noise depends partially on the inside noise of the plant. The noise evaluation will consider the different noise sources in order to comply with the requirements, which specify emission limits of noise levels at the boundary of the plant. As the location of HHM2 is the same as the existing one, the total noise level will be calculated. If necessary, some counter-measures will be designed (sound insulation wall, sound proof construction, etc.).

5.9.3 Plan for the Final Disposal Sites

(1) Existing final disposal sites

The disposing of the MSW in the existing final disposal sites is far from environmentally friendly, mainly because of disposing of residue and ash mixed together with the MSW. This situation, with an insufficient protective layer at the bottom of the sites and without any leachate collection system, might contaminate the ground water. Also, the ground water monitoring system is not developed enough to assure water protection. The use of soil as covering material for the MSW, and the separate disposal of residue, should at least be implemented as a new operational mode after new regulations are issued. The ash, if not treated, should be transported to the existing controlled final disposal site at Aszod.

(2) Future final disposal sites

The difficulty of obtaining the new final disposal sites is known mainly because of the opposition of the local Authorities. A study of the possible impacts of a final disposal site can demonstrate that, with adequate design of the disposal site, no effects will be feared in the neighbourhood and these new sites will be safe for the environment. Regarding ash disposal, a specially controlled final disposal site has to be considered if the capacity of the Aszod site is insufficient. According to the regulation the future final disposal site will be subjected to the EIA and a monitoring system will be implemented.

5.9.4 Evaluation

In the light of the description of the environmental aspects of the components of the M/P, the future improvement of the situation is demonstrated in the Table 5-7. It is important not to forget the significant effect on the MSW volume reduction given by the M/P.

Table 5-7 Trends of Environmental Conditions

Component	Environmental element	Evaluation	
		Actual	Future
Collection and transportation			
T/S	Air	-	△
	Noise	-	△
Intermediate treatment			
Composting	Odor	△	△
	Noise	△	△
HHM1	Air	◎	△
	Odor	△	△
	Ground, surf. water	○	○
	Noise	○	○
	Natural background	◎	△
HHM2	Air	-	△
	Odor	-	△
	Ground, surf. water	-	△
	Noise	-	○
	Natural background	-	△
Land filling	Ground water	◎	△
	Noise	△	△
	Natural background	◎	△

△: No impact with countermeasures, ○: Slight impact,
◎: Remarkable impact

5.10 Conclusion of the Master Plan

The results of examination of technical, institutional, economic and environmental aspects were concluded as follows.

5.10.1 Composition of the Master Plan

The M/P consists of;

- Construction of T/S,
- Operation of HHM1,
- Construction of HHM2,
- Plan of the final disposal sites, and
- Purchase of collection vehicles.

5.10.2 Technical Aspects

- T/S with two compaction lines will be constructed at the district-X Akna site.
- The number of collection vehicles to be purchased can be minimized in cooperation with the functional effects of T/S.
- HHM1 will be continuously operated with the modification of boilers to maintain an incineration capacity of 2,100,000 m^3/year.
- HHM2 will be located in district-XV at the same site with HHM1 and will satisfy the national environmental standards and regulations of the Republic of Hungary.

- For the new final disposal sites, a sanitary landfill method will be adopted.

- Capacities of the new final disposal sites are anticipated to be 16,500,000 m^3. (Refer to the Table 4-12 in the Section 4.4.2.)

5.10.3 Organizational and Institutional Aspects

- T/S will be operated by a new organization established in FKFV with seven FKFV employees.

- HHM1 and HHM2 will be managed under a common administrative organization; HHM2 requires fewer employees (89) than HHM1 (182).

- For the new final disposal sites' operation, administrative control of the Budapest Capital City Government will be strengthened to establish a sanitary landfill method.

- The establishment of a special section comprised of ten experts by the year 1995 will be needed to strengthen the present Department of Communal Matters organization, particularly in order to strengthen the following matters of management:

  1) Implementation and supervision of the M/P
  2) Management of information and data concerning the MSW management
  3) Research and development of a MSW management system by separate collection, recycling, treatment by composting and a new fee collection system, etc.
  4) Strengthening of cooperative relationships between the residents and the Budapest Capital City Government in the MSW management system
  5) Supervision of FKFV

- Continuation of experiments on resource recovery and recycling systems and on a compost pilot plant should be carried out by the Budapest Capital City Government.

5.10.4 Financial and Economic Aspects

On the basis of cost and revenue comparison for the both system alternatives, the following advantages and disadvantages are noted.

(1) There is a considerable difference in the investment costs of the two alternatives. In the case of the Alternative-1, only the investment costs for the new final disposal sites and purchase of new vehicles are needed, while in the Alternative-2 the costs of several new items are incurred. Especially, the investment cost for the HHM2 construction makes a big difference between both estimates.

(2) The cost difference between both estimates for operation and maintenance is narrower than the investment cost; however, there is still a 1.2-fold difference. The Alternative-2 costs more than the Alternative-1.

(3) In terms of revenue, however, the Alternative-2 is slightly higher (1.25-fold) than the Alternative-1. The main factor for a small revenue difference is the service fee for final disposal which is higher than the incineration fee under the present service fee system.

(4) Revenues from energy sales contribute a little to the profitability of the project.

(5) In comparison between the operation/maintenance cost and revenue over the projected period, the revenue

exceeds the operation/maintenance cost by a great margin in both cases. This means that the operation/ maintenance cost is covered within the present revenue structure.

(6) The Alternative-2 will have a cash shortage after 1999 (when the operation of HHM2 is started) due to an inbalance between the expenditures (investment cost plus operation cost) and revenues.

In this case, taking into account of the economic, social factors for the project and the following socioeconomic benefits as well as political backgrounds in connection with the decision of the Budapest City General Assembly, which agreed with the necessity of HHM2, and the difficulty of securing the final disposal sites, the Alternative-2 was selected as the M/P.

Socioeconomic benefits

i) Creation of clean environment and contribution to public health
ii) Prolongation of the final disposal sites' lives by reducing the MSW volume generated
iii) Benefit from electric power generation by utilizing the waste energy from the MSW incineration causing fuel import reduction
iv) Contribution to tourism industry

5.10.5 Environmental Aspects

- T/S will be free from environmental problems since noise protection and odor protection as well as a wastewater treatment will be provided.

- The national emission and immission limit values can be satisfied for HHM1 if a new flue gas treatment system is installed properly. However, this issue is not included in the Scope of Work (S/W) of this Study.

- HHM2 will satisfy the national emission and immission limit values from the initial stage of operation, if necessary countermeasures defined by the Environmental Evaluation (EE) are applied. However the night time noise level at two points on the site boundaries will not satisfy the noise limit value due to the facility location being close to the boundaries.

- For the new final disposal sites the environmental problems such as ground water contamination and odor will be minimized by adoption of a sanitary landfill method.

- Environmental impacts of traffic will be minimized in cooperation with the functional effects of T/S.

5.11 Selection of the First Priority Project

One of the main objectives of the Study is to formulate the First Priority Project that will be the measure to improve the present insufficient situation of the MSW management system in the Budapest city in a short-term condition.

At the same time this project must be the foundation in cooperation with the M/P as a long-term project.

Through the selection process of the system alternatives and planning the M/P, the most essential necessities to satisfy the goals, targets and policy of the M/P were summarized as follows.

- Lack of the MSW final disposal sites and difficulty of obtaining the new final disposal sites
- Insufficient capacity of the MSW disposal
- Insufficient funds

In order to fulfill the essential necessities, the system Alternative-2 was selected as the M/P in the Chapter 4, and the construction of HHM2 can be selected as the First Priority Project that will be able to comply with the necessities most effectively in the shortest time.

At the same time, technical evaluation on the soft and hard basis of technologies for putting the plan of HHM2 in practice was performed in the Chapter 5.

In October 29, 1992, the General Assembly of Budapest Capital City Government decided on the construction of HHM2 as the First Priority Project on the basis of a preliminary study prepared by the city government.

In the following Chapters, the construction of HHM2 will be studied chiefly concerning the following aspects.

- Technical aspects
- Economic and financial aspects
- Organizational and institutional aspects
- Environmental aspects
- Operational aspects

PART II
FEASIBILITY STUDY

CHAPTER 6 DIRECTION AND CONDITIONS OF THE FIRST PRIORITY PROJECT IN THE FEASIBILITY STUDY

6.1 Direction

6.1.1 General

The annual MSW amount generated in Budapest in the target year 2005 is anticipated to increase by approximately 1,000,000 m^3.

The area that can be secured as the final disposal sites within the Budapest city decreases steadily in proportion to the increase in the MSW quantity. In other words, securing of the final disposal sites is becoming increasingly difficult.

This is one of the most important factors that needs to be considered in order to establish an optimal MSW management system for Budapest in the future.

It was concluded that the establishment of a new incineration plant (HHM2) for the maximal incineration of the combustible MSW is optimal and, at the same time, urgently required.

In the F/S, the financial, technical and environmental aspects for the first priority project of the HHM2 construction were examined.

Furthermore, the first priority project was predicated upon the decision of the Steering Committee of November 12, 1992. The decision of the Steering Committee is based on the decision of the Budapest City General Assembly of October 29, 1992 which underlines the necessity of the construction of HHM2 and the decision to locate it in district-XV at the same site with HHM1.

The installation of a flue gas treatment facility at HHM1 must satisfy the emission and immission values of Hungary as a prerequisite for the construction of HHM2.

In order to construct and maintain HHM2, it is very important that revenues be secured and financial conditions be improved in the Budapest Capital City Government.

Thus, this Study concludes that implementation of the "burden share principles" towards this purpose is necessary.

In other words, the government, municipality and citizens must share expenditure within suitable ranges.

Considering that presently, citizens in other cities of Hungary are paying fees for waste collection, the adaptation of similar systems in the city of Budapest should by all means be possible.

Thus, the most fundamental issues have been oriented. In the Chapters 6 and 7, the extent, configuration and characteristics of HHM2 are discussed. Further examination of financial and environmental issues is presented in the Chapters 10 and 11.

6.1.2 Financial Analysis and Plan of Project Implementation

On an incremental basis, the Financial Internal Rate of Return (FIRR; for the period 1994 - 2013) is -3.81% and the Economic Internal Rate of Return (EIRR; for the period 1994 - 2013) is 0.49%.

Although the ratio of revenue to operation/maintenance cost is balanced, investment cost is high relative to the revenue structure. Therefore, total year-end cash balances show deficits for every year.

The execution of the following financial substantiation is therefore necessary.

(1) To minimize the investment cost

- Tax deduction or exemption on the project

(2) To lighten the municipality's financial burden

- Use of government's subsidy or grant for the project
- Use of concessional loans under government's guarantee
- Introduction of a new fee collection system

From the burden share principles (government, municipality, citizen), a desirable financial plan for the project is a combination of the following.

- Total tax exemption by the central government
- Use of foreign concessional loans and budgeting a repayment in the municipality's budget
- New fee collection system from citizens

The model plan based on this combination is described below (Refer to the Figure 6-1).

It is necessary to exempt all custom duties and VAT on the project and on the other hand to collect the user charges at 118 Ft/month·household for first five years (1994-1998) then increase to 235 Ft (1999-2013) by FKFV. The municipality as the project owner takes responsibility for loan repayment on the project. It is assumed that the municipality's burden amount will be 840 million Ft (≒10 million US$) every year after the commencement of the HHM2 operation.

- Financial plan
  . Tax exemption (by the Government)
    .... Duty/VAT exemption

. Repayment of loans (by the Municipality)

.... 10 Million US$/year

. New fee collection (from citizens)

.... 118 Ft/month·household (1994-1998)

.... 235 Ft/month·household (1999-2013)

In this case the Financial Internal Rate of Return (FIRR) is as follows and the project can be considered financially feasible.

- Financial Internal Rate of Return (1994 - 2013)
  . On the incremental basis
    FIRR: 3.97%
  . On the "With" case*)
    FIRR: 4.54%

The degree of the burden for the government, municipality and citizens, in the event that this financial plan is executed, is respectively shown below:

- Degree of burden
  . Government
    Ratio to national import duty : 0.014%
    Ratio to national VAT : 0.016%

  . Municipality
    Ratio of 10 million US$ to Municipality budget : 1.32%

  . Citizen
    Ratio to average monthly earning (42,100 Ft in 1992) of household
    1994-1998: 0.28% (118 Ft/Month·household)
    1999-2013: 0.56% (235 Ft/Month·household)

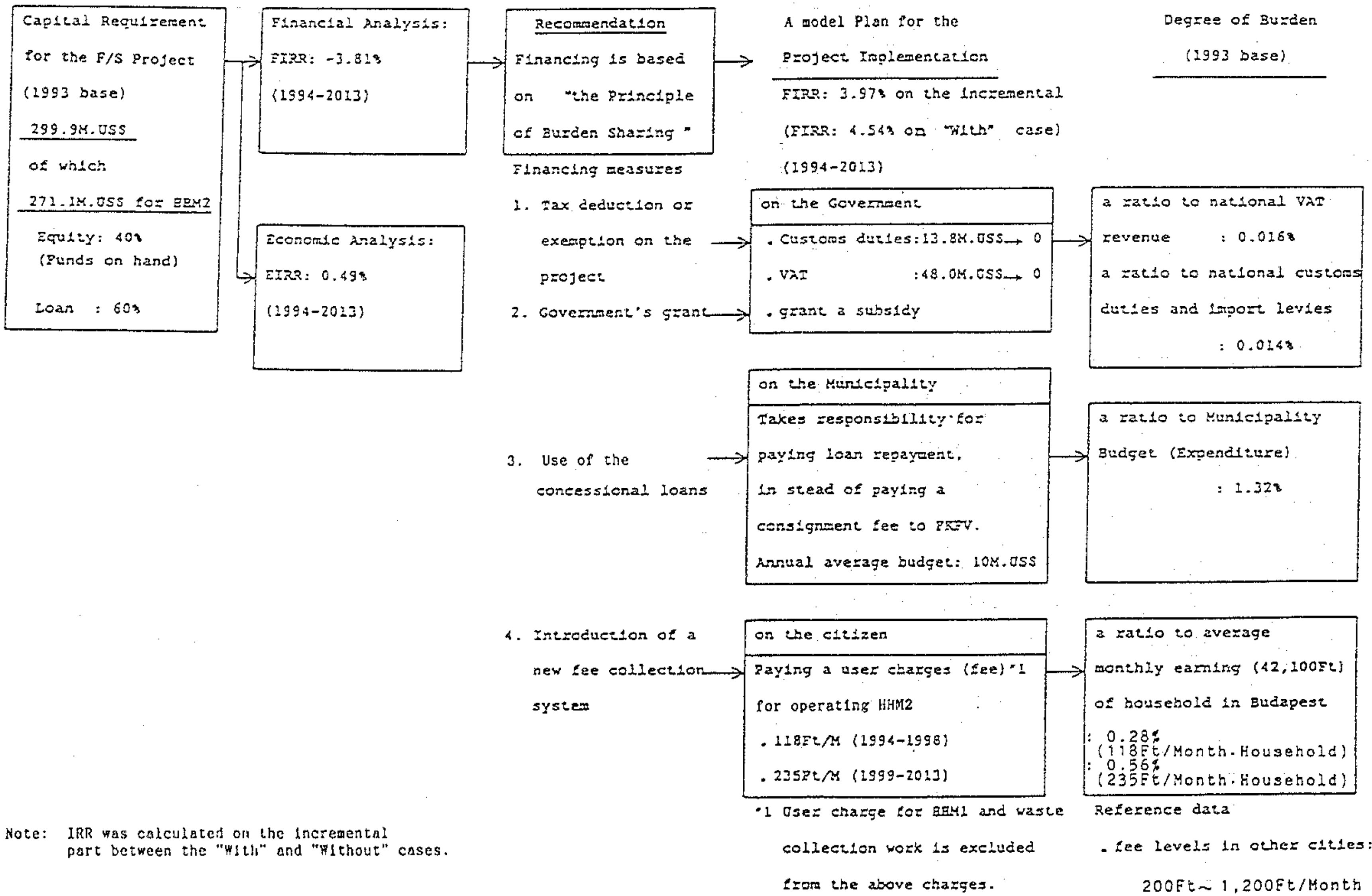
In comparison with the collection fees (200 - 1,200 Ft/month) collected from citizens in other cities in Hungary, this burden should not be difficulty for the citizens of Budapest.

The Figure 6-2, image of cashflow describes the conceptual image of cashflow in this financial plan.

Note*): "With" case

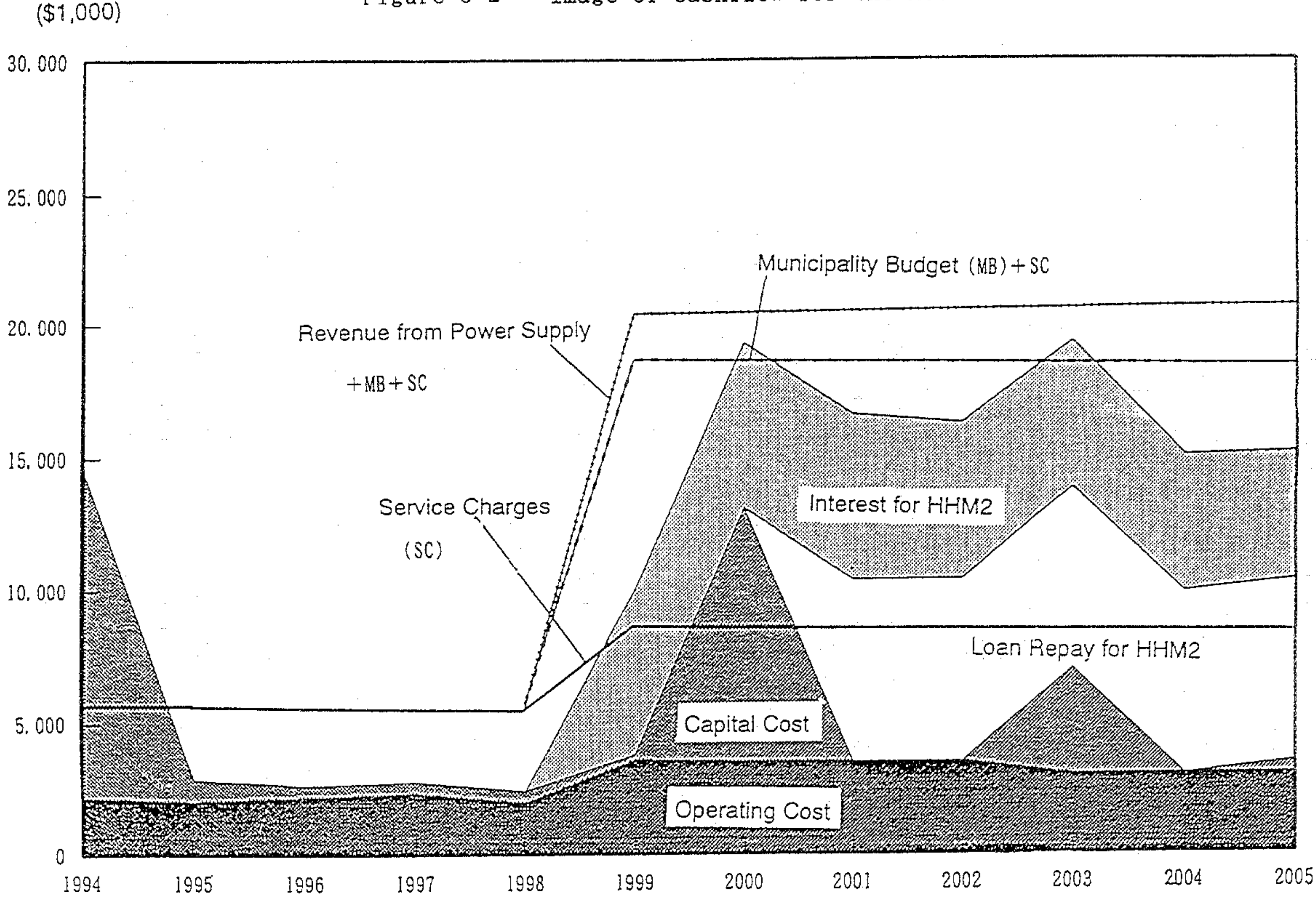
The scope of the Feasibility Study (F/S) is defined as the construction of HHM2. It is, however, a fact that in the future the MSW management system cannot be achieved only by maintaining HHM2. Complementary components such as vehicles to transport the MSW to HHM2 and the final disposal sites for disposing residues from HHM2 are at least needed. The "With" case refers to the project in which such necessary components are included.

Figure 6-1 Recommended Plan for the F/S Project Implementation



Note: IRR was calculated on the incremental part between the "With" and "Without" cases.

Figure 6-2 Image of Cashflow for the Model Plan



Note: Capital cost includes only the cost for the final disposal facilities and purchase of collection vehicles.

6.2 Basic Conditions of the New Incineration Plant Planning

Fundamental conditions for planning HHM2 are described in two phases. The first phase is for key conditions in general. In the second phase, more detailed plans are presented in the Sections 6.3 and 6.4.

6.2.1 Amount of the Municipal Solid Waste to be Incinerated

According to the MSW mass balance in the Table 4-12, the total amount of the MSW to be incinerated by HHM1 and HHM2 in 2005 is about 3.7 million m^3, 2.1 million m^3 by HHM1 and the rest by HHM2.

However, in the Table 4-12, the usual amount of the MSW incinerated by HHM1, 2.1 million m^3/year, will be reduced during 1996 to 2004, because the boilers of HHM1 will be modified again during that period.

6.2.2 Characteristics of the Municipal Solid Waste

In comparing analyzed data of the MSW for the off heating and heating seasons, no remarkable differences are observed in physical and chemical compositions, and heating values.

Data which have been obtained by FKFV, presented in the Section 3.8, can be used for planning for HHM2. In the Section 4.2.2 the medium (normal) heating value was examined with the second method, that is 8000 KJ/kg. Low heating values of the MSW summarized in the Table 6-1 are shown in the Figure 6-3, the Firing Diagram, by taking into account the ratio 2:1 between the maximum and minimum heating values.