8.1.4 Discharge, Storage, Collection and Haulage

Since these activities are closely related to each other, the system constituting various sub-components must be analyzed entirely for the formulation of the optimal system.

1) Introduction

The collection and haulage system in Poznan city has been fully developed in the course of MSWM activities, and is functioning almost satisfactorily. However, to adopt the waste flow proposed in the MEWM Master Plan, some operations should be improved and some new systems have to be introduced.

a. Proposed Modification Measures for the Present System

Discharge, storage, collection and haulage procedures are very difficult to drastically alter in places where they are effectively working because they have become a part of the peoples' way of life. However, because of the introduction of new intermediate treatment facilities to the present collection and haulage system, some modifications will be required. These modifications will lead to changes in the discharge and storage system which have become very much a part of the peoples' way of life.

Since the present system is working well, the modifications will be minimized to help the people cope with the changes smoothly. The modifications will be in conformity with the requirements for the proposed intermediate treatment plants.

b. Proposed New Systems

The introduction of new intermediate treatment facilities requires the enforcement of separate collection which would include the use of a few collection systems.

c. Change in Final Disposal Site

The MSWM Master Plan proposes to change the location of the disposal site from Suchy Las to Franowo-Michalowo. The change in the final disposal site will influence present work efficiency and this should be considered as a precondition for all proposed modifications.

2) Target of Discharge, Storage, Collection and Haulage Plan

- 100 % collection service coverage
  (This target can be attained, provided that a law for compulsory waste collection is introduced.)
- Realization of controlled waste flow
- Highly efficient of collection and haulage works with more cooperation from the citizens

3) Collection Systems

i. Introduction

A separate collection system must be introduced to maintain a highly efficient incineration plant and also to protect the incinerators from damage caused by unsuitable wastes.

In addition, new collection systems should be provided for wastes unsuitable for incineration, such as bulky wastes, ashes, garden wastes, construction waste, soil and rocks, which might cause problems.

In order to promote recycling and to protect the environment from damages caused by hazardous wastes, such as batteries which are often discharged by households, separate collection is advisable.

The introduction of a separate collection will require the help of the citizens and increase the cost of collection and haulage operations. Although separate collection system consists of four sub-systems, careful review and preparation are required prior to their implementation.

ii. Aims of Sub-systems

Three collection sub-systems shown below were planned:

- Regular separate collection of combustible and non-combustible wastes
- Bulky waste collection
- Public Recycling centre collection

The aims of these collection sub-systems are summarized in Table 8.1.4-1.

Table 8.1.4-1 Aims of Collection Sub-systems

Collection Sub-system	Aims
Regular separate collection of combustible and non-combustible wastes	- to supply wastes with high calorific values to the incineration plant. - to protect incinerators from damage by unsuitable wastes.
Bulky waste collection	- to provide people with a collection service for bulky wastes.
Public Recycling centre collection	- to provide people with a collection system for wastes rejected by the regular collection service. - to promote recycling. - to collect hazardous wastes generated at home.

iii. Method of Collection Sub-systems

The methods of each collection sub-system are presented in Table 8.1.4-2.

Table 8.1.4-2 Method of Collection Sub-systems

Collection Sub-system	Obliged or Compulsory	Method
Regular separate collection of combustible and non-combustible wastes	Yes	People are requested to discharge combustible and non-combustible wastes separately. Discharged wastes are regularly collected by the collection agencies.
Bulky waste collection service for bulky waste	No	Bulky wastes, which are not included in the regular collection service, are collected by request.
Recycling centre collection	Partly	Householders carry their own wastes unsuitable for regular collection to public recycling centres and sort them into categorized containers.

The available collection sub-systems for wastes are presented in Table 8.1.4-3.

Table 8.1.4-3 Available Collection Systems by Waste Category

Classification	Regular collection		Bulky waste collection	Public Recycling centre collection
	Combustible	Non-combustible		
garbage	x			
paper	x			
textile	x			
plastic	x			
grass and wood	x			
leather and rubber	x			
metal		x		
glass		x		x
ceramic and soil		x		x
ash		x		x
bulky			x	x

iv. Waste Flow by Building Categories

New Apartment Building Areas

Table 8.1.4-4 Proposed Waste Flow from New Apartment Buildings Areas to Reception

Collection system		Discharge	Storage	Collection	Haulage	Reception
Regular	Combustibles	Manual delivery	6-10 m^3	Curb	Hoist truck	Incinerator
	Non-combustibles	Manual delivery	6-10 m^3	Curb	Hoist truck	Landfill
Bulky waste		none	in the house	Door to door	Flat-bed truck	Landfill
Recycling centre		none	in the house	none	Personal delivery	P.R.C

Regular collection of combustible waste

- Discharge system : Transported manually
  Dust chute discharge will be prohibited.
- Storage system : 6 to 10 m^3 containers
- Collection system : Container yard collection
  Frequency depends on the covered population.
- Haulage system : Hoist truck

Regular collection of non-combustible waste

- Discharge system : Transported manually
  Dust chute discharge will be prohibited.
- Storage system : 6 to 10 m^3 containers
- Collection system : Container yard collection
  Frequency depends on the covered population.
- Haulage system : Hoist truck

Bulky waste

There are two options available to the people for the discharge of wastes mentioned above.

- Option No.1: Recycling Centres
  - . Discharge system : Transported manually
  - . Storage system : storage in the house
  - . Collection system : personal delivery
  - . Haulage system : personal delivery

- Option No.2: Bulky waste collection Service
  - . Discharge system : Transported manually
  - . Storage system : storage in the house
  - . Collection system : Door to door
  - . Haulage system : Flat-bed truck

Recyclable waste

There are two options available to the people for the discharge of recyclable waste.

- Option No.1: Recycling Centres
  - . Discharge system : Transported manually
  - . Storage system : storage in the house
  - . Collection system : personal delivery
  - . Haulage system : personal delivery

- Option No.2: Private Recycler
  - . Discharge system : Transported manually
  - . Storage system : storage in the house
  - . Collection system : depends on the recycler
  - . Haulage system : depends on the recycler

Old Building Areas

Table 8.1.4-5 Proposed Waste Flow from Old Building Areas to Reception

Collection system		Discharge	Storage	Collection	Haulage	Reception
Regular	Combustibles	Manual delivery	110 l 1.1 m^3	Curb	Compactor truck	Incinerator
	Non-combustibles	Manual delivery	110 l 1.1 m^3	Curb	Side loading truck	Landfill
Bulky waste		none	in the house	Door to door	Flat-bed truck	Landfill
Recycling centre		none	in the house	none	Personal delivery	P.R.C

Regular collection of combustible waste

- Discharge system : Transported manually
  Dust chute discharge will be prohibited.
- Storage system : 110 l dustbins and 1.1 m^3 containers, Bobr
- Collection system : Curb collection
  Frequency - approximately once a week.
- Haulage system : Compaction truck

Regular collection of non-combustible waste

- Discharge system : Transported manually
  Dust chute discharge will be prohibited.
- Storage system : 110 l dustbins and 1.1 m^3 containers, Bobr
- Collection system : Curb collection
  Frequency - approximately once a month.
- Haulage system : Compaction truck

Bulky waste

There are two options available to the people for the discharge of bulky waste.

- Option No.1: Recycling Centres
  . Discharge system : Transported manually
  . Storage system : storage in the house

. Collection system : personal delivery
. Haulage system : personal delivery

- Option No.2: Bulky waste collection Service
  . Discharge system : Transported manually
  . Storage system : storage in the house
  . Collection system : Door to door
  . Haulage system : Flat-bed truck

Recyclable waste

There are two options available to the people for the discharge of recyclable waste.

- Option No.1: Recycling Centres
  . Discharge system : Transported manually
  . Storage system : storage in the house
  . Collection system : personal delivery
  . Haulage system : personal delivery

- Option No.2: Private Recycler
  . Discharge system : Transported manually
  . Storage system : storage in the house
  . Collection system : depends on the recycler
  . Haulage system : depends on the recycler

Detached and Semi-detached Houses

Table 8.1.4-6 Proposed Waste Flow from Detached and Semi-detached Houses

Collection system		Discharge	Storage	Collection	Haulage	Reception
Regular	Combustibles	Manual delivery	Paper bag	Curb	Compactor truck	Incinerator
	Non-combustibles	Manual delivery	110 l	Curb	Side loading truck	Landfill
Bulky waste		none	in the house	Door to door	Flat-bed truck	Landfill
Recycling centre		none	in the house	none	Personal delivery	P.R.C

Regular collection of combustible waste

- Discharge system : Transported manually
- Storage system : Paper bags
- Collection system : Curb collection
  Frequency - approximately once a week.
- Haulage system : Compaction truck

Regular collection of non-combustible waste

- Discharge system : transported manually
- Storage system : 110 l dustbins
- Collection system : Curb collection
  Frequency - approximately once a month.
- Haulage system : Side loading truck

Bulky waste

There are two options available to the people for the discharge of bulky waste.

- Option No.1: Recycling Centres
  - . Discharge system : Transported manually
  - . Storage system : storage in the house
  - . Collection system : personal delivery

. Haulage system : personal delivery

- Option No.2: Bulky waste collection Service
  . Discharge system : Transported manually
  . Storage system : storage in the house
  . Collection system : Door to door
  . Haulage system : Flat-bed truck

Recyclable waste

There are two options available to the people for the discharge of recyclable waste.

- Option No.1: Recycling Centres
  . Discharge system : Transported manually
  . Storage system : storage in the house
  . Collection system : personal delivery
  . Haulage system : personal delivery

- Option No.2: Private Recycler
  . Discharge system : Transported manually
  . Storage system : storage in the house
  . Collection system : depends on the recycler
  . Haulage system : depends on the recycler

v. Concept of Each Collection System

Regular Collection of Combustible and Non-combustible Waste

The discharger is required to dispose combustible and non-combustible wastes separately. Combustible wastes included in the regular collection must be suitable for incineration, bulky wastes are, therefore, excluded.

The main waste categories dealt with in the regular collection of combustible waste are:

- kitchen waste
- paper
- textile
- plastics
- grass and wood
- leather and rubber

Other wastes are also included in the regular collection of non-combustible wastes except for bulky wastes, ash, wastes, etc., because they disturb the collection work efficiency.

Bulky waste collection

Bulky waste is received at public recycling centres. However, there are some householders who cannot afford to carry bulky waste to recycling centres due to various reasons such as lack of transportation. Bulky waste collection service is provided for such householders.

Recycling Centres Collection

Recycling centres supervise container sites and admission is free for all householders. The householders carry unsuitable wastes for regular collection to the most convenient recycling centre and sort their waste into appropriate containers. Recyclable wastes are sold to customers and the remainders are carried and disposed of at the landfill.

4) Estimation of Cycle Time for Regular Collection

Refuse Truck

The cycle time of collection work is estimated to be longer for compaction truck collection because of the expected increase in collection frequency due to the introduction of regular separate collection. Changes, however, are not expected in the cycle time of hoist truck collection.

The cycle time of compaction trucks is estimated to be influenced at a lesser rate: approximately 15 % of the collection time.

114 min. x 15 % = 17.1 min.

Hence, cycle time of collection work of compaction truck is estimated to be longer by 17.1 minutes. However, this 17.1 minutes can be covered by saving time due to alteration of landfill site.

Container

The required number of containers was estimated to increase as shown below, due to the introduction of separate collection:

- 110 litre and 1.1 m^3 : 1.5 times
- 7 to 10 m^3 : 2 times

5) Bulky waste collection

i. Introduction

The introduction of a bulky waste collection service is planned, because bulky waste is refused by regular collection services. There are two collection methods prepared for bulky wastes; one is bulky waste collection and the other is recycling centre collection.

The recycling centre collection will not charge the receipt of bulky waste, but requires that dischargers transport their bulky waste themselves to the recycling centres. The bulky waste collection service on the other hand collects, hauls and disposes these bulky wastes for a certain amount.

The bulky waste collection system is convenient for people who can not carry bulky waste to recycling centres but can afford to pay for its discharge.

Handicapped people, people with low income etc., should be provided with free bulky waste collection services because they are incapable of carrying out both ways.

This service is, therefore, necessary to supplement the regular collection service and recycling centre collection.

ii. Proposed Method

The discharger can always phone a collection agency to request the collection of bulky waste. The collection agency answers the request for a certain fee transports the waste to the final disposal site. The collection fee for bulky wastes should be determined to cover all costs.

iii. Estimation of Cycle Time

The cost are estimated based on the following design data.

- Type of truck : Flat-bed with crane truck
- Payload of truck : 10 tons
- Design load : 3 tons/trip
- Average number of trips : 2 trips/day
- Working days : 304 days/year
- Work efficiency : 0.8

The capacity of the truck was calculated as follows:

3 tons/truck x 2 trips/day x 304 days/year x 0.8 = 1,459 tons/year/truck

Hence, the estimated total amount of bulky waste carried by a truck per year is 1,459 tons.

6) Cost Estimation

a. Container

The introduction of separate collection will require more containers, as stated in 8.1.4-4). The required number of containers by the introduction of separate collection, and their prices, are presented below.

Table 8.1.4-7 Price List of Containers

Container	Price level in Poland (mill.zl)
- Paper sack holder	0.30
- 110 l dustbin	0.22
- 1.1 m^3 steel container "Bobr"	2.43
- 6 to 10 m^3 communal container	13.92

Table 8.1.4-8 Required Number of Containers by the Introduction of Separate Collection

Year	Separate collection ratio	Increased number of container by separate collection		
		110 l dustbin	1.1 m^3	6 - 10 m^3
	100 %	17,340	2,757	651
1998	35 %	6,069	965	298
2002	35 %	6,069	965	298
2007	30 %	5,202	827	255

b. Flat-bed truck for bulky waste collection

Bulky waste collection will use flat-bed trucks for collection and transportation of bulky wastes from users' houses to recycling centres. Costs estimate and the required number are presented below.

Table 8.1.4-9 Cost for Bulky Waste Collection

Item	Price level in Poland mill. zl/year
Investment - Flat-bed truck with crane	320
O & M Cost - Labour Cost (Driver and 2 workers) - Diesel and lubricant oil - Maintenance	292 139 32
Annual O & M cost	463

Note: Annual O & M cost excludes tipping fee.

Table 8.1.4-10 Required Number of Truck for Bulky Waste Collection

Year	Bulky Waste Discharged		Bulky Waste Collection, 30 % of discharged amount (ton/year)	Required number of Truck (units)
	(ton/day)	(ton/year)		
1995	16.5	6,023	1,807	2
1996	16.8	6,132	1,840	2
1997	17.1	6,242	1,873	2
1998	17.3	6,315	1,895	2
1999	17.6	6,424	1,927	2
2000	17.9	6,534	1,960	2
2001	18.5	6,753	2,026	2
2002	19.1	6,972	2,092	2
2003	19.6	7,154	2,146	2
2004	20.2	7,373	2,212	2
2005	20.8	7,592	2,278	2
2006	21.4	7,811	2,343	2
2007	22.0	8,030	2,409	2
2008	22.7	8,286	2,486	2
2009	23.4	8,541	2,562	2
2010	24.1	8,797	2,639	2

Note : Productivity of a flat-bed truck is 1,459 ton/year/truck.

c. Roll-on Roll-off Truck for Public Recycling Centres

The estimation of the transportation cost from public centres to the final disposal site is presented in Table 8.1.4-11 and -12.

Table 8.1.4-11 Cost Estimate for Roll-on Roll-off Truck

Item	Price level in Poland mill. zł/year
Investment - Roll-on roll-off truck with crane	470
O & M Cost - Labour Cost (Driver) - Diesel and lubricant oil - Maintenance	139 154 47
Annual O & M cost	340

Note: Annual O & M cost excludes tipping fees.

Table 8.1.4-12 Required Number of Roll-on Roll-off Truck

Year	Operated number of R.C.	Amount of residue from Recycling centres		Required number of Roll-on Roll-off (units)
		ton/day	ton/year	
1996	3	20.9	7,629	2
1997	6	42.4	15,476	3
1998	8	57.4	20,951	4
1999	8	58.3	21,280	4
2000	8	59.4	21,681	4
2001	8	61.3	22,375	4
2002	8	63.2	23,068	4
2003	8	64.9	23,689	4
2004	8	67.1	24,492	5
2005	8	69.1	25,222	5
2006	8	71.1	25,952	5
2007	8	73.4	26,791	5
2008	8	75.7	27,631	5
2009	8	78.0	28,470	5
2010	8	80.7	29,456	5

Note: Productivity of a roll-on roll-off truck was estimated at 5,837 tons/year/truck.
20 m^3 x 0.3 ton/m^3 x 0.8 x 4 trips/day = 19.2 tons/day/truck
19.2 tons/day/truck x 304 days/year = 5,837 tons/year/truck

8.1.5 Final Disposal: Sanitary Landfill

1) Introduction

Sanitary landfill is generally recognized as the basic element in modern solid waste management.

Thus, it is acknowledged that a considerable quantity of waste has to be disposed of even if efforts are provided for their reuse (recycling) or utilization (incineration, composting).

Therefore, as a first step towards modern solid waste management, the landfill activity of Poznan should be strengthened to minimize environmental impacts. Having the requirements for sanitary landfill clarified and the proper design and operation implemented, attention can be focused on other treatment methods.

This Section presents the conceptual lay-out and cost estimates of the new landfill site to be established at Franowo-Michalowo, the site selected by the Municipality of Poznan as the future location of a landfill site and treatment facilities. The site comprises an area of approximately. 180 ha, as shown in Fig.8.1.5-1.

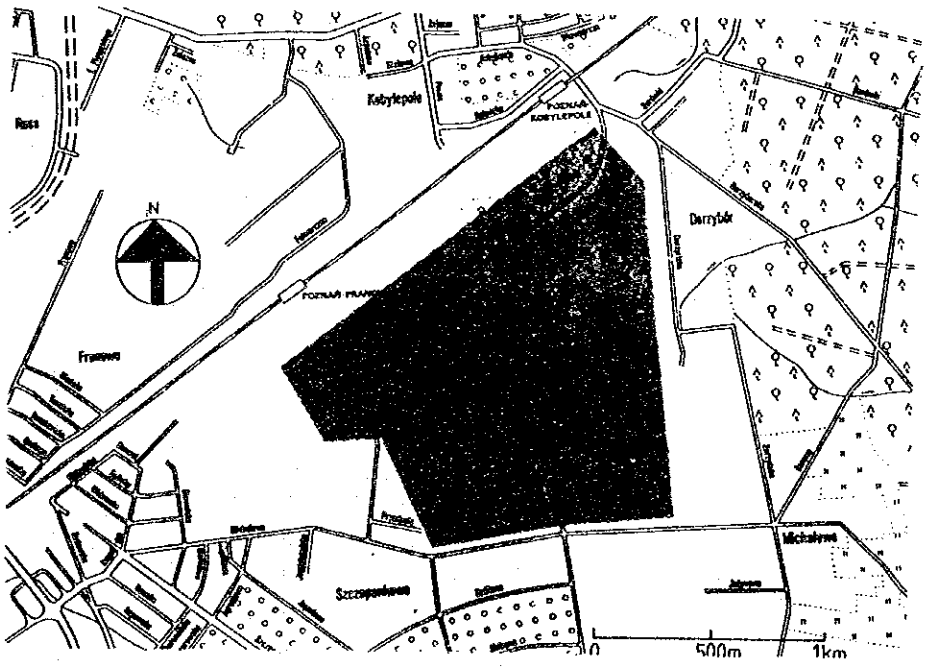


Fig.8.1.5-1 Location of the Selected Area for the New Landfill and Future Treatment Plants.

2) Design Data

a. Waste Quantity for Disposal

The required landfill volume stated in the Table is based on the following precon-ditions:

- An incineration plant, with a 10.0 tons/hour capacity will be operated in year 2001.
- The incineration plant will be expanded in year 2006 and 2010.
- Eight recycling centres will be operated during the period 1996 to 1998.

Table 8.1.5-1 Estimated Waste Generation in Poznan City and Required Capacity of New Landfill at Franowo-Michalowo

Year	Waste Generation (tons/year)	Incineration plant (nos. of lines)	Recycling centres (nos.)	Required Landfill Volume			
				Annual m^3/year x 1,000		Generated m^3 x 1,000	
				Slag	Other	Slag	Other
1994	191,900	0	0	0	0	0	0
1995	189,900	0	0	0	229	0	229
1996	188,000	0	3	0	227	0	456
1997	186,200	0	6	0	225	0	681
1998	184,300	0	8	0	224	0	905
1999	182,600	0	8	0	223	0	1,129
2000	180,800	0	8	0	223	0	1,351
2001	186,100	1	8	18	157	18	1,508
2002	191,700	1	8	18	164	36	1,672
2003	197,400	1	8	18	171	54	1,842
2004	203,300	1	8	18	178	72	2,020
2005	209,300	1	8	18	185	90	2,223
2006	215,500	2	8	36	120	126	2,326
2007	229,500	2	8	36	128	162	2,454
2008	228,600	2	8	36	136	198	2,590
2009	235,400	2	8	36	145	234	2,635
2010	242,397	3	8	54	81	288	2,815

b. Future Use of the Landfill Area

When the landfilling of the area ends, it will be covered with soil and furnished with planting appropriate for future recreational utilization of the area.

The final cover of the landfill comprises at least 1 m. soil. Uncontrolled release of methane gas released from the waste is avoided by a layer of gravel, one of three recommended precautionary measures against gas.

Most of the soil required for final cover as well as for daily cover of waste may be excavated to the site when preparing areas for later sections of the landfill.

The future landscape plan is presented in Drawing no. L1. No slopes are allowed to be steeper than 1:4 taking into account the varying frictional strength of waste disposed of at the landfill and since no special measures will be taken to ensure the stability of the future hill. This requirement for the slopes of the hill is obtained through the experiences from landfills in Western Europe.

The general slope of the hill is proposed to be 1:8 to accommodate the surrounding landscape. The final design of the hill is recommended to be designed by a professional architect.

Assuming a future landscape as presented in Drawing no. L1, approximately. 7.0 mill. m^3 of compacted waste may be disposed of on the site. This is more than twice as much as the required volume for the planning period (up to year 2010).

The proposed future landscape does not include any filling in the north eastern part of the selected area. This area is reserved for future treatment plants, incineration etc..

c. Capacity of Landfill Sections

The area for waste disposal is proposed to be divided into sections as shown in Drawing No. L4. Each section of the sanitary landfill is to be filled up corresponding to the planned final terrain before a new section is opened. This way, the total area open for infiltration of rain water is kept at a minimum, as well as the generation of leachate.

From year 2001 the landfill is supposed to receive slag and ash from waste incineration. In order to avoid a substantial washing out of metals and other pollutants from wastes, separate landfill sections are constructed for slag and ash.

This washing out of slag and ash will occur in case acid leachate from other waste infiltrate the slag.

It is appropriate to design and construct landfill sections with a capacity complying with the volume required for 2 to 3 years use.

In compliance with the estimated waste generation and the required landfill capacity presented in Table 8.1.5-1, the recommended capacity of the landfill sections as well as the construction year appear in Table 8.1.5-2 and 8.1.5-3.

Table 8.1.5-2 Required Capacity and Year for construction of Landfill Sections for Other Waste but Slag and Ash

Landfill Section for Other Waste No.	Year for Construction	Required Capacity of Landfill Section (m^3)	Disposal Period (year)
W 1	1994	681,000	1995 - 1997
W 2	1997	670,000	1998 - 2000
W 3	2000	491,000	2001 - 2003
W 4	2003	484,000	2004 - 2006
W 5	2006	489,000	2007 - 2010
Total	-	2,815,000	1995 - 2010

Table 8.1.5-3 Required Capacity and Year for Construction of Landfill Sections for Slag and Ash.

Landfill section for slag and ash No.	Year for Construction	Required Capacity of Landfill Section (m^3)	Disposal Period (year)
S 1	2000	90,000	2001 - 2005
S 2	2005	108,000	2006 - 2008
S 3	2008	90,000	2009 - 2010
Total	-	288,000	2001 - 2010

d. Forecasts on Leachate

Quantity of Leachate

The quantity of leachate which is generated from the landfill depends primarily on the following :

- Precipitation and evaporation at the landfill site

- The size of the area which has been occupied by landfill sections with disposed waste

- The capability of waste to absorb water

According to the Statistical Year Book of Poland (1991), the average annual precipitation in Poznan for the last decade is calculated at 500 mm. The average evaporation is estimated at 350 mm/year.

Based on the experiences from landfills in Western Europe, the generation of leachate from a landfill with bottom liner at Poznan is assessed as follows:

- Approximately 300 mm/year for landfill sections under filling with waste

- Approximately 150 mm/year for landfill sections which have been utilised for waste disposal and are furnished with final soil cover.

Assuming the landfill sections are filled up corresponding to the planned final terrain and furnished with final cover, the generation of leachate is kept at a minimum before a new section is opened. The generation of leachate is estimated and presented in Table 8.1.5-4.

Table 8.1.5-4 Estimated Generation of Leachate from the Landfill

	Landfill Section Operated	Estimated Leachate Generation (cu.m./year)
1994	-	0
1995	W1	0.3 x 40,000 = 12,000
1996	W1	12,000
1997	W1	12,000
1998	W2	(0.3+0.15) 40,000 = 18,000
1999	W2	18,000
2000	W2	18,000
2001	W3+S1	0.3 (30,000+10,000) + 0.15 x 80,000 = 24,000
2002	W3+S1	24,000
2003	W3+S1	24,000
2004	W4+S1	0.3 (30,000+10,000) + 0.15 x 110,000 = 33,000
2005	W4+S2	0.3 (30,000+10,000) + 0.15 x 120,000 = 28,500
2006	W4+S2	28,500
2007	W5+S2	0.3 (30,000+10,000) + 0.15 x 150,000 = 34,500
2008	W5+S3	0.3 (30,000+10,000) + 0.15 x 160,000 = 36,000
2009	W5+S3	36,000
2010	W5+S3	36,000

e. Landfill Gas

Landfill gas is 3 to 35 l/kg moist household waste per year and approximately 160 l/kg of organic matter is totally produced.

Landfill gas has a calorific value of 15 to 21 MJ/cu.m. The calorific value does not remain constant in the lifetime of a landfill and decreases is time.

A number of problems has been experienced:

- dying of vegetation
- fires
- explosions

To avoid the recurrence of these problems, many countries are now requiring monitoring and control of landfill gas. The British authorities, for one, have produced a second edition of a guideline for the control of landfill gas.

It is important to ensure that landfill gas is not spread to neighbouring buildings and areas. Suitable measures should be taken to deal with landfill gas on completed landfills.

The migration of landfill gas depends on local ground conditions. The problems with migration of gas have particularly been noticed when former quarries were used for landfilling. Problems with migration of gas are seldom observed near landfills on flat areas of land.

A number of methods can be applied to deal with landfill gas:

- Collection of landfill gas by suction pumps and gas drain pipes. The gas can be utilized for heating or production of electricity, ventilated or burned.

- Dispersion of landfill gas through a porous final capping.

- Collection of landfill gas in drain pipes and ventilating the gas through shafts.

- Collection of landfill gas in porous layers of sand and gravel. The gas is ventilated through compost filters where it is being bio-degraded by micro organisms.

f. Hydrogeological Investigations

As part of a Landfill project for the City of Poznan financed by the Danish Ministry of Environment and carried out by the Danish company, RH&H Consult, a hydro-geological investigation was carried out in 1992. A report on existing information (Plan of geological investigation of the site in the region Michalowo Franowo, October 1992) was carried out by the Polish company: Geokom.

As a result of the above mentioned investigations, two reports were elaborated: "Hydrogeological investigations of Site at Michalowo Franowo, January 1993" by Geokom, and "Hydrogeological investigations at Michalowo Franowo, February 1993", by RH&H Consult.

Summary of reports is presented below.

Geological conditions

Within 15 m from the upper surface are glacial deposits, primarily of sandy boulder clay layers, interbedded with sandlenses/-layers.

In some parts of the area, primarily in the northern and eastern part, two sandy layers have been found:

- one unsaturated layer around 1-3 m below the ground
- one saturated layer within 6-12 m below the ground

Only boulder clay was found about 60-70 m below these layers, where the tertiary deposits are distributed. The upper 30-50 m of tertiary deposits comprise primarily of silt subsequently followed by sand interbedded with organic deposits like char-coal.

Hydrogeological conditions

The regional primary groundwater reservoir, a confined sand reservoir with a groundwater table of about 20 m below the ground, is located in the tertiary deposits at, approx. 100-120 m below the ground.
Furthermore there are local secondary partly confined, partly unconfined reservoirs in the sand layers within the upper 15 m of glacial deposits. The water tables are situated at 3 m below the ground.

Locally, the secondary reservoirs are used as drinking water sources. Some of the houses located east of the site have private wells with a depth of about 5-10 m below the ground.

Water in the primary reservoir is expected to flow eastward while those in the secondary sand reservoirs flow northward then eastward. In the northern part of the Site, the flow direction is north – north–west due to a local drainage system.

3) Technical Description

a. Main Principles for Design and Operation of the Sanitary Landfill

The main task involved in sanitary landfill is to have waste disposal under full control, to avoid environmental pollution. The main hazards caused by a landfill are:

- Ground water pollution
- Surface water pollution
- Air pollution
- Diseases spread by insects, rodents, birds, etc.
- Noise

Preliminary lay–out and principles for the sanitary landfill located at Franowo–Michalowo is shown in the Drawings No. L1 to L6.

The above–mentioned hazards are overcome by the following measures:

- Bottom liner made of clay is constructed to prevent leachate from percolating into the ground. It is assumed that an appropriate formation of clay is available on or near the site. Otherwise, an artificial bottom liner (eg. polyethylene) might be used.

- Above the bottom liner a gravel layer comprising a system of stone drains is constructed for collection of leachate. The leachate is assumed to be pumped to a future municipal sewage treatment plant (refer to Drawings L3 and 4).

- Compaction of waste by heavy equipment to reduce the required volume of landfill and diseases being spread by rodents.

- Daily cover of waste with soil to prevent air pollution and spreading of diseases by insects, etc.

- Avoiding fires at the site to prevent air pollution.

- Planting of trees and construction of embankments around the landfill area to prevent visual nuisance.

- Boundary fencing to prevent scavenging.

- Control of incoming waste including construction of a weigh bridge.

- Construction of a leachate control and monitoring system based on a set of boreholes at the landfill area.

- Phased restoration of landfill areas including approximately 1 m soil cover, measures against gas and planting.

The quantity of leachate and contaminated run-off water produced is limited by the following precautions:

- Construction of landfill sections with a capacity corresponding to the required volume for about 2 to 3 years' disposal.

- Construction of ditches around the landfill area to prevent run-off water from the surrounding areas from infiltrating the waste.

- The daily covering of waste with soil will also reduce the quantity of rain water that infiltrates the waste.

The sanitary landfill will be operated by the following permanent staff:

- A foreman, to supervise the operation at the landfill.

- Inspectors, to undertake the registration at the weigh bridge and guide the trucks to the correct site for unloading of waste.

- Operators of heavy equipment, to be responsible for compacting and covering the waste with soil.

- Labourers, to maintain tidiness of the surroundings.

Working hours will be 6.00 to 15.00 hours.

b. Arrangements for the Sanitary Landfill

The proposed arrangements for the sanitary landfill (Phase 1) are shown in Drawing No. L3, and include the following main items:

- Access road to the sanitary landfill.

- Fencing and planting.

- Entrance area with weigh bridge and guard house.

- Administration building and workers' canteen and staff rooms.

- Garage with workshop.

- Heavy equipment for compaction of waste.

- Construction of bottom liner and drainage system for the disposal area, Section W 1.

- Construction of system for leachate including reservoir and pump station.

- Ditches and embankments around the landfill (Phase 1).

- System of boreholes for control of leaking leachate.

The Sanitary landfill (Phase 1) is proposed to be constructed in year 1994.

The disposal areas W 2 to W 5 will be constructed during the period 1997 to 2006 (refer to Drawing L4).

The disposal areas S 1 to S 3 for slags and ashes from the incineration of waste will be constructed during the period 2000 to 2007.

Leachate from the sanitary landfill is assumed to be pumped for treatment at the nearest municipal sewage treatment plant. During operation of the landfill section W1, leachate will be transported by truck.

As the generated quantity of leachate increases as more landfill sections are constructed, a pipe line for pumping of leachate to the nearest municipal sewage system should be built when the landfill area is expanded with the construction of the disposal area Section W2.

The nearest existing pipe line for sewage is located at Darzyborska St. This pipe line is 100 mm in diameter and connected to a bigger system at Piwna St. (refer to Drawing No. L4).

Alternative methods for treatment and removal of some of the leachate are as follows:

- Pumping and recirculation of leachate into old waste. This method is based on the idea that old wastes work as a biological filter. Thus, it is possible to transform "young" leachate into "old" leachate (refer to Table 8.1.5-7).

- Pumping and sprinkling of leachate on top of landfill areas to utilize the evaporation during the summer months.

- Pumping of excess leachate to the municipal system for rain water should be avoided, unless the landfill is equipped with its own sewerage treatment plant.

c. Bottom Liner and Drainage System

The bottom of the sanitary landfill is furnished with a liner appropriate for the prevention of leachate from infiltrating the ground. On top of the bottom liner is a system constructed for collection and drainage of leachate to a storage tank (see drawings No. L3 and L4). From the storage tank the leachate is pumped or transported by truck to a facility for treatment before discharge to the surrounding body of water.

The liner must be designed taking into account the physical, chemical, and biological effects which will or may take place during the construction phase as well as in the entire lifetime of the landfill. Materials to be used for the bottom liner, through experience or ageing tests, be proven that they are resistant to both young and old leachate.

In Western Europe, most bottom liners are constructed either with clay of low permeability or with a polymeric membrane.

Clay liner

A distinction is made between in-situ and installed clay liners. In-situ clay liners are made by the adjustment and homogenization of the surface of native clay deposits. Installed clay liners are built from two or more layers of homogeneous clay that is transported to the site from a clay pit.

The clay material must be selected and installed in order that the liner has the required degree of tightness. It is recommended that the clay liner should have a thickness of at least 0.5 m and a coefficient of permeability (k) not exceeding 10^{-10} m/sec.

Thus, materials for clay liners must contain more than 14 % clay and a plasticity index (I_p) larger than 5%. The material must be homogenous without layers and lenses of sand and silt. The water content of the clay should, at the time of application, be superior to the optimum water content, determined by Standard Proctor tests. However, it must be possible to build the materials to at least 95% of the maximum dry density of this test.

The collection and drainage system comprises a 0.3 m thick drainage layer with drains. The drainage layer must consist of a granular material appropriate for drainage ($k > 10^{-3}$ m/sec) and be free from clay and silt. The drains may be constructed from pebbles proven resistant to the load from high fillings of the landfill. The distance between the drains should not exceed 20 m.

Polymeric Membrane Liner

The construction of the bottom liner is as follows:

- 0.1 m fine sand to protect the polymeric membrane against perforation and tearing caused by stones in the subgrade.

- 1.0 mm thick membrane from polyethylene. The elongation at break must be at least 50%. The membrane should be delivered to the site in sections of up to 800 m^2. The sections should be constructed from at least 4 m wide membrane rolls that are welded together in the workshop.

- 0.3 m drainage layer with drains. The requirements for this layer and the drains are as for the clay liner. However, the drainage layer must not comprise stones and the pebble drains must be designed in a way that the membrane is protected against perforation.

4) Cost Estimates

Based on the described preliminary design of the sanitary landfill, this section presents cost estimates for the construction, operation and re-establishment of the sanitary landfill.

All estimates were made based on the following:

- Price level in ANNEX I.1.5.

- Leachate can be treated in a future municipal sewerage plant located near the sanitary landfill.

- Bottom liners can be constructed from a clay formation located on or near the site.

- Investments for pre-investigation (location, hydrogeological investigations, etc.) are not included.

a. Initial Investments

The following initial investments for facilities have to be performed when constructing the sanitary landfill, Phase 1. These facilities will be utilized throughout the life span of the sanitary landfill.

Table 8.1.5-5 Initial Investments for Sanitary Landfill

Item	Price level in	
	Western Europe USD x 1000	Poland mill. ZL
- Access road and entrance area including 2,000 m^2 asphalt pavement		1,390
- Weigh bridge, computerized	100	120
- Guard house and weigh room (50 m^2)		290
- Administration building and staff rooms (200 m^2)		990
- Garage (250 m^2)		930
- Water, electricity and sewerage		520
- Installation for leachate . Storage tank . Pump installation . Conduct for leachate (1,000 m.) . Electrical installation		1,740
- Boreholes (50 m.) for control of ground water		580
- Fencing		810
- Planting		580
- Connection fee (electricity, water, sewerage)		580
- Training of employees	20	
- Design and supervision	100	1,510
- Miscellaneous (20 %)	30	2,060
TOTAL initial investments	250	12,100

b. Equipment

In compliance with the composition and quantity of waste (approximately 200,000 tons/year up to year 2000), the landfill is proposed to be equipped as stated below:

Table 8.1.5-6 Proposed Equipment up to year 2000

Sanitary landfill, capacity 200,000 tons/year Equipment	Price level in Poland mill. ZL
- 2 compactors	3,480
- 1 traxcavator	1,390
- 1 dump truck	470
- 1 tractor with brush and watering equipment	230
- Others, tools and spare parts	230
TOTAL equipment	5,800

c. Landfill Sections

The following cost estimate meets the costs for construction of a landfill section with a capacity of 700,000 m^3 corresponding to the required capacity for each of the landfill sections W 1 and W 2.

Table 8.1.5-7 Cost Estimate for Landfill Section, capacity 700,000 m^3

Capacity:	Price level in	
- Volume: 700,000 m^3 - Area: 40,000 m^2 - Waste quantity: approx 200,000 t/year	Western Europe USD x 1,000	Poland mill. Zl
- Clearing and earthworks for bottom and embankment		2,670
- Bottom liner (0.5 m clay 40,000 m^2)		8,930
- Drainage layer (0.3 m gravel, 40,000 m^2)		3,480
- Leachate drains		1,740
- Temporary roads		230
- Design and supervision,	50	2,320
- Miscellaneous, 20 %		3,830
TOTAL, landfill section 700,000 m^3	50	23,200

Cost estimates for landfill sections with a capacity of 500,000 m^3 (W3, W4 and W5) and 100,000 m^3 (S1, S2 and S3) are elaborated as follows:

Table 8.1.5–8 Cost Estimate for Landfill Sections: Capacity 500,000 m^3 and 100,000 m^3

Capacity: Volume: / Area:	500,000 m^3 / 30,000 m^2		100,000 m^3 / 10,000 m^2	
	Price level in			
	Western Europe USD x 1,000	Poland mill. Zl	Western Europe USD x 1,000	Poland mill. Zl
TOTAL landfill section	50	21,000	50	5,800

d. Operation Costs

The following cost estimates meet the average annual costs for operation and maintenance of the landfill during the period 1995 to 2010 (approximately 200,000 tons/year). These costs, especially the costs for maintenance of equipment, may considerably vary annually.

Table 8.1.5–9 Operation Costs for Landfill, Capacity 200,000 tonnes/year.

Operation Costs	Mill. Zl/year
– Salaries . 5 operators of equipment . 1 mechanician . 1 operator of weighbridge . 1 foreman . 10 workers	1,740
– Administration	120
– Diesel and lubricants	810
– Maintenance of equipment	700
– Maintenance of buildings	120
– Current earth works: . Excavation of soil for daily coverage . Measures against bio gas . Internal roads	1,160
– Operation and maintenance of system for leachate	230
– Insurance, electricity and water	60
– Control and monitoring	60
– Miscellaneous (20%)	1,000
TOTAL, operation costs	6,000

Note: Fees for treatment of leachate at the future municipal sewerage treatment plant is not included.

Based on the annual waste quantity disposed of at the landfill, the operation costs during the planning period are estimated as follows:

Table 8.1.5-10 Operation Costs for Sanitary Landfill at Franowo-Michalowo.

Year	Waste Generation (tons/year)	Annual m^3/year x 1000 in Section		Operation Costs mill Zl/year
		Slag and ash	Other waste	
1994	191,900	0	0	0
1995	189,900	0	229 - W1	5,706 *1
1996	188,000	0	227 - W1	
1997	186,200	0	225 - W1	5,600
1998	184,000	0	224 - W2	5,570
1999	182,600	0	223 - W2	5,550
2000	180,800	0	223 - W2	5,550
2001	186,100	18 - S1	157 - W3	4,350 *3
2002	191,700	18 - S1	164 - W3	4,530
2003	197,400	18 - S1	171 - W3	4,700
2004	203,300	18 - S1	178 - W4	4,880
2005	209,300	18 - S1	185 - W4	5,050
2006	215,500	36 - S2	120 - W4	3,880
2007	221,900	36 - S2	128 - W5	4,080
2008	228,600	36 - S2	136 - W5	4,280
2009	235,400	36 - S3	145 - W5	4,500
2010	242,400	54 - S3	81 - W5	3,360

Operation cost were estimated in proportion to waste amount based on the standard operation cost given in Table 8.1.5-10, for example;

*1 6,000 x (189,900/200,000) = 5,697 → 5,700 mill. Zl
*2 5,697 x (227/229) = 5,647 → 5,650 mill. Zl
*3 5,697 x ((18 + 157)/229) = 4,354 → 4,350 mill. Zl

e. Re-establishment of the Site

When the capacity of a landfill section is utilized, the landfill section must be covered with soil and the final measures against bio gas must be established.

The cost estimate for re-establishment of landfill section (every 4 ha) is as follows:

Table 8.1.5-11 Cost Estimate for re-establishment of Landfill Section, 4 ha.

Re-establishment, landfill section 4 ha (volume 700,000 m3)	Mill. ZL
- Final coverage (0.2 m gravel and 1.0 m soil) including measures against gas	3,500
- Planting of grass and bushes	600
- Miscellaneous	600
TOTAL	4,700

Estimates for re-establishment of other landfill sections are elaborated as follows:

Table 8.1.5-12 Cost Estimate for re-establishment of Landfill Sections, 3 ha and 1 ha

Landfill section Volume: / Area:	500,000 m^3 / 30,000 m^2	100,000 m^3 / 10,000 m^2
	Mill. Zl	Mill. Zl
TOTAL, re-establishment	3,500	1,200

f. Operation After Completion

Operation costs for the following items will continue after completion of the landfill. The cost estimate is as follows:

Table 8.1.5-13 Operation Costs after completion of the Landfill

Operation after completion	Mill. Zl
- Operation and maintenance of system for leachate	230
- Control and monitoring	60
- Miscellaneous	60
TOTAL, operation after completion	350

5) Payment Schedule

Based on the cost estimates for the described sanitary landfill, the following Table presents payment schedule for construction costs, operation costs and costs for re-establishment of the sanitary landfill.

The payment schedule is based on the following preconditions:

- An incineration plant with a capacity of 10 tons/hour will operate in the year 2001.

- The capacity of the incineration plant will be doubled in the year 2006 and tripled in the year 2010.

- Eight recycling centres will operate in Poznan during the period 1996 to 1998.

Table 8.1.5-14 Investments for Sanitary Landfill at Franowo-Michalowo

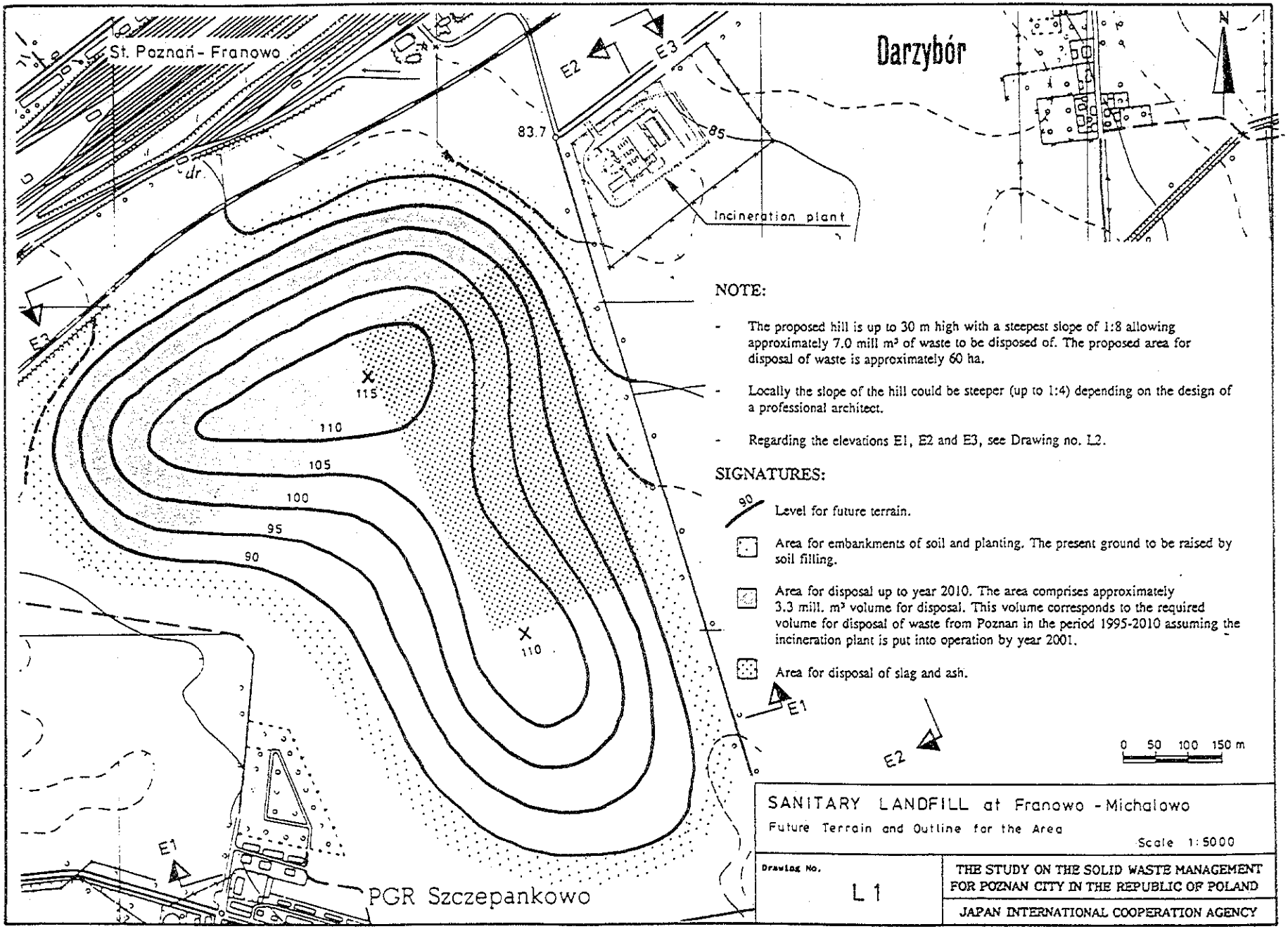
Year	Initial invest-ment	Equip-ment (mill. Zl)	Landfill	Operation costs (mill. Zl)	Re-estab-lishment (mill. Zl)	Costs after comple-tion	Utilized capacity (mill. m^3)
1994	S	5,000	W1				
1995				5,700			0.2
1996				5,650			0.5
1997			W2	5,600			0.7
1998				5,570	4,700		0.9
1999				5,550			1.1
2000			W3 + S1	5,550			1.4
2001		3,130 *1		4,350	4,700		1.5
2002				4,530			1.7
2003			W4	4,700			1.9
2004				4,880	3,500		2.1
2005			S2	5,050			2.3
2006			W5	3,880	1,200		2.5
2007				4,080	3,500		2.6
2008		3,130 *2	S3	4,280			2.8
2009				4,500	1,200		2.9
2010				3,360			3.1
2011					4,700	C	
2012						C	
2013						C	
2014						C	
2015						C	
2016						C	
2017						C	
2018						C	
2019						C	
2020						C	

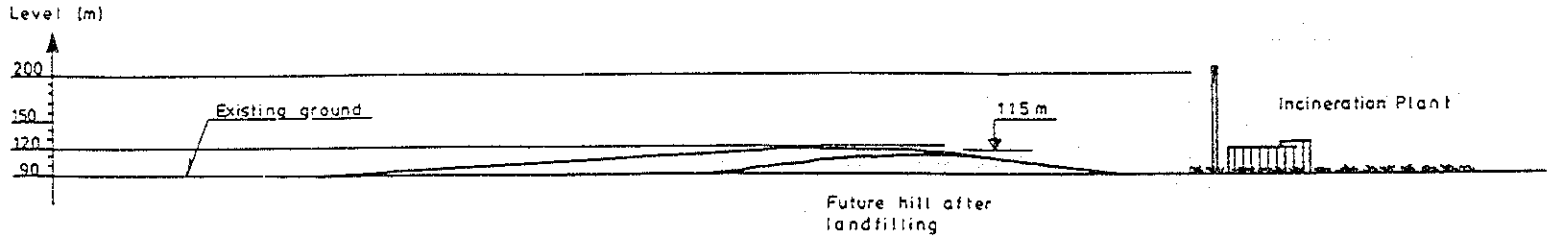
S = 250,000 USD + 12,100 mill. Zl.
W1 = W2 = 50,000 USD + 23,200 mill. Zl (capacity: 700,000 m^3)
W3 = W4 = W5 = 50,000 USD + 21,000 mill. Zl (capacity: 500,000 m^3)
S1 = S2 = S3 = 50,000 USD + 5,800 mill. Zl (capacity: 100,000 m^3)
C = 350 mill. Zl. These annual costs will proceed beyond year 2020.

*1

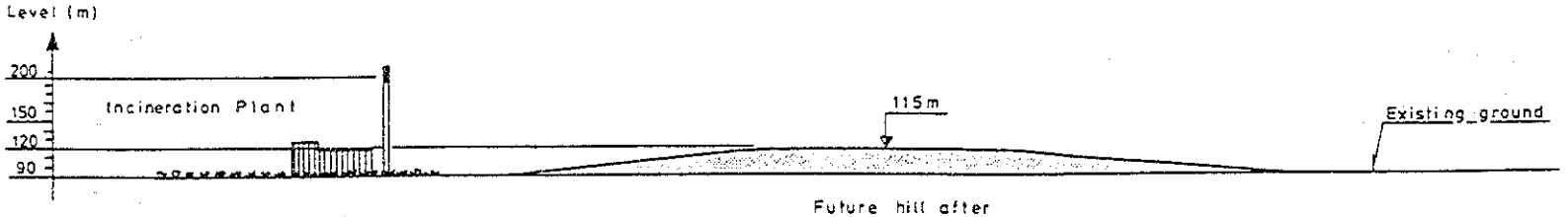
- 1 compactors - 1,740 Mill. Zl
- 1 excavator - 1,390 Mill. Zl

3.130 Mill. zl

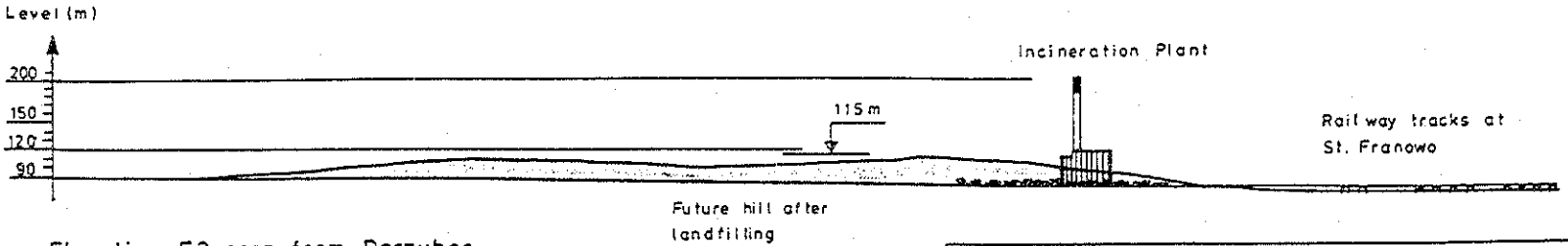

St. Poznań - Franowo
Darzybór
E2
E3
83.7
85
dr
Incineration plant
E3
115
110
105
100
95
90
110
E1
PGR Szczepankowo
N
NOTE:
- The proposed hill is up to 30 m high with a steepest slope of 1:8 allowing approximately 7.0 mill m³ of waste to be disposed of. The proposed area for disposal of waste is approximately 60 ha.
- Locally the slope of the hill could be steeper (up to 1:4) depending on the design of a professional architect.
- Regarding the elevations E1, E2 and E3, see Drawing no. L2.
SIGNATURES:
90
Level for future terrain.
Area for embankments of soil and planting. The present ground to be raised by soil filling.
Area for disposal up to year 2010. The area comprises approximately 3.3 mill. m³ volume for disposal. This volume corresponds to the required volume for disposal of waste from Poznan in the period 1995-2010 assuming the incineration plant is put into operation by year 2001.
Area for disposal of slag and ash.
E1
E2
0 50 100 150 m
SANITARY LANDFILL at Franowo - Michalowo
Future Terrain and Outline for the Area
Scale 1:5000
Drawing No.
L 1
THE STUDY ON THE SOLID WASTE MANAGEMENT FOR POZNAN CITY IN THE REPUBLIC OF POLAND
JAPAN INTERNATIONAL COOPERATION AGENCY



Elevation E1, seen from Szczepankowo



Elevation E3, seen from St.Franowo



Elevation E2 seen from Darzybor

NOTE:

Regarding direction for elevation, see Drawing no. L1

0 50 100 150 m

SANITARY LANDFILL at Franowo - Michalowo

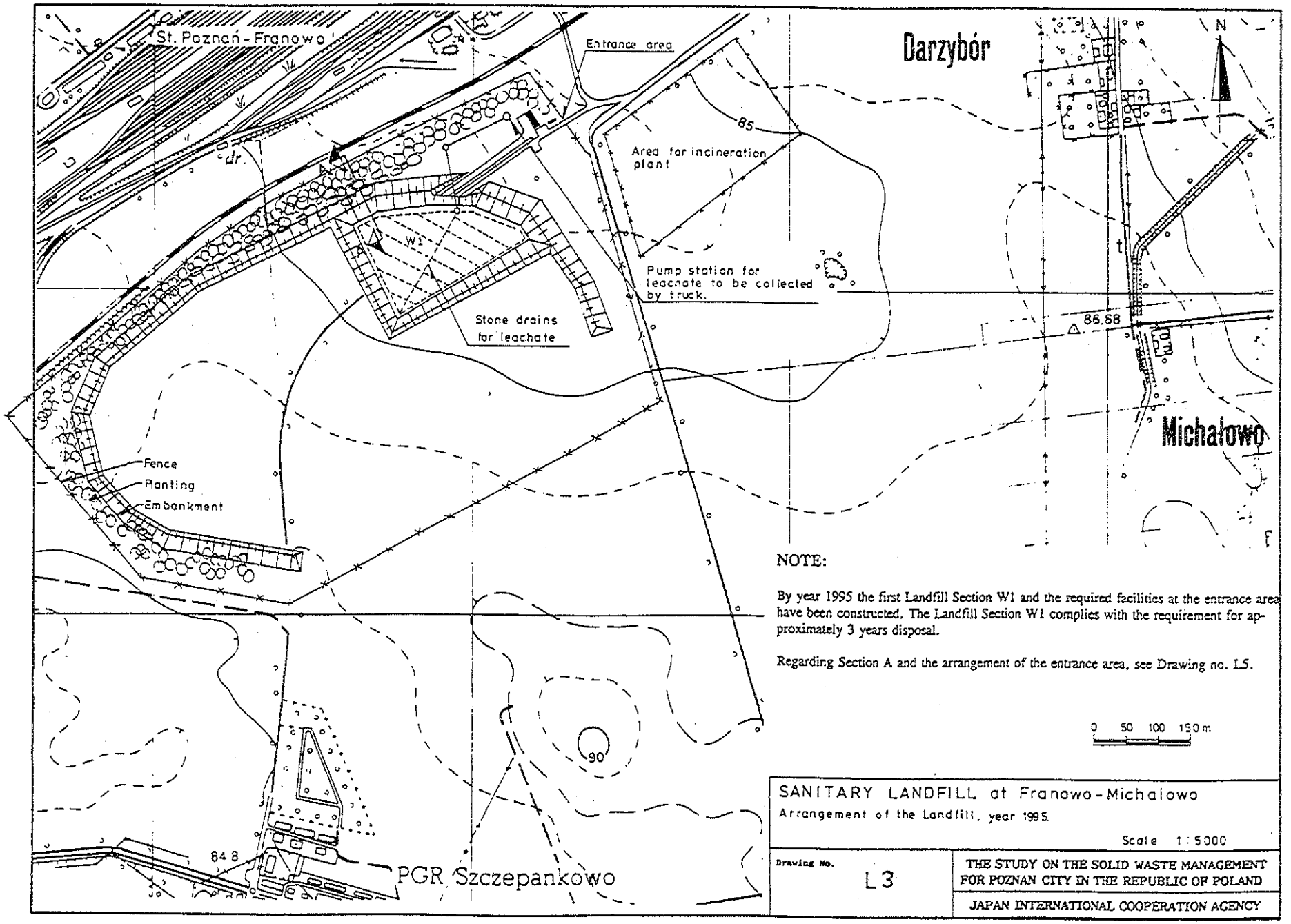
Elevations

scale 1:5000

Drawing No. L2

THE STUDY ON THE SOLID WASTE MANAGEMENT FOR POZNAN CITY IN THE REPUBLIC OF POLAND

JAPAN INTERNATIONAL COOPERATION AGENCY



NOTE:

By year 1995 the first Landfill Section W1 and the required facilities at the entrance area have been constructed. The Landfill Section W1 complies with the requirement for approximately 3 years disposal.

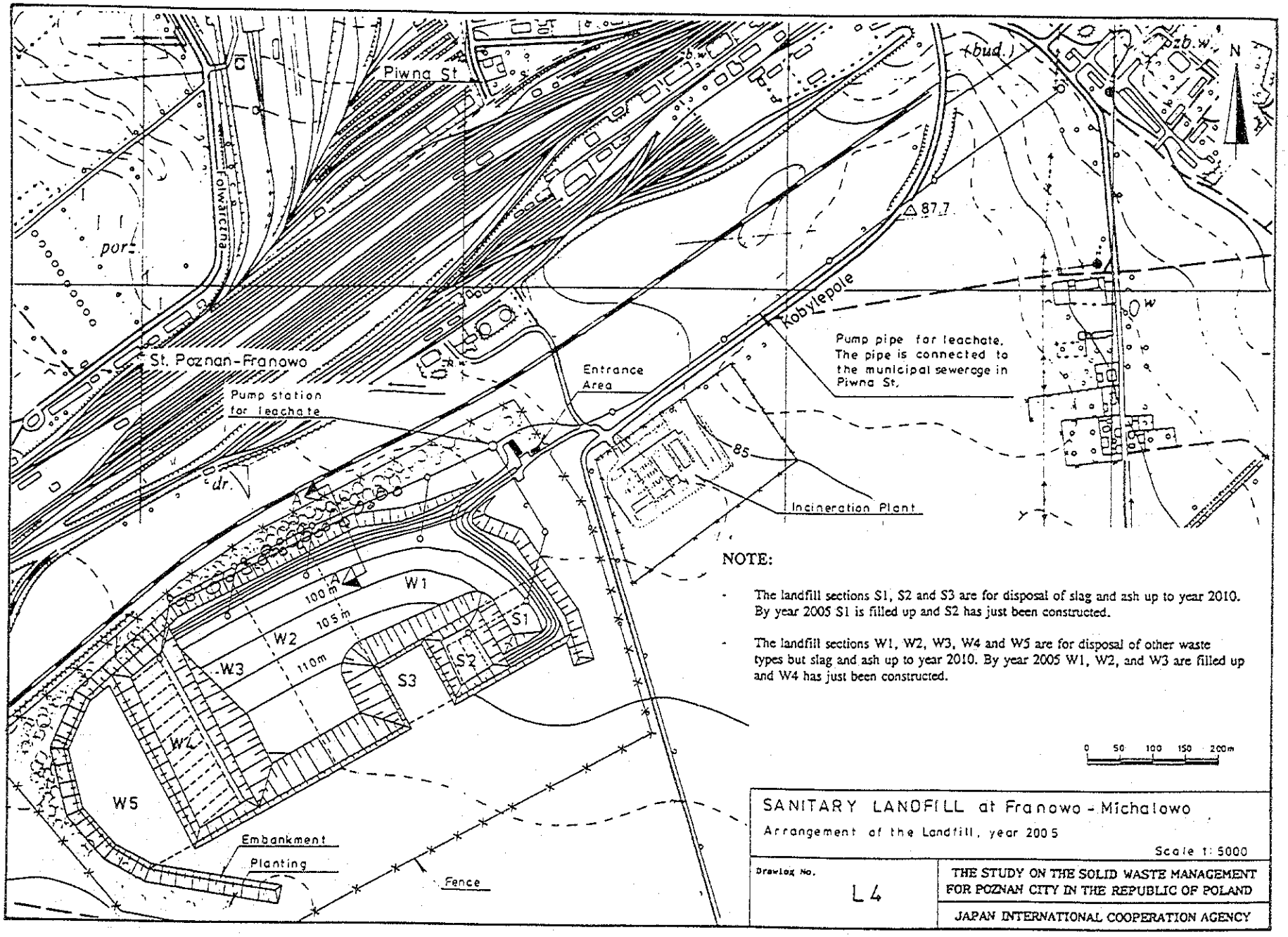
Regarding Section A and the arrangement of the entrance area, see Drawing no. L5.

SANITARY LANDFILL at Franowo - Michałowo

Arrangement of the Landfill, year 1995

Scale 1 : 5000

Drawing No.	THE STUDY ON THE SOLID WASTE MANAGEMENT FOR POZNAN CITY IN THE REPUBLIC OF POLAND
L 3	JAPAN INTERNATIONAL COOPERATION AGENCY



NOTE:

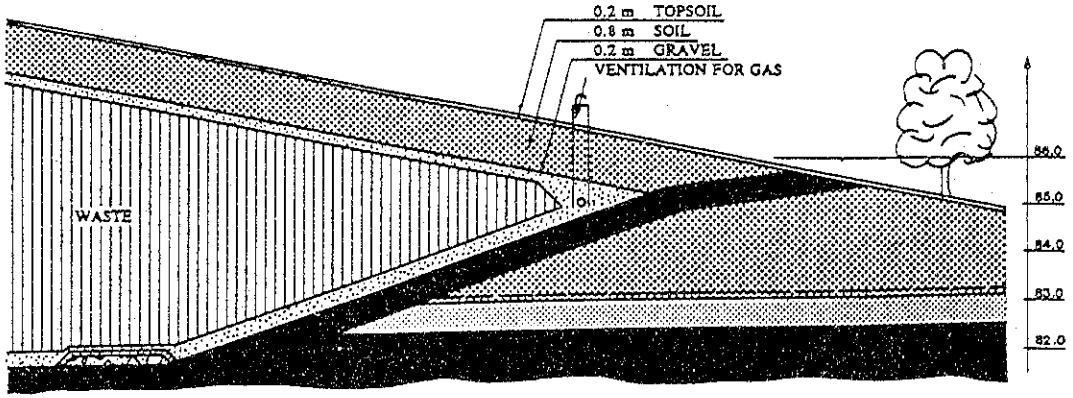
- The landfill sections S1, S2 and S3 are for disposal of slag and ash up to year 2010. By year 2005 S1 is filled up and S2 has just been constructed.
- The landfill sections W1, W2, W3, W4 and W5 are for disposal of other waste types but slag and ash up to year 2010. By year 2005 W1, W2, and W3 are filled up and W4 has just been constructed.

SANITARY LANDFILL at Franowo - Michalowo

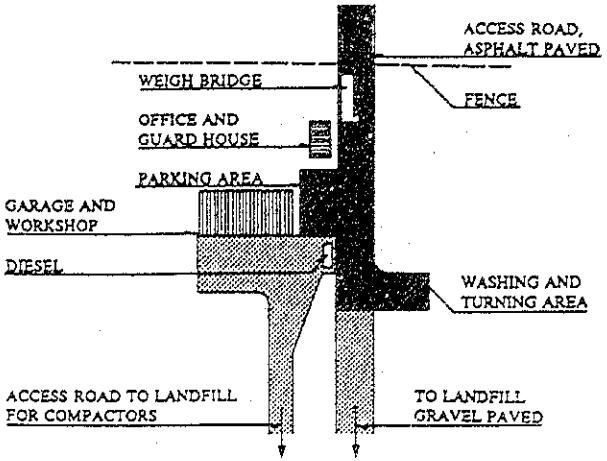
Arrangement of the Landfill, year 2005

Scale 1: 5000

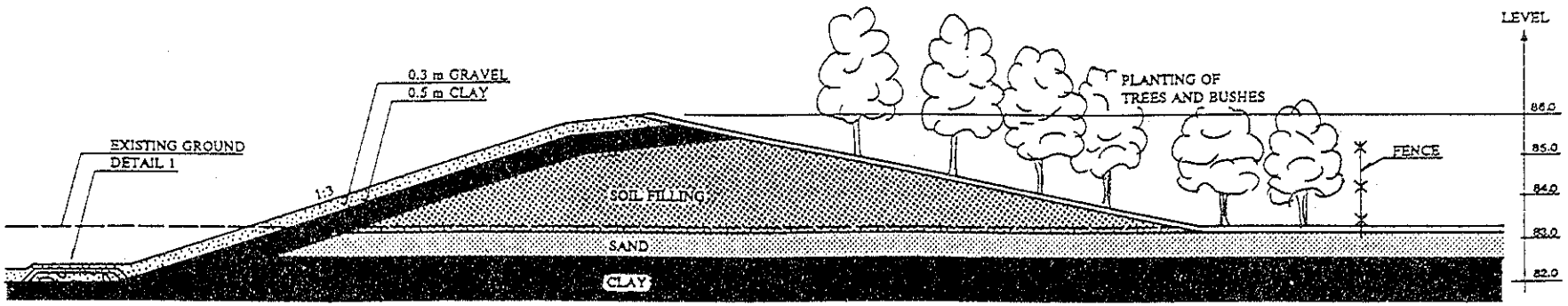
Drawing No.	THE STUDY ON THE SOLID WASTE MANAGEMENT FOR POZNAN CITY IN THE REPUBLIC OF POLAND
L 4	JAPAN INTERNATIONAL COOPERATION AGENCY



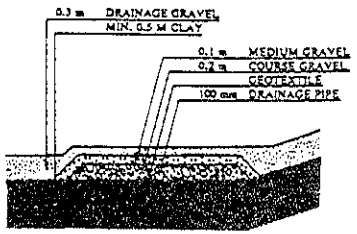
SECTION A, Scale 1:100
(after waste filling and final soil coverage)



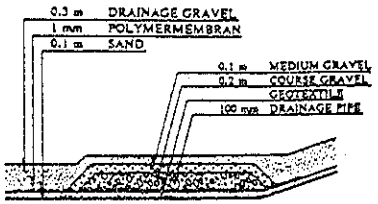
ENTRANCE AREA, Scale 1:100



SECTION A, Scale 1:100
(before waste filling)



DETAIL 1, Scale 1:50
(in case of clay liner)



DETAIL 1, Scale 1:50
(in case of polymermembran)

SANITARY LANDFILL

Sections and Details of Principle

Drawing No. L 5

THE STUDY ON THE SOLID WASTE MANAGEMENT FOR POZNAN CITY IN THE REPUBLIC OF POLAND

JAPAN INTERNATIONAL COOPERATION AGENCY

8.1.6 Recycling

1) Introduction

"Recycling" is the reutilization of non-valuable materials as resources or refers to the collection and reproduction of these for effective reuse. Recycling reduces the waste generation amount and decreases consumption of natural resources. Therefore, with increase in waste generation, recycling is expected to play a very important role in municipal solid waste management in the future.

At present there are some recycling systems in Poznan. Most recycling activities are being carried out by SURMET, a private recycling company that collects reusable materials and sells them to producer for reproduction. This recycling business is observed to be stagnant and is not supported by the people. The recycling business is not stable, as it is easily influenced by the fluctuating market prices of salvaged recyclable materials. One of the unfortunate results was the liquidation of the other recycling company S & W in 1991.

Conclusively, proper strategies must be formulated and implemented to stabilize and develop the recycling business.

2) Strategy

There are many sorts of recycling activities. There are profitable recycling activities and non-profitable activities, but the most activities are categorized as non-profitable.

Profitable recycling activities should be executed by private companies with support from the local administration and the public for stability.

Non-profitable recycling activities should be initiated by the administration, and public cooperation must be utilized as much as possible.

Accordingly, the following concrete strategies were set up:

- To utilize the maximum amount of waste feasibly.
- To develop and stabilize the market for recycled materials in the Polish industry.
- To support organizations involved in recycling to cut collection and disposal cost.

3) Planned Recycling Activities

a. Heat recovery by incinerating wastes

i. Introduction

The calorific value of municipal waste in Poznan has been confirmed to be sufficiently high for incineration after separate collection process by the field survey. In 2010, combustible wastes will occupy 71 % of the total municipal wastes and are planned to be incinerated for heat recovery. This method will help realize a large scale recycling activity.

ii. Method

The method for heat recovery is described in the section of incineration plant.

b. Administrative support in private recycling business

i. Introduction

Private recycling business highly depends on the market price of a reusable material. Market prices usually fluctuate in very wide ranges, making the recycling business unstable.

Private recycling business activities are very important because they contribute to the reduction of the generated amount of waste and consumption of raw material. Therefore, the expansion of the private recycling business should be promoted.

Since fluctuating demands for and selling prices of reusable materials greatly obstruct the development of private recycling businesses, the municipality should control and stabilize market conditions.

ii. Method

- The municipality will bring about a demand for recycled paper by imposing the use of recycled paper in all government institutions.

- The municipality provides private recycling companies with public spaces for installation of containers, collection stations for reusable materials, etc., free of charge.

- The municipality provides them with opportunities to advertise free of charge.

c. Promotion of public cooperation initiated by the administration

i. Introduction

Most recycling activities are unprofitable mainly due to high cost of collection work. Public cooperation is, therefore, most effective to minimize collection cost.

According to the public opinion survey result, more than 90 % of the interviewees indicated willingness to cooperate in recycling activities. Their willingness to cooperate should be utilized for the collection of recyclable materials. Although this is not organized in Poznan, this is widely practised in many developed countries at present.

In order to promote public cooperation in the collection of recyclable materials, the municipality should establish incentives to stimulate and motivate the public. The cost for such activities might be cheaper than the treatment cost of wastes.

ii. Method

- To organize events for SWM promotion and education.
- To invite citizens and students to SWM facilities.

d. Introduction of on-site composting of household waste

i. Introduction

Composting is technically the simplest method for utilization of waste. In order to maintain the acceptable quality of compost, it is essential to supply only qualified organic wastes after segregation. Segregation is too difficult to be satisfactorily executed in a largely populated town. However the on-site composting method is easy to apply for wastes of detached and semi-detached houses. The initial investment is little. A good compost quality can be produced depending on the householders' efforts, because the producer of waste will be the compost user at the same time. The introduction of on-site composting method to the detached and semi-detached houses is also effective for the reduction of waste generation amount.

ii. Method

An on-site composting container will be installed in the yard. The householder discharges kitchen wastes into the on-site composting container and leaves it until it decomposes. Composts are utilized as soil conditioners in the householder's yard.

On-site composting requires:
- the sorting of organic wastes in the kitchen
- the provision of a standard model closed compost container for each household, or several for each block of flats.

For use in Poland where the climate in winter is very cold, the container should be simply insulated or placed in a shed or shelter so as to avoid freezing.

The microbiological process is accelerated by adding water to the container so as to keep a dry matter content in the range of 300 to 500 kg per ton of waste.

The contents have to be aerated by mixing them occasionally, a handling technique that also accelerates composting with substantial microbial heat production.

The generation of offensive odour is also avoided by mixing the contents.

8.1.7 Road Sweeping and Public Area Cleansing

The present road sweeping and the public area cleansing services performed in Poznan City are sufficiently functioning, from the satisfactory results observed. Therefore, special improvements are not required immediately, although the following suggestions were made:

1) Road Sweeping

A road sweeping system in Poznan City has been established and a sufficient number of equipment have been ready for the works. There are twelve units of road sweeping equipment in Poznan City, however, only four are being employed in 1992 due to financial difficulties.

Consequently, the existing problems concerning the road sweeping work in Poznan City are not technological in nature but mainly financial.

Most of the work is executed by the authority for provincial roads. In order to cope with the financial problem this authority introduced tendering to select a contractor in 1992, which resulted in the consignment of the works to four contractors. Prior to the tendering, SANITECH monopolized the works. The tender system should be continued to curtail cost, although it might deteriorate work quality. The authority for roads should be completely capable of supervising the works to motivate the contractor to fulfil the specified work quality and to avoid corruption.

The targets of road sweeping work are, thereby, set as follows:

- The performance level of the year 1991 should be maintained until the year 2010, as the 1992 level is proven to be insufficient.
- Introduction of more tendering cases.
- Improvement of supervision capability.

2) Public Area Cleansing

A public area cleansing system has been also established and functioning nicely in Poznan City as evidenced from the well kept public spaces.

The authority on green areas is in charge of this work in Poznan. Most works are directly carried out by this authority although it is expected to introduce more tendering in future. The introduction of tendering is unavoidable and desirable to minimize cost, although it might deteriorate work quality. The authority on green areas should be completely capable of supervising the works to motivate the contractor to fulfil the specified work quality and to avoid corruption.

The targets of public area cleansing are, thereby, set as follows:

- The performance level of the year 1991 is maintained until the year 2010.
- gauged tendering.
- gauged supervision capability.

8.1.8 Environmental Examination

1) Introduction

The objective of an environmental survey is to forecast and evaluate environmental impacts caused by the construction and operation of the proposed incineration plant and sanitary landfill in the proposed Franowo–Michalowo site.

2) Contents of the Survey

The field survey includes the following items:

- Collection of existing data
  - Meteorological conditions
  - Current pollution concentration level

- Field Surveys
  - Water quality
  - Noise
  - Traffic volume
  - Land use

3) Results of Survey

The results of the field survey are included in ANNEX J.1.8.

8.2 Institutional Plan

This section will provide recommendations for the institutional development for the implementation of the First Priority Project addressed to Poznan Municipality.

The overall institutional system for Poznan Municipality included a combination of direct tendering and introduction of a municipal company for execution of waste services.

8.2.1 Poznan Waste Treatment and Disposal Company

The formation of a municipally controlled company responsible for waste treatment and disposal is recommended. It is essential that Poznan Municipality has full ownership and responsibility for the company as it will include disposal activity.

The company should have a director to take charge of investigations required for the construction of treatment and disposal facilities. A director is especially necessary to supervise the design and tender aspect of the construction of the incineration plant, as well as the managing of the contract for the sale of heat and other works required prior to the start of operation.

The recommended organization of the Poznan Waste Treatment and Disposal Company is shown in fig. 8.2.1-1.

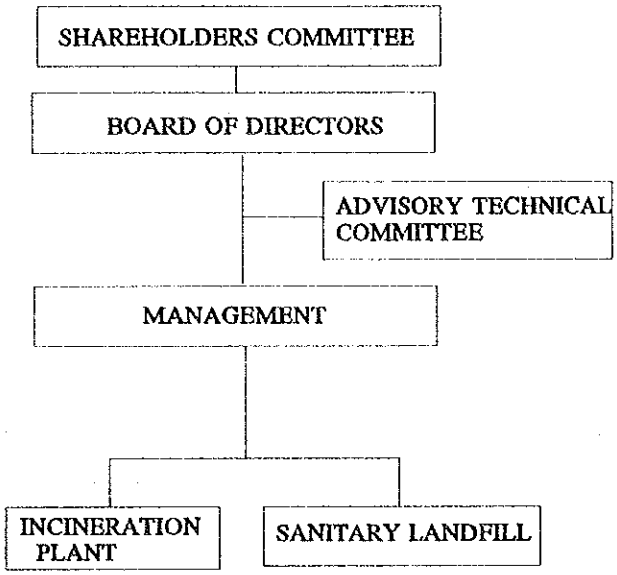


Fig.8.2.1-1 Recommended Organization of the Poznan Waste Treatment and Disposal Company.

We recommend a company structure similar to the Rethman-Poznan Waste Management Co. Ltd., however, with increased governmental influence and a decision-making body unanimous in their decisions. Although increased governmental influence would mean vesting less authority on the Management level, as compared with the collection company, (see presentation in section 4.8.3), past experiences show that careful preparation of the projects can secure a continuity in the operation of the company despite political changes.

Political or governmental influence is necessary due to the public responsibility of the company regarding waste management. The companies cannot only be regarded as profitable short-term business ventures, but should be viewed in terms of their responsibilities to the public.

Organization of the Management in Poznan Waste Treatment and Disposal Company

The proposed organization chart for the Management of the Poznan Waste Treatment and Disposal Company is based on the premise that the company will operate the following facilities:

- Incineration Plant

- Sanitary Landfill

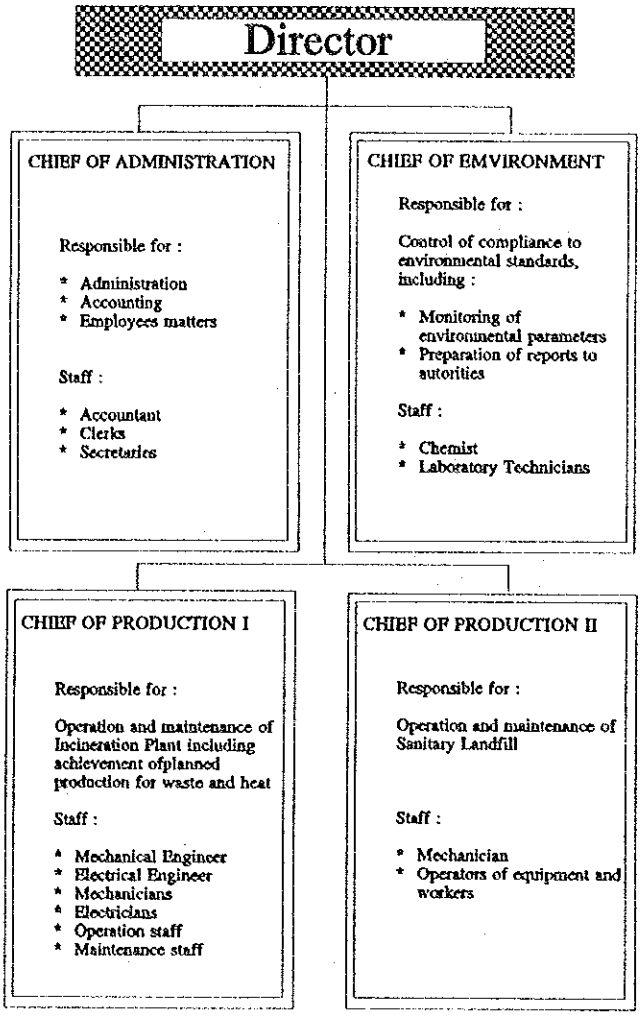


Fig.8.2.1-2 Organization of the Management in Poznan Waste Treatment and Disposal Company

The proposed organization includes two Production Chiefs:

- Production Chief I is responsible for the Incineration Plant.
- Production Chief II is responsible for the Sanitary Landfill and Recycling Centres.

We propose a Chief of Environment to be responsible for monitoring and reporting to authorities. The separation of the production units from the monitoring unit will enable independent control over delegated responsibilities.

Each production unit will be organized under the responsibility of the Production Chiefs.

8.2.2 Tendering

Hard competition is inherent in a free market economy, therefore, it is profitable to carefully examine the market prior to purchase or construction.

In case of a major purchase or construction, tendering (competitive bidding) should carried out. Along with the definition of the conditions of the contract, the tender documents will contain the demands and requirements of the investor regarding the purchase or construction. These documents will be made available to possible candidates for competitive bidding.

The advantages gained from tendering are:

- The investor can define his demands.
- The equal basis for provision of tender allows for full competition and, thus, the cheapest price.
- The equal basis for provision of tender allows for an easier comparison and evaluation of the tenders.

The First Priority Project should be subject for tendering to secure that the Incineration Plant will meet the requirements and that performance guarantees etc., are issued to protect the investor from a failed investment due to purchasing materials of poor quality.

There are several ways of tendering, but the following two are mainly used:

- Open tender based on an announcement in magazines and newspapers.

In this tender all interested companies can participate and tender.

- selective tender. Only selected suppliers, those prequalified can participate after a pre-qualification.

The World Bank has specified demands for the tendering of their own projects and these demands may be applied to the facilities involved. A World Bank tender includes the following documents prepared by the purchaser and submitted to the tenderers:

- Volume 1, General Conditions

  . Invitation to Bid
  . Instruction to Bidders
  . Conditions of Contract
    - Part I, General Conditions
    - Part II, Conditions of Particular Application
  . Contract Forms
    - Form of Tender
    - Bid Security Form
    - Form of Agreement
    - Form of Performance Security
    - Letter of Credit
    - Certificate of Insurance
    - Schedules

- Volume 2, Technical Specifications

  Technical requirements for the purchase including standard for the works, demands on performance, etc.

- Volume 3, Bills of Quantities

  Quantities of works, materials and equipment in the Contract (eg. amount of earthworks, concrete, reinforcement, etc.).

- Volume 4, Drawings

  Necessary drawings or illustrations

  There exists international "Conditions of Contract" prepared by FIDIC for civil works and machinery and electrical works respectively. These conditions are well implemented by investors, donators like the World Bank, consultants, and suppliers and, thus, they are often used.

For tender of the incineration plant in Poznan Municipality, the FIDIC conditions are applicable.

For tender method adopted for the Incineration Plant is assumed to affect the total price of the plant.

The machinery may be tendered internationally, while the civil works may be tendered in Poland. Thus, there are several models for the tender:

A: One Contract with the supplier of machinery as holder of Contract for machinery and civil works.

B: One Contract with the civil works contractor as holder of Contract for machinery and civil works.

C: Two Contracts; one with the supplier of the machinery and one with the contractor for civil works.

For A and B, the holder of the Contract must guarantee the safe administration of the whole contract (the holder must be fully responsible, for the safety of another contractor consigned to do work on an area where he is not very familiar of).

Thus, we recommend the implementation of model C with an international tender of the machinery and subsequent detailed design of civil works, followed by a tender in Poland. Thus, the purchaser (herein refers to Poznan Municipality) will make the necessary arrangements for the two Contracts through his consultant engineer. This model will require, all Contract holders to be familiar with their area of responsibility and the Contract prices are assumed to be the cheapest. Furthermore, through the detailed design, Poznan Municipality will be given the opportunity to include its own architectural design and demand in the lay-out.

Model C necessitates a competent consultant engineer for the detailed design, tendering, administration and coordination of Contracts and the supervision of the works.

Fig.8.2.2-1 illustrates the recommended structure of the tender.

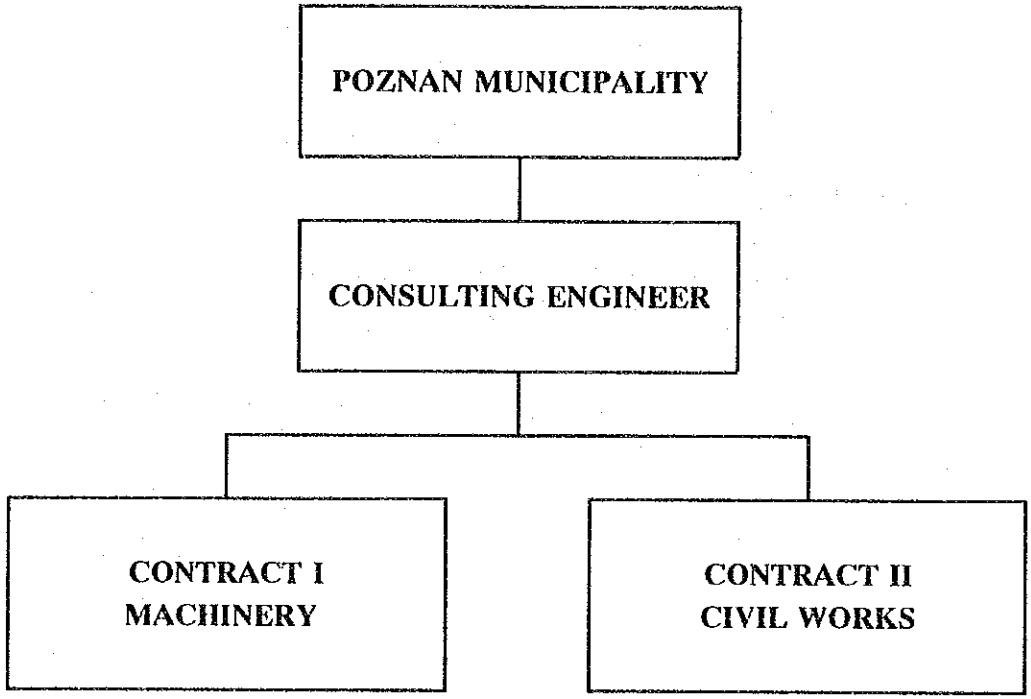


Fig.8.2.2-1 Proposed Structure for the Tender of Incineration Plant

Tender of Collection Services

Tender of collection services can be carried out based on similar principles as the above described, however, compared with tender of an incineration plant, the tender documents are less comprehensive.

The tender of collection services must be planned and carried out in appropriate districts allowing for participation of smaller contractors. On the other hand, the district must have enough waste volume, so truck capacities, staff, etc., can be utilized to the fullest.

8.2.3 Training of MSWM Personnel

Training of staff for operation of the Incineration Plant must be included in the contract for machinery. The training (and education) may be divided into the following main categories:

- General and not very detailed courses on the entire operation process and operation of all equipment. Target group is the whole staff.

  The general courses shall be held in advance prior to the start of operation.

- Specific courses for:

  . Machinery operation.

  . Monitoring and control system.

  Target group is the personnel assigned for daily operation and maintenance.

  The specific courses shall be held in the early operation (in the test period where the contractor's staff is responsible for the operation and will be present at the plant).

- Trouble shooting courses to be held at the end of the test period before the take over. At this time the staff will be familiar with the plant and, thus, have gained full benefit of very detailed courses.

It has been observed from past experiences that introductory detailed courses are not very beneficial, while some months of on the job training provides the best foundation for detailed courses.

For a selected group of leading operational staff, on the job training at an incineration plant is recommended.

8.3 Estimation of Project Cost

8.3.1 Investment cost

The foreign currency portion of financial cost includes 10% of import tax and 5% of turn over tax. The local currency portion of it includes only 5% of turn over tax. The economic cost excludes import tax and turn over tax.

The investment costs of the 3 projects are estimated and shown in Table 8.3.1-1.

Table 8.3.1-1 Investment Cost unit: mill.zl

	Financial Cost			Economic Cost
	Foreign	Local	Total	
Public Recycling Centres	0	16,264	16,264	14,941
Incineration	379,155	160,000	539,155	401,852
Final Disposal	5,417	41,100	46,517	42,071
Total	384,572	217,364	601,936	458,864

Note:
1. Investment was estimated based on 1993 price.
2. Investments for Public Recycling Centres is a total of 3 years from 1995 to 1997.
3. Investment for an incineration plant is a total of 3 years from 1998 to 2000.
4. Cost for final disposal is the investment in 1994.
5. Total cost includes engineering fees and physical contingencies.

8.3.2 Operation cost

Operation cost consists of the depreciation cost and the operation / maintenance cost which covers costs for fuel, personnel, construction and management, etc.

Based on the above assumption, the operation cost in 2005 is calculated and shown below in Table 8.3.2-1.

Table 8.3.2-1 Operation Cost in 2005 unit: mill.zl

	Operation & Maintenance			Depreciation Cost	Total
	Personnel Cost	Fuel & Others	Maintenance Cost		
Public Recycling Centres	2,457	5,606	597	1,730	10,390
Incineration	6,380	7,540	3,480	30,610	48,010
Final Disposal	1,465	2,895	690	10,343	15,393
Total	10,302	16,041	4,767	42,683	73,793

8.4 Project Evaluation

8.4.1 Environmental Evaluation

The objectives for the evaluation are shown below:

- Project of eight public recycling centres
- Project of incineration plant phase 1; and
- Project of sanitary landfill section 1

The facilities installed are planned to be in accordance with EC standards. Environmental control equipments, regarding the emission of pollutants from incineration plants conforming with the levels of pollutants outlined in the table below, are planned to be installed.

Table 8.4.1-1 EC Emission Standard of Incinerator

Pollutant	Permissible Amount (mg/Nm^3)
Total dust	30
Heavy metals - Pb+Cr+Cu+Mn - Ni+As - Cd and Hg	 5 1 0.2
Hydrochloric acid (HCl)	50
Hydrofluoric acid (HF)	2
Sulphur dioxide (SO_2)	300

Evaluations were made on the following environmental aspects. However, there is a need for a secondary environmental impact assessment at the point where details of the main facilities are known.

- Water pollution (surface and ground water)
- Air pollution
- Odour
- Noise

A comment on the altering landscape and scattering of wastes was made accordingly.

1) Public Recycling Centre

a. Water Pollution

The aim of the public recycling centre is to reduce the amount of illegal dumping. If illegal dumping and the known illegal sites are eliminated and is reinstated, leachate which may leak from the present sites, causing considerable damage to the environment, should cease.

The actual operation of the public recycling centre seldom has any impact on the quality of the water in its vicinity.

b. Noise

The operation of the public recycling centre induces noise levels caused by citizens vehicles bringing wastes to the centre and trucks carrying out the wastes. The surrounding areas together with the access roads where vehicles operate further adds to the problem of noise pollution. However, as the amount of waste brought to one centre is 10 tons/day, if it is assumed that each load carried is 50 kg and the time taken to transport the waste is 6 hours, it amounts to only 30 vehicles entering the site per hour. This amount is comparatively small; the noise produced and its impact will also be minimal.

c. Landscape

There are a total of eight public recycling centres located in various parts of the city; with two of the largest having an area of 3,000 m^2, and the other six being smaller with an area of 2,000 m^2. The facilities on the site include just containers and an office and guard house. If management and separation of wastes is enforced in a proper manner, impact on the surrounding landscape is minimal. Also, with the operation of the public recycling centre and the termination of the illegal dumping, the landscape of the present site will be recovered.

2) Incineration Plant

a. Air Pollution

To lower the level of pollutants below the EC limits the incineration plant is planned to be installed. However, in the case regarding the nitrogen oxides (NOx) there are no EC regulations, therefore the Japanese standard shall be used as a guideline.

SO_2 : 300mg/Nm^3
NOx : 250mg/Nm^3
HCl : 50mg/Nm^3
SP : 30mg/Nm^3

By using these values and frequent weather conditions as a guideline, concentrations of pollutants emitted in the surroundings were estimated. From these estimations it is deemed that by the year 2010 the effect on the environment will be minimal.

Table 8.4.1-2 Estimated Air Quality

Pollutant	Estimation	EC Standard *1	Polish Standard *2
SO_2	0.006 ppm	0.028 ppm	0.011 ppm
Nox	0.005 ppm	0.097 ppm (NO_2)	0.024 ppm (NO_2)
Hcl	0.001 ppm	-	-
SP	0.001 mg/m^3	0.040 mg/m^3	0.022 mg/m^3

*1 SO_2 : 80 μg/m^3 x 22.4 ÷ 64 x 10^{-3}
NO_2 : 200 μg/m^3 x 22.4 ÷ 46 x 10^{-3}
SP : 40 μg/m^3

*2 SO_2 : 0.032 mg/m^3 x 22.4 ÷ 64
NO_2 : 0.050 mg/m^3 x 22.4 ÷ 46
SP : 0.022 mg/m^3

In 1991, the amount of heat energy distributed to citizens was 8,760 TJ per annum. The amount of heat reclaimed from the Phase 1 incineration plant amounts to 4% of the total; the level of pollutants emitted from PEC shall decrease. Pollutants discharged from the plant are in accordance with the EC standard. Therefore, the total amount of pollutant shall decrease.

b. Water Pollution

Leachate produced within the waste pit is collected and sprayed into the incinerator to be burnt and the water is vaporized. Fumes are treated and pollutants removed in the semi-dry type removal plant and air is remitted into the atmosphere after its quality satisfies the EC requirements.

As the sewage from the incineration plant is directed to the sewage treatment plant, little harm to the environment is anticipated.

The possibility of pollution caused by leachate at the landfill is reduced in the case where by the waste is incinerated first and organic materials removed, compared to the instance where the waste is transported directly to the landfill.

c. Noise

It is deemed unlikely that noise pollution is a problem as the majority of the equipment audible from a distance remain within the building. However, the ventilation fans are installed outside of the building and the noise level at the boundary of the site is estimated 54.7 dB(A).
Approximately 150 collection vehicles enter and leave the site daily; if the working day is considered as six hours, it amounts to only 25 vehicles entering the site per hour and noise emission from the roadside is estimated about 65 dB(a).
These values exceed the upper limit of the sound emission acceptable in Poland, but as there are no housing areas in the vicinity the impact is considered to be very slight.

d. Odour

Offensive odour emitted from the incineration plant is produced on the platform as well as in the waste pit. An opening is needed on the platform for access of collection vehicles to and from the building, and therefore, there is a plan to install an air curtain at the opening to reduce the possibility of putrid gas diffusing out of the building.

Air including Odour from the waste pit is drawn into the incinerator for combustion. The final gas produced causes far less damage even outside the building.

Furthermore, by incineration, organic substances are decomposed and offensive odours at the final disposal site are then reduced.

c. Conservation of the Environment

In extracting and utilizing heat energy from the incineration plant, use of natural resources can be minimized conserving the natural environment.

3) Sanitary Landfill

a. Water Pollution

As the sides of the disposal site is to be lined with an impermeable liner it is impossible for the leachate to leak into the surroundings. The leachate produced shall be diverted by pipelines into the sewage treatment plant. The present Suchy Las disposal site bears high risks of polluting the surrounding waters, but, ceasing its operation and safely covering it with soil reduce further risks of pollution.

b. Odour

After incinerating organic substances and nullifying their negative impact on the environment, the main source of the offensive odour at the sanitary landfill is eliminated. On immediate coverage of the landfill further production of putrid fumes is minimized.

c. Noise

Spreading and soil coverage of the waste require construction equipment producing some amount of noise, but on the other hand as operation only takes place during the day and there is a limited amount of housing in the neighbouring areas there is very little impact. The access road leading to the site. The noise of the access road leading to the site has been analyzed in the evaluation of incineration plant.

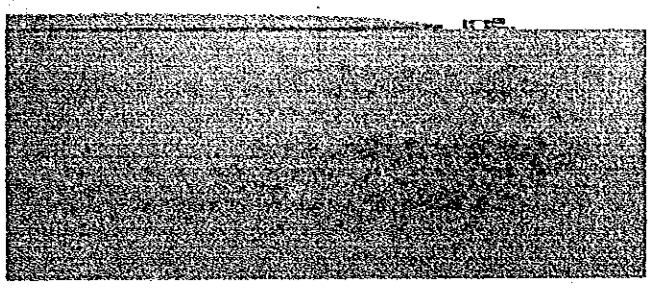
Ceasing the operation of the current disposal site will further diminish the noise level as this leads to a reduction in the number of vehicles utilizing the access road.

d. Landscape

Section 1 of the final disposal site will have a net height of approximately 10m, the incineration building 30m and the stack 100m. Some impact on the landscape is otherwise unavoidable. However, citizens do not need to see the view of the site mundanely. The nearest residential area is more than six hundred metres away. Therefore its impact is believed to be very little. A line of trees is planned to be

planted around the site, forming a Green Belt, preserving an aesthetic view of the disposal site from the residential areas.

A planned view of the disposal site from the residential area after 2010 is shown in the picture below:



Desisting the operation of the current disposal site in Suchy Las and planting trees in its place will accelerate the recovery of the landscape.

e. Scattering of Waste

A movable fence and immediate soil coverage is planned to be introduced at target landfill sections of the new disposal site to prevent the scattering of wastes.

Desisting the operation of the current disposal site in Suchy Las will also reduce the spreading of wastes.

8.4.2 Economic and Financial Evaluation

1) Method of Economic and Financial Evaluation

a. Method of project evaluation

The objective of the economic and financial evaluation in the feasibility study is to determine whether the project is economically and financially necessary and feasible.

The methods of project evaluation applied in this study are summarized in Table 8.4.2-1.

Table 8.4.2-1 Project Evaluation Methods

Project	Public Recycling Centre	Incineration Plant	Sanitary Landfill
Economic Evaluation	- Cost-benefit analysis - Qualitative analysis	- Cost-benefit analysis - Qualitative analysis	(- Least cost method) - Qualitative analysis
Financial Evaluation (1)	nil	- Income and expenditure analysis in 2005	- Income and expenditure analysis in 2005
Financial Evaluation (2)	nil	- Cash flow analysis on Poznan Treatment and disposal Company from 1998 until 2015	

The method presented in the table were adopted for the following reasons:

- Economic evaluations on environmental projects are usually carried out based on a least cost method because quantitative benefits are too difficult to estimate.

- A cost-benefit analysis is used for the project that proposes an incineration plant in order to analyze its economic value on a national scale.

- The cost-benefit analysis is adopted for public recycling centres in order to analyze the cost saving effect of collection.

- Qualitative analysis is adopted for a sanitary landfill project which fulfil the EC standard because it is an indispensable facility for MSWM, although the quantitative benefits are not expected.

- Financial evaluation is carried out on the following:

. Income and expenditure of the incineration plant in 2005.
. Income and expenditure of the sanitary landfill in 2005.
. Cash flow analysis of the Poznan Treatment and Disposal Company from 1998 to 2015.

- Financial evaluation is not carried out for public recycling centres because the Municipality proposes to operate them directly.

b. Methods of economic evaluation

The benefits, costs, etc., to be accounted for the economic evaluation are summarized in Table 8.4.2-2.

Table 8.4.2-2 Benefits, Costs and Criteria

	Public Recycling Centre	Incineration Plant	Sanitary Landfill
Benefit	- Recovery of reusable substances * - Cost saving on collection * - Cost saving on final disposal * - Termination of illegal dumping	- Recovery of heat * - Saving haulage cost - Reduction of final disposed volume * - Incineration of sewage sludge - Incineration of hospital waste - Others . Environmental improvement . Promotion of regional development	- Environmental improvement . Improvement of sanitary condition . Preservation of ground water . Protection from scattering waste
Cost	- Investment - O & M - Treatment and disposal	- Investment - O & M - Treatment and Disposal	- Investment - O & M
Criteria	B - C > O %	EIRR > 15 %	-
Evaluated Period **	from 1995 until 2010	from 1998 until 2015	-

Note: * These were analyzed quantitatively.
** Evaluation period was determined based on the construction year and their life years.

c. Methods of financial evaluation

As for public recycling centres, the financial evaluation is not carried out because the Municipality proposes to operate them directry due to much less income (sale of reusables) than expenditure (O&M cost, disposal cost, depreciation and interest). The income, expenditure and evaluation criteria for financial evaluation are tabulated in Table 8.4.2-3.

Table 8.4.2-3 Income, Expenditure and Evaluation Criteria

	Incineration Plant	Sanitary Landfill
Income	- Sale of heat - Tipping fee . standard fee . special fee for * sewage sludge * hospital waste	- Tipping fee
Expenditure	- O & M - Disposal cost of residues - Depreciation - Interest (7.5%; 3 years grace period)	- O & M - Depreciation - Interest (13.5%)
Criteria 1	FIRR > 8 %	FIRR > 8 %
Evaluation Period	from 1998 until 2015	from 1994 until 2010 *
Criteria 2	FIRR > 15%	
Period for Evaluation	from 1998 until 2015 **	

Note: * Only the financial evaluation of the sanitary landfill project was determined based on the target year of the Master Plan.

** Evaluation period was determined based on the construction year and life year of the incineration plant.

Main assumptions on income and expenditure analysis are as follows:

- Income and expenditure of the incineration plant from 2010 will remain the same.
- The amount of investment, operation, maintenance and income after 2010 will remain the same until 2015.
- Income and expenditure of the landfill after 2000 will remain the same.

Table 8.4.2-4 Investment and O & M cost for Evaluation

unit: mill.zl

	Investment		O & M cost	
	Incineration Plant	Sanitary Landfill	Incineration Plant	Sanitary Landfill
2006	0	23,103	29,000	3,880
2007	0	3,500	29,000	4,080
2008	0	18,763	29,000	4,280
2009	252,770	1,200	29,000	4,500
2010	0	21,903	40,600	3,360
2011	0	10,203	40,600	3,360
2012	0	1,200	40,600	3,360
2013	0	0	40,600	3,360
2014	0	28,606	40,600	3,360
2015	0	16,760	40,600	3,360

d. Economic and Market Prices

The economic and market prices used in the economic and financial analysis are shown in Table 8.4.2-5.

Table 8.4.2-5 List of Economic and Market Prices

	Unit	Economic Price	Market Price
- Sale of heat	zl/GJ	92,100	88,300
- Haulage of waste	zl/ton	314,000	314,000
- Incineration of sewage sludge	zl/ton	1,790,000	1,790,000
- Final disposal	zl/ton	139,000	139,000
- Compensation	zl/ton	52,200	-
- Land use	USD/ha	241.5	-
- Reusable components			
. Glass	zl/ton	60	60
. Textile	zl/ton	580	580
. Paper	zl/ton	400	400
. Metal	zl/ton	4,650	4,650
- Incineration plant			
. Foreign currency portion	mill. USD	21.00	24.15
. Local currency portion	mill. zl	75,200	160,000
. O & M	mill. zl/year	17,400	17,400

2) Project Evaluation on Public Recycling Centres

a. Economic evaluation

The flow chart of the economic evaluation for public recycling centres is illustrated and shown in Fig. 8.4.2–1.

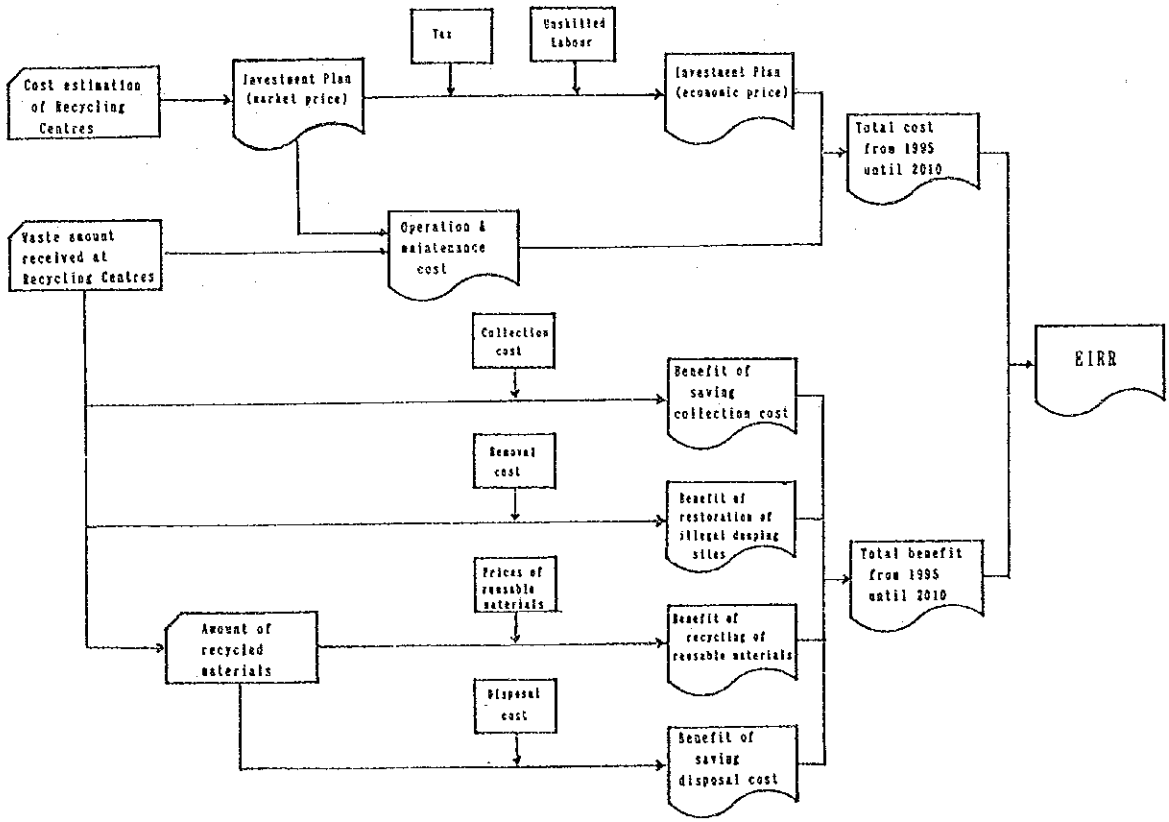


Fig.8.4.2–1 Flow Chart of Economic Evaluation (Public Recycling Centre)

The following benefits can be expected:

i. Recycling reusable materials
ii. Saving collection cost
iii. Saving disposal cost
iv. Restoration of illegal dumping sites
v. Motivate citizens to cooperate in SWM.

The benefits of item i, ii, iii and iv were estimated.

i. Effect of recycling reusable materials

The effects are shown in Table 8.4.2-6.

Table 8.4.2-6 Benefits in Recycling Materials in P.R.C.

Materials	Quantity Recycled (ton/day)	Unit Rate (zl/ton)	Benefit (mill.zl/ton)
Glass	1.4	60,000	30.66
Textile	0.7	580,000	148.19
Paper	4.2	400,000	613.20
Metal	4.8	4,650,000	8,146.80
Total	11.1		8,938.85

The benefit in 2005 was estimated as follows:

7.0 tons/day x 8,938.85 mill.zl ÷ 11.1 tons/day = 5,637 mill.zl

ii. Effect of saving collection cost

The collection cost required for the wastes carried to public recycling centres from sources can be saved. This benefit in 2005 is estimated as follows:

314,000 zl/ton x 69.1 tons/day x 365 days = 7,920 mill.zl

iii. Effect of saving disposal cost

The disposal cost required for wastes recycled in public recycling centres can be saved. This benefit in 2005 is estimated as follows:

138,000 zl/ton x 7.0 tons/day x 365 days = 353 mill.zl

iv. Restoration of illegal dumping sites

This benefit is to save removal cost of waste illegally dumped in public recycling centres. Assuming the amount of waste, which is protected from illegal dumping in public recycling centres, is 6 % of the total waste generation amount, the benefit in 2005 is estimated as follows:

314,000 zl/ton x 389.9 tons/day x 0.06 x 365 days = 2,681 mill.zl

In case the discount rate is 15 %, it is concluded to be feasible because the cost-benefit rate is 1.22 and the net present value is 13,246 mill.zl. As for EIRR, it is 29.4 %.

This is concluded to be qualitatively feasible because it contributes to environmental improvement such as restoration of illegal dumping sites.

b. Financial evaluation

The financial analysis shows that the expenditure would exceed the income. This means that public recycling centres can not be operated unless the municipality financially supports them.

Table 8.4.2-7 Income and Expenditure of P.R.C. in 2005.

unit: mill.zl

Item	Amount
Income	
-- Sale of reusable materials	5,637
Total	5,637
Expenditure	
- O & M	6,960
- Haulage cost of residue	1,700
- Disposal cost of residue	12,172
Sub-total	20,832
- Depreciation	1,730
- Interest	0
Total	22,562
Balance	-16,925

2) Project Evaluation on Incineration Plant

a. Economic evaluation

The flow chart of the economic evaluation for the incineration plant is illustrated and shown Fig.8.4.2-2.

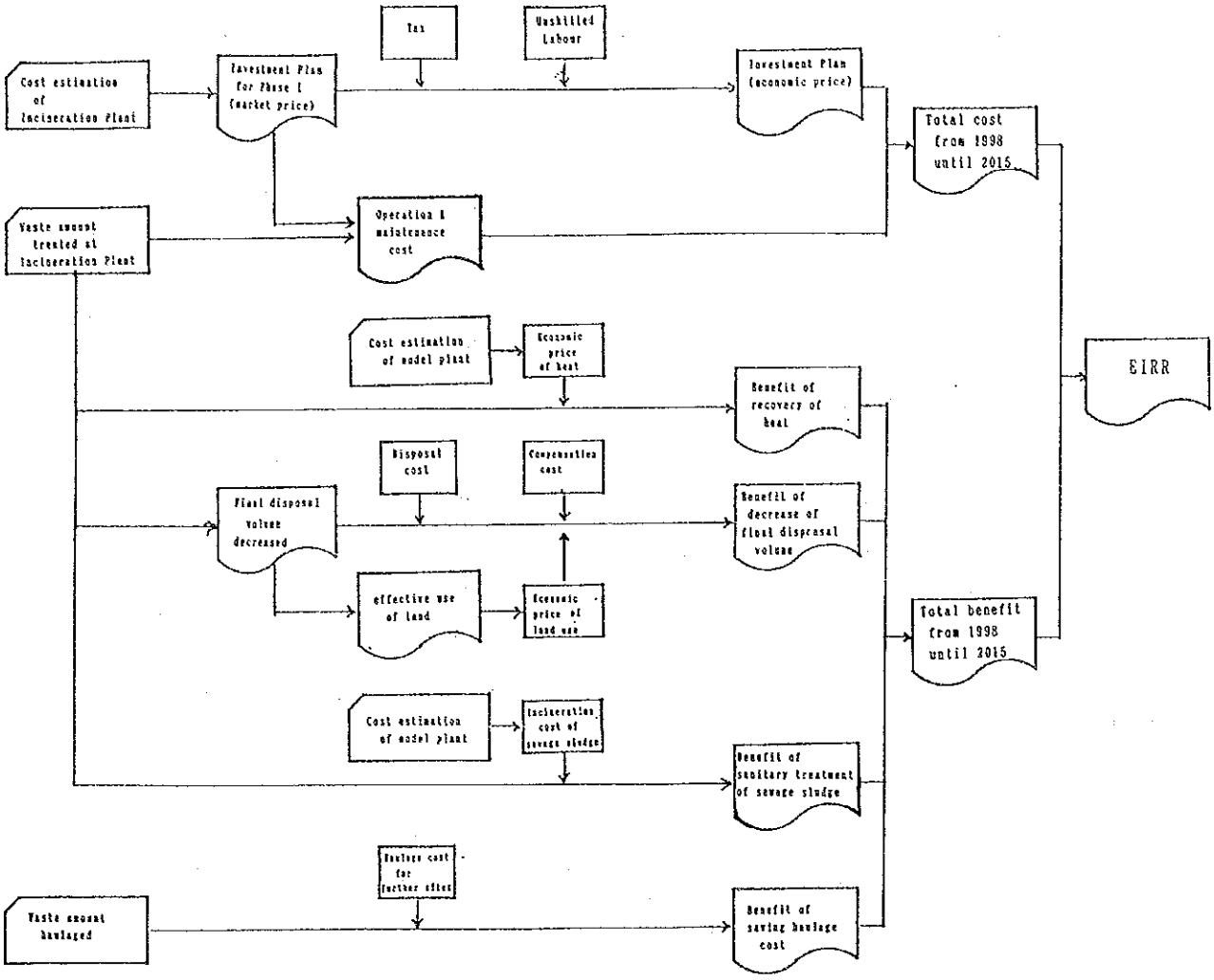


Fig.8.4.2-2 Flow Chart of Economic Evaluation (Incineration Plant)

The following benefits are expected:

i. Recovery of heat
ii. Saving haulage costs
iii. Decrease of final disposal volume
iv. Sanitary treatment of sewage sludge
v. Others
   - Sanitary treatment of hospital waste
   - Decrease in the generation of methane
   - Improving sanitary level of landfill
   - Promoting regional development with utilization of heat

The benefits of item i, ii, iii and iv were estimated as shown below.

i. Recovery of heat

The benefit in 2005 is estimated as follows:

92,000 zl/GJ x 320,835 GJ/year = 29,549 mill.zl

ii. Saving haulage cost

If an incineration plant is not included in the facilities to be constructed, the disposal site's location may be farther than the existing one in Suchy Las, consequently leading to a decrease in the working ratio of vehicles and a haulage cost 1.5 times more than what was proposed. However, the selection of Franowo-Michalowo and the realization of its use as a disposal site is estimated to bring about curtailed haulage cost in 2005.

157,000 zl/ton x 389.9 ton/day x 365 days = 29,549 mill.zl

iii. Decrease of final disposal volume

Incineration of waste will lead to the decrease in final disposal volume, thus curtailing disposal cost and environmental protection cost. For example, the benefit in 2005 will be as follows:

(139,000 + 52,200) zl/ton x (104.8 - 54.1) ton/day x 365 days
= 3,538 mill.zl

An indirect effect will be the effective use of land. For example, the benefit in 2005 will be as follows:

241.5 USD/ha x (60 - 45 + 2.5) ha x 15,700 zl/USD = 66 mill.zl

iv. Sanitary treatment of sewage sludge

Incineration is the best treatment measure for sewage sludge. However, it is more economical to construct an incineration plant designed for the mix incineration of sewage and wastes. For example, the benefit in 2005 is as follows:

1,790,000 zl/ton x 54.2 tons/day x 365 days = 35,412 mill.zl

v. Other benefits

The following benefits were not quantitatively, but qualitatively analyzed.

- Sanitary treatment of hospital wastes`
  The law presently imposes hospital waste incineration. Few hospitals own incinerators. The construction of an incineration plant will, therefore, help curtail costs and improve the treatment methods.

- Decrease in amount of methane generated at landfills
  Methane generated from the landfill will decrease due to decrease in final disposal volume.

- Improvement of sanitary landfill conditions
  Dumping ashes of incinerated wastes is more sanitary than dumping waste directly.

- Promotion of regional development by using heat energy
  The development of industrial zones can be expected from the utilization of heat and construction of the incineration plant.

The result of the analysis concluded that this project is feasible because of a 15.8 % EIRR.

The results of the qualitative analysis concluded that this project is feasible because of the benefits described in "v. other benefits".

The sensitivity analysis on main factors which may influence benefit and cost is shown in Fig. 8.4.2-3.

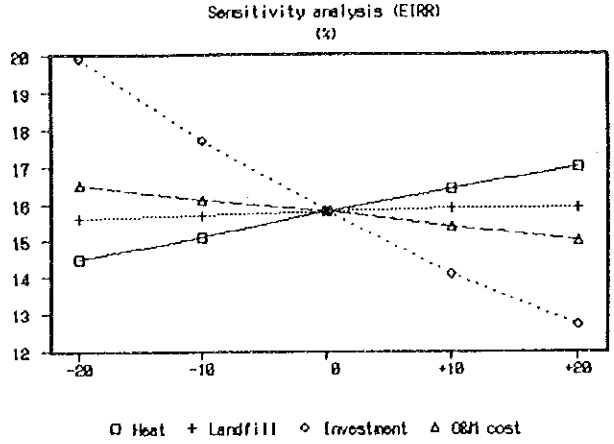


Fig.8.4.2-3 Sensitivity Analysis Diagram

b. Financial Evaluation

The flow chart of the financial evaluation for the incineration plant is illustrated and shown in Fig. 8.4.2-4.

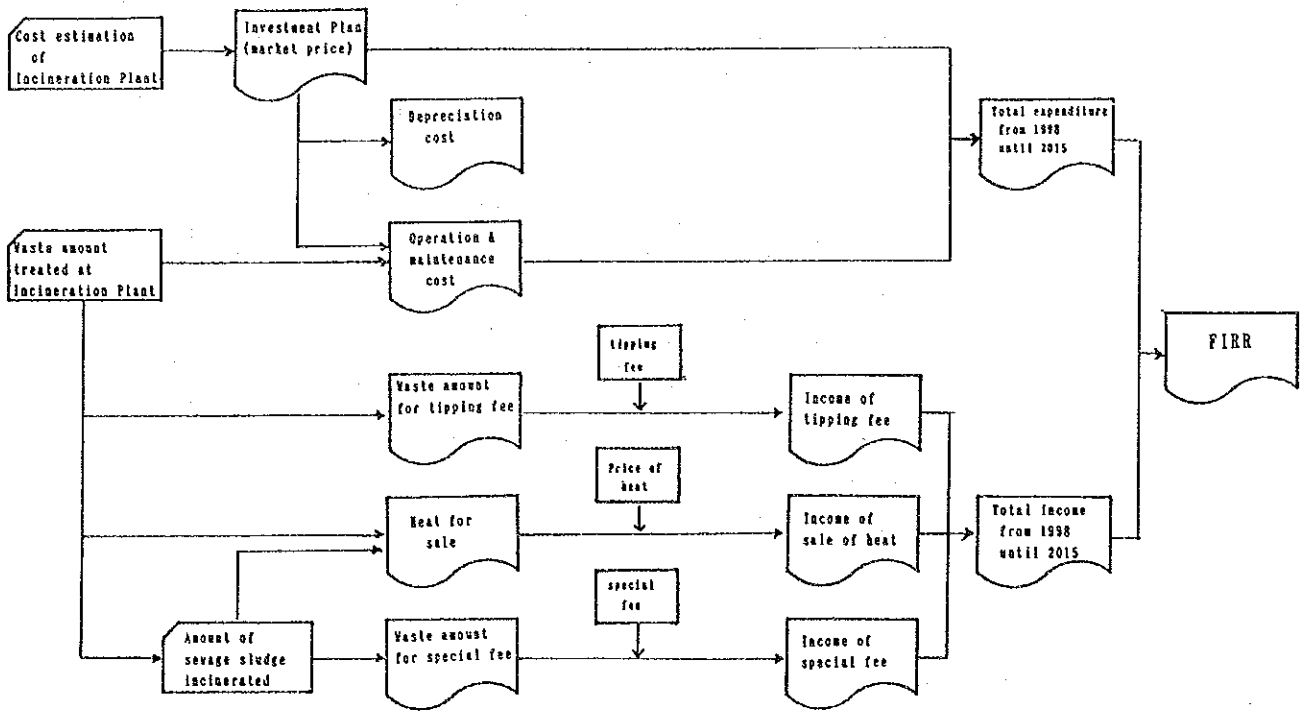


Fig.8.4.2-4 Flow Chart of Financial Evaluation (Incineration Plant)

i. Income

The following incomes were assumed:

-	Heat sale	88,300 zl/GJ
-	Tipping fee until 2000	138,000 zl/ton
	after 2001	456,000 zl/ton
-	Special fee	1,790,000 zl/ton

ii. Income and Expenditure Analysis

The income and expenditure in 2005 is shown in Table 8.4.2-8.

Table 8.4.2-8 Balance of Incineration Plant

Item		Calculation
Income		
Heat sale	28,330	88,300 zl/GJ x 320,835 GJ/year
Tipping fee	20,541	537,000 zl/ton x 104.8 ton/day x 365 days
Special fee	35,412	1,790,000 zl/ton x 54.2 ton/day x 365 days
Total	84,283	
Expenditure		
Labour cost	6,380	
Lime, electricity	4,640	
Disposal cost of residue	774	33,000 zl/ton x 54.1 ton/day x 365 days
Maintenance cost	3,480	
Administration cost	2,126	
Sub-total	17,400	
Depreciation	30,610	
Interest	33,307	Long-term:7.5%, short-term 13.5%
Total	81,317	
Balance	2,966	

iii. FIRR

The financial evaluation between 1998 and 2015 of only the incineration plant Phase 1 was concluded to be 7.7 % FIRR. In addition, the FIRR of the incineration project including Phase 2 and 3, between 1998 and 2015, was estimated to be 9.9 %.

iv. Sensitivity Analysis

The sensitivity analysis on main factors which may influence benefit and cost is shown in Fig. 8.4.2-5.

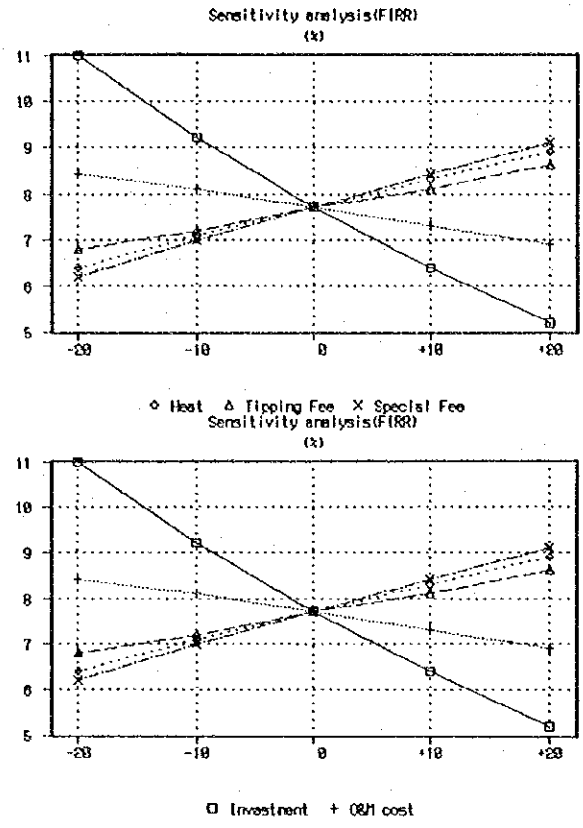


Fig. 8.4.2-5 Sensitivity Analysis of Incineration Plant

Since the cost of the Phase 1 construction of the incineration plant holds the biggest influence, it is necessary to minimized the costs. The income balance is largely affected by special fees, followed by sale of heat. Studies should be fully conducted prior to implementation.

The sensitivity analysis results concluded that adequate tipping fees and special fees made the incineration project feasible.

3) Sanitary Landfill

a. Economic analysis

The following benefits are expected from the sanitary landfill:

- Improvement of landfilling method improves surrounding environment and public health condition.
- Installation of impermeable liner will prevent ground water pollution due to leachate.
- Installation of a fence will prevent wastes from scattering.

Qualitative analysis is not carried out because quantification of these benefits is difficult and also because sanitary landfill is the least among the technologies in conformity with EC standard, albeit its importance.

b. Financial analysis

i. Income and expenditure analysis

The analysis of income and expenditure in 2005 shows a positive result as income exceeds expenditure.

Table 8.4.2-9 Income and Expenditure of Sanitary Landfill

Item	Amount	Calculation
Income		
Tipping fee	20,669	139,000 zl/ton x(461.5-54.1)ton/d x 365 days
Total	20,669	
Expenditure		
Labour cost	1,465	
Heavy oil	682	
Soil	976	
Maintenance cost	690	
Administration cost	1,237	
Sub-total	5,050	
Depreciation	10,343	
Interest	854	Long-term loan:4.5%
Total	16,247	
Balance	4,422	

* Income does not include tipping fees for ash discharged from the incineration plant, as the incineration plant and the landfill are operated by the same company.

** The long-term loan with the same condition for the incineration plant project was assumed for the investment in 1994.

ii. FIRR

This is also proven as financially feasible due to an 18.8 % FIRR between 1994 and 2000.

4) Financial Evaluation of Poznan Treatment and Disposal Company

a. FIRR

Financially it is evaluated to be feasible due to a 17.5 % FIRR.

b. Money Flow

The overall money flow analysis showed profitable results, although loss was estimated in 1999 and 2000. Please refer to Fig.8.4.2-6.

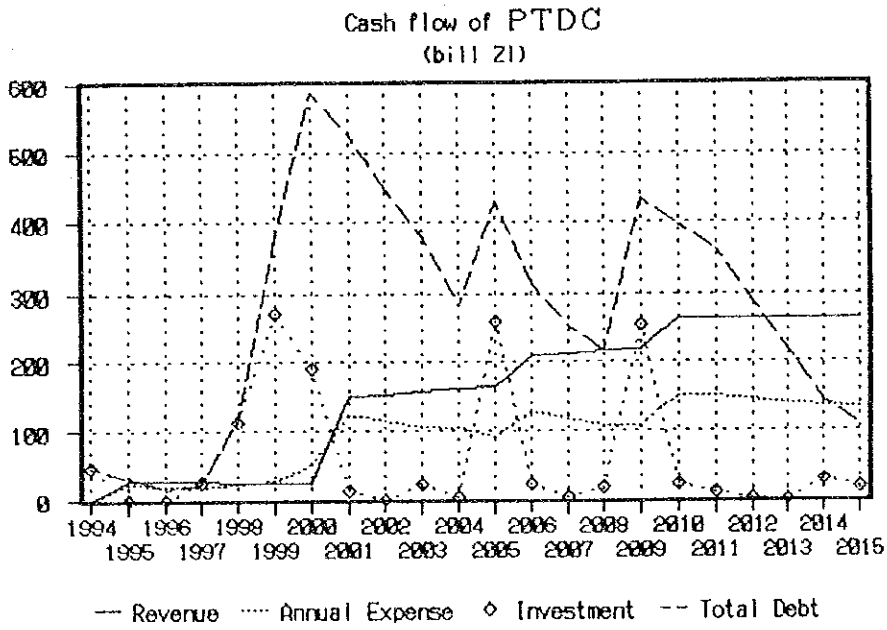


Fig.8.4.2-6 Cash Flow Diagram of Poznan Treatment and Disposal Company

c. Influence of Inflation

Inflation effects increase in loan payments to international lending agencies due to fluctuations in exchange rates. However, the analysis proves that problems can be overcome if income increases in proportion to inflation because internal reserve increases, too.

5) Conclusion

The first priority projects studied in this report were all considered feasible.

CHAPTER 9

IMPLEMENTATION PLAN

CHAPTER 9 IMPLEMENTATION PLAN

This chapter describes the project implementation bode and shcedule, monitoring system to present the financial plan and detailed directions on implementation of the first priority projects.

9.1 Project Implementation Schedule

1) Project Implementing Bodies

The implementing bodies of the 3 projects will be as follows:

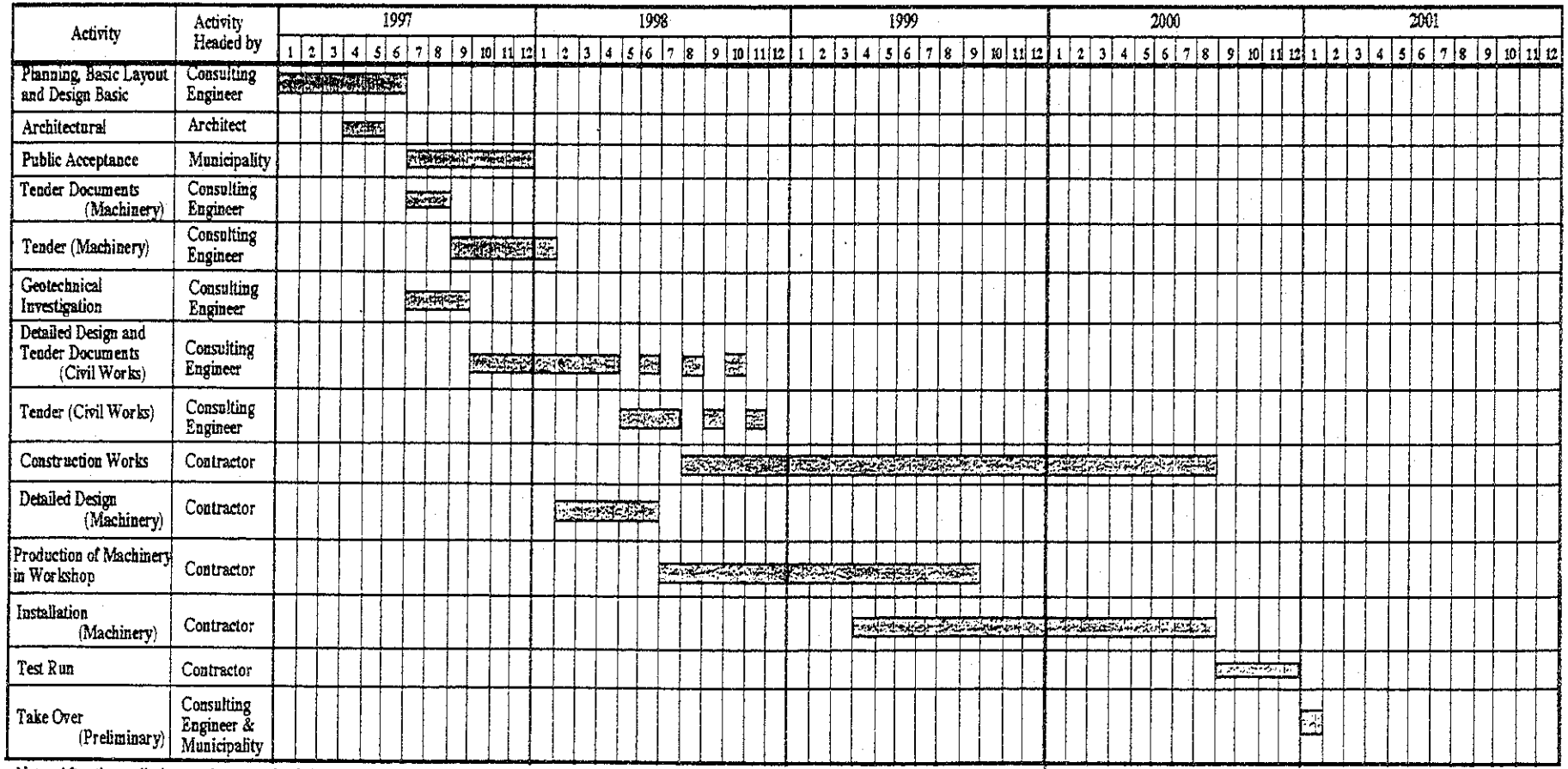
- Public Recycling Centres : Department for MSWM
- Incineration Plant : Poznan Waste Treatment and Disposal Company
- Sanitary Landfill : Poznan Waste Treatment and Disposal Company

2) Implementation Schedule

The proposed implementation schedule of the 3 projects are tabulated in Table 9.1-1. A detailed implementation schedule for the incineration plant is also prepared as shown in Fig. 9.1-1.

Table 9.1-1 Implementation Schedule

Project / Schedule	Public Recycling Centres	Incineration Plant	Sanitary Landfill
1. Design Target Year	1997	2001	1995
2. Service Commencement Year	No. 1,2,3: 1996 No. 4,5,6: 1997 No. 7, 8 : 1998	January 2001	January 1995
3. Preparatory Period			
- Acquisition of Fund	1994	1996	1993
- Detailed Design	1994	Jan. 1997 - Apr. 1998	1993
- Tender	1994	Machinery: Sep. 1997 - Jan. 1998 Civil: May 1998 - July 1998	
4. Construction			
- Construction	No. 1,2,3: 1995 No. 4,5,6: 1996 No. 7, 8 : 1997	July 1998 - Aug. 2000	1994
- Test Run	-	Sep. 2000 - Dec 2000	-
- Take Over	-	January 2001	January 1995



Note : After the preliminary take over , the defects and liabillity period will start. After this period the final take over will take place.

Fig.9.1-1 Implementation Schedule of Incincration Plant

9.2 Financial Plan

The financial plan was based on the results of the financial analysis described in the section 8.4.2. In the financial analysis of the Poznan Treatment and Disposal Company, corporation tax was excluded. However, 40 % corporation tax is included in the financial plan.

9.2.1 Public Recycling Centres

As shown in Table 9.2.1-1, required finance and its source will be secured from the budget of Poznan Municipality.

Table 9.2.1-1 Required Finance and Source for P.R.C unit: mill.zl

	1995	1996	1997	1998	1999	2000	Total
Required investment	6,508	6,038	3,718	0	0	* 1,380	17,644
Budget of Municipality	6,508	6,038	3,718	0	0	1,380	17,644
O & M Cost		4,370	8,405	10,943	10,984	11,034	34,793
Budget of Municipality		4,370	8,405	10,943	10,984	11,034	34,793

Note: * The investment in 2000 will be based used for the replacement of old containers.

9.2.2 Incineration Plant

1) Financial Source

Financial sources are proposed as follows:

- Long-term loan from an international lending agency
- Short-term loan from a lending agency in Poland

Table 9.2.2-1 Required Finance and Source for Incineration Plant unit: mill.zl

	1998	1999	2000	Total
Required investment	107,831	269,578	161,747	539,156
Breakdown				
Long-term loan	75,831	189,578	113,747	379,156
Short-term loan	32,000	80,000	48,000	160,000

The operation and maintenance cost shall be covered by income of heat sale and treatment and disposal fee.

Table 9.2.2-2 Breakdown of Financial Sources for Operation unit: mill.zl

	2001	2002	2003	2004	2005	Total
Required O & M cost	48,010	48,010	48,010	48,010	48,010	240,050
Sources						
Heat sale	29,297	29,007	28,878	28,620	28,330	144,132
Tipping fee						
Standard	21,737	21,443	21,169	20,855	20,541	105,745
Special	31,426	32,406	33,321	34,366	35,412	166,931
Total	82,460	82,856	83,368	83,841	84,283	416,808

2) Expenditure

Investment and O & M cost are presented in Table 9.2.2-3.

Table 9.2.2-3 Investment and Annual Expenses for Incineration Plant
unit: mill.zl

Year	Investment	Annual Expense		total
		O & M	Depreciation	
1998	107,831	0	0	107,831
1999	269,578	0	0	269,578
2000	161,747	0	0	161,747
2001	0	17,400	30,610	48,010
2002	0	17,400	30,610	48,010
2003	0	17,400	30,610	48,010
2004	0	17,400	30,610	48,010
2005	0	17,400	30,610	48,010

9.2.3 Sanitary Landfill

1) Financial sources

The short-term loan of local lending agencies are planned as investment source. O & M cost is planned to be covered by tipping fee.

Table 9.2.3-1 Required Finance and Source for Sanitary Landfill unit: mill.zl

	1994	1995	1996	1997	1998	1999	Total
Required investment	46,517	0	0	24,103	4,700	0	75,320
Short-term loan	46,517	0	0	24,103	4,700	0	75,320
Required O & M		15,034	14,984	14,934	19,604	14,884	79,440
Tipping fee		26,397	26,037	25,667	25,332	25,083	128,516

2) Expenditure

Investment and O & M cost are presented in Table 9.2.3-2.

Table 9.2.3-2 Investment and Annual Expenses for Sanitary Landfill

unit: mill.zl

Year	Investment	Annual Expense	
		O & M	Depreciation
1994	46,517		
1995	0	5,700	9,334
1996	0	5,650	9,334
1997	24,103	5,600	9,334
1998	4,700	5,570	14,034
1999	0	5,550	9,334

Note: Investment for replacing old equipment is included.

9.2.4 Financial Plan of Poznan Treatment and Disposal Company

The balance sheet and the money flow sheet are shown in Table 9.2.4-1.

These tables prove that the income basically tends to exceed expenditure excepted for in 1999 and 2000. The total debt decreases after the peak in 2000. Consequently, the financial status of the Poznan Treatment and Disposal Company will be sound accordingly to the financial plan.

Table 9.2.4-1 Balance Sheet and Money Flow of PTDC

unit : mill Zl

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Revenue																							
Sale																							
Heat supply	0	0	0	0	0	0	0	0	29,297	29,007	28,878	28,620	28,330	28,330	28,330	28,330	28,330	28,330	28,330	28,330	28,330	28,330	28,330
Special Fee	0	0	0	0	0	0	0	0	31,426	32,406	33,321	34,366	35,412	35,412	35,412	35,412	35,412	35,412	35,412	35,412	35,412	35,412	35,412
Tipping Fee																							
Incineration plant	0	0	0	0	0	0	0	0	21,737	21,443	21,169	20,855	20,541	20,541	20,541	20,541	20,541	20,541	20,541	20,541	20,541	20,541	20,541
Final disposal	0	0	26,397	26,037	25,667	25,332	25,083	24,830	67,563	70,562	73,541	76,677	79,852	79,852	79,852	79,852	79,852	79,852	79,852	79,852	79,852	79,852	79,852
Subtotal(A)	0	0	26,397	26,037	25,667	25,332	25,083	24,830	150,023	153,417	156,908	160,518	164,135	164,135	164,135	164,135	164,135	164,135	164,135	164,135	164,135	164,135	164,135
Expense																							0
O/M	0	0	5,700	5,650	5,600	5,570	5,550	5,550	21,750	21,930	22,100	22,280	22,450	22,450	22,450	22,450	22,450	22,450	22,450	22,450	22,450	22,450	22,450
Depreciation	0	0	9,334	9,334	9,334	14,034	9,334	9,334	45,251	40,954	40,954	44,454	40,954	43,047	43,522	40,022	41,625	40,425	43,925	41,625	40,425	40,425	45,125
Interest	0	0	6,280	4,608	2,826	4,179	12,801	36,910	58,163	55,131	49,984	47,109	41,049	34,841	30,231	22,575	13,299	814	0	0	0	0	0
Subtotal(B)	0	0	21,313	19,592	17,759	23,783	27,685	51,794	125,164	118,014	113,038	113,842	104,453	100,338	96,203	85,047	77,373	63,688	66,375	64,075	62,875	62,875	67,575
Profit or Loss (C=A	0	0	5,084	6,446	7,907	1,549	-2,601	-26,964	24,858	35,403	43,870	46,676	59,682	63,797	67,932	79,088	86,762	100,447	97,760	100,060	101,260	101,260	96,560
Profit tax	0	0	2,034	2,578	3,163	620	0	0	9,943	14,161	17,548	18,670	23,873	25,519	27,173	31,635	34,705	40,179	39,104	40,024	40,504	40,504	38,624
Profit excluding tax	0	0	3,050	3,867	4,744	930	-2,601	-26,964	14,915	21,242	26,322	28,005	35,809	38,278	40,759	47,453	52,057	60,268	58,656	60,036	60,756	60,756	57,936

unit : mill Zl

Year	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Balance	0	0	3,050	3,867	4,744	930	-2,601	-26,964	14,915	21,242	26,322	28,005	35,809	38,278	40,759	47,453	52,057	60,268	58,656	60,036	60,756	60,756	57,936
Depreciation	0	0	9,334	9,334	9,334	14,034	9,334	9,334	45,251	40,954	40,954	44,454	40,954	43,047	43,522	40,022	41,625	40,425	43,925	41,625	40,425	40,425	45,125
Subtotal(C)	0	0	12,384	13,201	14,078	14,963	6,733	-17,631	60,166	62,196	67,276	72,459	76,763	81,326	84,282	87,475	93,682	100,693	102,581	101,661	101,181	101,181	103,061
Money Demand																							
Investment	0	46,517	0	0	24,103	112,531	269,578	190,352	13,630	0	21,903	3,500	6,703	23,103	3,500	18,763	1,200	21,903	10,203	1,200	0	28,606	16,760
Loan																							
Long Term	0	0	0	0	0	0	0	0	54,165	54,165	54,165	54,165	54,165	54,165	54,165	0	0	0	0	0	0	0	0
Short Term	0	0	12,384	13,201	0	0	0	0	0	8,031	0	14,794	15,895	4,058	26,617	68,712	92,482	6,028	0	0	0	0	0
Subtotal	0	46,517	12,384	13,201	24,103	112,531	269,578	190,352	67,795	62,196	76,068	72,459	76,763	81,326	84,282	87,475	93,682	27,931	10,203	1,200	0	28,606	16,760
Money Supply																							
Budget from PM	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
from Inn.Fund	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10,203	1,200	0	28,606	16,760
Long Term	0	0	0	0	0	75,831	189,578	113,747	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Short Loan	0	46,517	0	0	10,025	21,737	73,267	94,236	7,629	0	8,792	0	0	0	0	0	0	0	0	0	0	0	0
Subtotal	0	46,517	0	0	10,025	97,568	262,845	207,983	7,629	0	8,792	0	0	0	0	0	0	0	10,203	1,200	0	28,606	16,760
Surplus of	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	72,761	92,378	100,461	101,181	72,575	86,301
Money																							
Reserved Fund	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	72,761	165,140	265,600	366,781	439,357	525,658
Total of Debt	0	46,517	34,132	20,931	30,956	128,524	391,369	599,351	552,815	490,619	445,246	376,287	306,227	248,004	167,222	98,510	6,028	0	0	0	0	0	0

9.3 Establishment of Monitoring System

9.3.1 Monitoring System for Incineration Plant

1) Monitoring Programme

The monitoring programme for the incineration plant must comprise the following issues:

- Control of waste supply
- Control of the operation and emissions from the incineration plant

The proposed monitoring programme is in brief described in the following. Moreover, measuring of noise emission and control of waste water from the flue gas cleaning must be carried out.

2) Control of waste supply

At the weigh bridge of the incineration plant all incoming waste is controlled. The following is registered by the computer system of the weigh bridge:

- Specification of waste supply (type and quantity)
- Name of customer who must pay for the waste supply

The computer system must as a minimum be able to provide the following material:

- Making out of bills prepared for each customer
- Preparation of statistics for the waste supply

3) Control of operation and emission from the incineration plant

The following emissions and parameters must continuously be registered for each incineration line:

- CO-concentrations of the flue gas after the boiler, based on dry flue gas at 11 % O_2
- O_2 percentage after the boiler
- Temperature of the flue gas in the furnace, in the zone for after burning, after the boiler and in the stack
- The opacity of the flue gas after the flue gas cleaning equipment
- HCL-concentration in the flue after the cleaning equipment, based on dry flue gas at 11 % O_2

The above registrations should be carried out at least 2 times a minute. The registrations must be elaborated by the computer system of the plant and utilized for adjustment of the operation of the plant. The computer system must each day supply reports on the above data. Further the reports must state operation periods of auxiliary fired burners.

Control of the following emissions should be performed at least each second month: particles, Cd, Pb, Cr, Cu, Mn, Hg, HF, SO_2 and TOC.

Requirements to the emission from the incineration plant is presented in Table 9.3.1-1.

Table 9.3.1-1 Requirements to Emissions from the Incineration Plant

Type of emission period for average	Max. emission (mg/Nm^3) Dry flue gas, 11 O_2, 273^0 Kelvin,1013 M Bar	Method for control
Particles		
week	30	Continuous
24 hours	40	Continuous
HCL		
week	50	Continuous
24 hours	65	Continuous
CO		
Hour	100	Continuous
90% quantile 0.5 hour	150	Continuous
NO_x	-	Continuous
SO_2	300	Spot test
HF	2	Spot test
TOC	20	Spot test
Pb+Cr+Cu+Mn	5	Spot test
Ni+As	1	Spot test
Cd+Hg	0.2	Spot test
Pb	1	Spot test

The control of all instrumentation should be automatic and take place continuously.

Reports for the planning of the operation and maintenance of the incineration plant should be elaborated at least twice a year. Further, reports should be elaborated on the following:

- Incinerated quantities of waste, quantity of consumed auxiliary fuel, daily heat production and quantity and quality of produced slag and ash.

- The operation of each stage of the flue gas cleaning equipment including descriptions of each disturbance which might occur.

9.3.2 Monitoring System for Sanitary Landfill

The purpose of the monitoring programme for the sanitary landfill is to supervise the surroundings influenced by the landfill. The programme must comprise the following issues:

- Control of waste supply
- Control of water (leachate, ground water and surface water)

1) Control of waste supply:

The type and quantity of waste of each truck load must be registered.

The registration must be carried out to facilitate statistics to be utilized for the planning of the sectional expansion of the disposal area.

2) Control of water:

The monitoring programme must be planned and the parameters for the control of leachate should be in agreement with the parameters for the control of ground and surface water. The parameters must be able to determine leachate characteristics and enable the comparison of a pollution-free and a polluted area. These parameters must be used at an early stage to detect whether the landfill is polluted with leachate or not.

3) Control of leachate:

The objective of the monitoring programme for leachate is to determine the degree of pollution. This information will be used as basis for the selection of parameters for control of ground and surface water.

4) Control of ground water:

The objective of the monitoring programme for ground water is to determine whether ground water alterations occur due to pollution from leachate.

The programme for ground water analysis is presented in Table 9.3.2–1.

Table 9.3.2–1 Programme for Ground Water Analysis

	Parameter	Programme		
		Basis	Enlarged	Supplementary
Characterization	Odeur	+	+	+
	Colour	+	+	+
	Clearness	+	+	+
	Conduct.	+	+	+
	Dry matter	+	+	+
Organic matter	COD		+	+
	$KMnO_4$	+	+	+
Nutrient salts	Total–N			+
	NH_4		+	+
Other salts	Cl	+	+	+
	Bor.B		+	+
	Fe		+	+
	Ca			+
	Mn		+	+
	SO_4		+	+
Heavy metals	Zn			+
	Pb			+
	Cd			+
Other toxics	Phenol			+

The frequency for analyzing ground water depends on the velocity of the ground water flow, which in turn depends on actual soil conditions. A ground water maximum flow was taken between 2 sample and is recommended for use.

CHAPTER 10

RECOMMENDATIONS

CHAPTER 10 RECOMMENDATIONS

This chapter describes the conclusion obtained through the study and the recommendations in the technical and institutional aspects.

10.1 Conclusion

1) Technical System

a. Present MSWM in Poznan

- Present amount of MSW discharged in Poznan City is 453.5 tons/day (769 g/person/day) in 1992, and the disposal amount at the present Suchy Las landfill including wastes other than MSW is 508.6 tons/day.

- The LCV (Lower Calorific Value) of MSW, excluding road sweeping and bulky wastes and domestic ash, was measured to be 1,854 kcal/kg. It is concluded that MSW in Poznan City does not require auxiliary fuel for an incineration plant.

- The Franowo-Michalowo site which shall be proposed as suitable for the management of MSW facilities in the Urban Development Master Plan of Poznan City to be formulated in December 1993, is also considered as the optimum site within the city in this study, provided that sufficient environmental measures are taken against the adverse impacts of the MSW facilities.

b. MSWM master plan

- It is forecasted that the amount of MSW discharged in Poznan City will be 537.7 tons/day (867 g/person/day) in 2010, and that the LCV of MSW excluding road sweeping and bulky waste will be 2,338 kcal/kg with a separate collection system and 1,924 kcal/kg without.

- The seven alternatives for the MSWM Master Plan were carefully examined. In order to achieve the goal established, Alternative 5 which consists of separate collection, public recycling centres, an incineration plant and a sanitary landfill was concluded to be the optimum technical system and approved by the Poznan City Council.

- The construction of MSWM facilities proposed in the Master Plan shall be implemented on a step by step basis, i.e. short term (1994–1998), middle term (1999–2003) and long term (2004–2010).

c. Feasibility Study

- The proposed cost is estimated based on the construction price in January 1993 as follows:

Table 10.1–1 Estimated Project Costs

Facility	Scale	Project Cost (mill.zl)
Public Recycling Centres	Large: 3,000 m^2 x 2 sites Small: 2,000 m^2 x 6 sites	16,264
Incineration Plant Phase I	Capacity: 10 tons/hour/1 line	539,155
Sanitary Landfill Section I	Landfill capacity: 700,000 m^3	46,517

- The economic/financial analysis regarding the implementation of the 3 projects shown in the table above is conducted and it is concluded that the three projects are feasible. As for the incineration plant (Phase I), the EIRR (Economic Internal Rate of Return) is 15.8 %. The FIRR of the Poznan Treatment Disposal Company is 17.5 %.

2) Institutional Development

For institutional development, the following conclusions on the study may be presented:

a. General conclusions

- The complete transition of the Polish society from a socialist, centralised system to a capitalistic, decentralised community with free market economy inevitably led to transitional problems due to the lack of tools in the local level required in managing public duties. Therefore, there is a need for tools to be transferred from national and regional levels to the local level.

For MSWM, the problems in transaction includes lack in legislative tools related to the enforcement of compulsory waste services and tools for financing through local taxation and the municipalities' capability in raising loans.

- Generally, it is difficult to overcome opposition and to obtain land for waste facilities due to lack of procedures for compulsory purchase of land for projects benefiting the whole community.

- General discussions should be conducted on standards appropriate for the MSWM, e.g. to determine the time schedule required for the transition to EC-standards.

- The implementation and evaluation of the project in terms of the provision of feasibility analysis for decision-making, execution of competitive bidding in the purchase phase and supervision of construction works were not adequately managed.

- The custom for public subsidization results in low financial contributions from the users leading to a lack of public monitoring and control of the services.

b. Conclusions for Poznan municipality

- Generally, the MSW-services in Poznan Municipality are carried out in a satisfactory way.

- The institutional system of MSWM in Poznan Municipality is being reorganized and strengthened. Furthermore, SANITECH is strengthened through the joint ownership of the municipality and a private German contractor possessing technology and the financial resources.

  Nevertheless, the municipality still requires further improvement and strengthened control over activities as majority of the shares are held by the private investor.

- The present method in the collection of fees for waste services, performed by the executing contractor, is insufficient and tends to provide unequal services to the citizens.

- The newly issued regulation for MSW services deals with deficiencies hindering the maximization of the collection service and competitive bid-

ding. Furthermore, without enforcement from the controlling authorities the level of cleansing services in the city may vary.

- Sanctions in controlling the disposal of construction waste are essential to the prevention of illegal dumping.

10.2 Recommendations

1) Technical System

a. Obtainment of basic data and its utilization

- Basic data on the waste stream diagram and composition were obtained from the Study. It is, however, insufficient for the formation of the detailed design of an incineration plant. Therefore, the execution of a periodical waste amount and composition survey and the reviewal of basic data for the successful design, construction and operation of the incineration plant are recommended.

- As for the amount of waste collected and disposed, measurement by volume shall be replaced by weight. Continuous observation of the amount of waste disposed shall be conducted in order to obtain the seasonal fluctuation in waste discharge to establish the capacity of the incineration plant. Consequently, the execution of a year-long measurement of the amount of waste disposed and preparation of a more precise waste flow diagram are requested.

b. Collection

- A separate collection system for combustible and non-combustible wastes shall be introduced in order to achieve a highly efficient of combustion process.

- Bulky wastes will be brought to public recycling centres by the citizens. And a bulky waste collection system shall be provided to citizens who can not transport their wastes to the centres.

- For the introduction of a separate collection system, a pilot area shall be selected for experimentation. Based on the results of the experiment, an expansion plan for the whole city shall be made.

- The same system will be used for the collection equipment. However, ownership of public containers not less than 1.1 m^3 shall belong to collection companies, while dustbins (110 l) shall belong to the citizens.

- To improve collection efficiency, the curb collection shall be adopted for the collection of dustbins and small public containers (1.1 m^3).

c. Recycling

- Eight public recycling centres shall be constructed as soon as possible. As the main purpose of public recycling centres is the prevention of illegal dumping, it is not advisable for profit-orientated private companies to have direct control over the operation. Instead, it is recommended that the Department for MSWM shall sublet, under a fixed budget, the operation to private companies

- It does not seem to be necessary for the Municipality to construct any special facility for recycling. However, the Municipality as well as the Central Government shall promote recycling activities in order to avoid stagnation due to decrease in the prices of recyclable materials. If necessary, they should offer incentives or subsidies for recycling activities because of the savings from collection and disposal costs to be gained.

d. Incineration plant

- In response to the need to reduce waste disposal amount, the citizen's intense awareness concerning environmental conservation and demand for heat supply in the area, the construction of the incineration plant (phase 1; capacity 10 tons/hour) is recommended.

- Financial aid from international lending agencies for the construction of the plant is recommended.

- In order to reduce the financial burden and smooth the operation of the plant, full incineration shall be performed step by step until 2010.

- Although the construction of phase 1 will commence in 1998, the schedule shall be renewed in case national/regional economic conditions and the financial state of the Municipality may not afford such a large investment.

- An EIA (Environmental Impact Assessment) shall be conducted before the construction.

e. Final disposal

- Since there is no disposal site in Poznan city, the immediate construction of the Franowo-Michalowo sanitary landfill, which will meet the EC environmental standard, is most desirable.

- The transfer of the landfill from Suchy Las to Franowo will bring about opposition to the Municipality from the nearby residents. Therefore, to obtain a consensus it is necessary to explain the impact of the establishment of the landfill site on the surrounding environment by using predicted data. The formulation of a periodical monitoring plan on environmental items, like water and air quality etc., is recommended.

- An EIA shall be conducted before construction.

2) Institutional Development

For institutional development the following recommendations are proposed:

a. General recommendations

- In order to provide the optimum conditions for the implementation of appropriate MSWM at the local level, the national authorities should complete:

  . The national MSW-policy including the determination of appropriate target years for implementation of specified (minimum) services complying with the standard applied. After determination of the policy, a period of at least 4-6 years should be settled for implementation and gaining of experience before new demands are imposed.

  . The necessary legislation including appropriate administrative tools for municipalities' implementation of compulsory waste service. With the administrative tools, the municipalities could control and supervise the private companies involved in the MSWM.

. The necessary legislation that will provide appropriate tools for the acquisition of land under compulsory powers in order to facilitate localization of the waste treatment and disposal facilities needed.

. The necessary tools for the implementation of competitive bidding including preparation of a general regulations concerning Tender Works.

. The necessary financial tools for financing local MSWM through local taxation and raising loans for feasible projects.

- Establishment of a new regional authority responsible for licensing waste utilities. This new authority will supervise the performance of these utilities and whether environmental standards are met. This duty will be enforced particularly during the updating of the licences, which should take place every 4 years. Non-compliance and violation of the environmental standards would lead to confiscation of license and termination of operation.

- To compensate for the urgent need for improved surveillance during construction, provincial authorities should carry out a more intensive supervision of the projects to ensure that environmental protection measures are implemented.

- In order to heighten public awareness, education programmes should be implemented. Schools and the media are the best ways to reach the public.

b. Recommendations for Poznan municipality

i. Establishment of the Department of MSWM

A clearer division in responsibilities and duties in MSWM is necessary to secure municipal control over the activities, and an unified and better service to the citizens. Furthermore, the division of responsibilities and duties for compulsory municipal services would entail informing the citizens of the definition of the various level of services, the methods in the handling of complaints and - most importantly -the determination and collection of fees.

Generally, a Department wholly responsible for Municipal Solid Waste Management must be formed. The department shall be responsible for overall planning, administration and control, and supervision of executing bodies.

ii. Executing bodies

The execution of compulsory municipal waste services, operation of facilities etc., will be tendered to private companies and also entrusted to companies to be established under municipal jurisdiction.

The newly formed Rethman-Poznan Waste Management Co. Ltd., regardless of the participation of Poznan Municipality, lack ultimate municipal control over the activities to be called a municipally (controlled) company. Consequently, we recommend that full control and supervision should be carried out on the activities of the company by the administrative tools of the Municipality. However, since the Municipality is not granted with these tools, contracts on municipal services may be given directly to the company, provided that the contract price for tendered districts were used as basis of the payment.

We recommend the execution of the following waste services:

Waste collection services

- Tendering by district (min. 25% of the total volume).
- The remainder is given to Rethman-Poznan Waste Management Co. Ltd., using the contract price for the tendered districts as basis of payment.

Incineration plant and sanitary landfill

- Formation of a new company under full municipal control to be responsible for construction and operation. Construction of the facilities will take place through competitive bidding.

Road sweeping and public area cleansing

- The responsible bodies will conduct tendering directly.

iii. Determination and collection of fees

- It is desirable to have a waste fee system based on the discharge amount (weight). However, it would be difficult at the moment to calculate waste fees by measuring each generation source. Therefore, the establishment of a waste fee system which consists of

collection fees (zl/person/month) and solid waste tax (for treatment and disposal costs) in accordance with income, is recommended.

- Poznan Municipality, in cooperation with other local governments, is highly recommended to make a request to the Central Government for the modification of the law related to MSWM, to enable local governments to regulate the above mentioned waste fee system and fee collection system.

PART IV

GENERAL RECOMMEN-DATIONS FOR THE IMPROVEMENT OF ISWM

CHAPTER 11

GENERAL RECOMMENDATIONS FOR THE IMPROVEMENT OF ISWM

CHAPTER 11 GENERAL RECOMMENDATION FOR THE IMPROVEMENT OF ISWM

This chapter describes the result of the various field survey and the recommendations concerning industrial solid waste management.

11.1 Present Industrial Solid Waste Management

11.1.1 Laws and Regulations

1) Poland

The laws and regulations in Poland on waste do not distinguish industrial waste and municipal waste.

The basic laws and regulations concerning waste management are presented below.

Law on Environmental Protection and Modeling of 31 January 1980 amended on 27 April 1989 and 10 May 1990

The law describes the basic principles involved in proceeding in all fields of anvironmental protection measures against pollution and also the legal responsibility for keeping the appropriate state of the environment.
Also, the law defines that local administrative authorities (municipalities) must provide organizational and technical conditions necessary for the protection of the environment.

Law of Ministers' councils of 30 September 1980 concerning Protection of the Environment against Waste and other Impurities and Cleanness of the Towns and Villages

This law is the executive law of the Law on Environmental Protection and Modeling concerning waste management. It defines the duty of the municipalities; among others:

- Considers environmental protection tasks in preparation of development plans.

- Provide facilities for treatment and disposal and gurantee their proper operation.

- Define tasks to be provided by the municipal cleaning enterprises and durantee the fulfilment of their duties.

Also, the law defines the duties of the landfill operator, e. g. to keep record of quantities and types of waste received, and refuse waste of unknown composition. Finally, the law defines the duties of owners and administrators of real estates in relation to the disposal of waste in non-developed parts and areas destined for public use and the equipping of the estate with facilities for waste storing and provision of a sanitary storage area.

Law of Ministers' Council of 21 December 1991 concerning Charges for Use of Environment

The law settles charges for 151 types of waste categorized under into 4 levels according to of harmfulness.

Law of the Ministry of Environmental Protection, Natural Resources and Forestry of 23 April 1990 concerning Investments specially Harmful to the Environment and Human Health and the Conditions to be included in the Environmental Impact Assessment

The law is issued on basis of the act for the protection and forming of the environment of 31st January 1980 and of 12th July 1984 on physical planning.

It determines the type of investments specially harmful to the environment and human health, which before obtaining location shoukd be approved by the Ministry of Environmental Protection, Natural Resources and Forestry and the General Sanitary Inspectorate.

2) EC Legislation and Directives

The EC has a comprehensive regulation on hazardous wastes. A number of the directives concern transfrontier shipment of hazardous waste and dumping at sea.

The cornerstone in the EC-policy concerning hazardous waste is the Directive on Toxic and Dangerous Waste of 20 March, 1978(78/319/EEC).

The directive lays down the principle that the disposal of toxic wastes must not pose a threat either to health or the environment and provides a series of measures to achieve this end.

11.1.2 Administration and Organization

1) Administration

a. National level

Currently, the ministries responsible for industrial solid waste management are:
- Ministry of Environmental Protection, Natural Resources and Forestry
- Ministry of Health and Social Assistance

The Ministry of Environmental Protection, Natural Resources and Forestry is responsible for the following activities in relation to the ISWM:
- Formulation of environmental policies and strategies.
- Preparation of legislation and guidelines related to the protection of the natural environment.
- Monitoring and control through the State Inspectorate of Environmental Protection represented at national and provincial levels

The Ministry of Health and Social Assistance is responsible for the human health aspects of solid waste management and exercises their power through the SANEPID. The SANEPID is represented at national, provincial and local levels.

b. Provincial level

The Provincial Government (Voivodeship) is the central figure in the Polish administrative system as the executive body of the central Government.

The Department for Environmental Protection is responsible for the issuance of permits for the industrial use of the environment. The use of the environment concerns all kinds of disposal and discharge to the environment (air, water and waste).

In connection with the ISWM, other duties of the department are:

- Decide on charges for use of the environment

- Collection of charges for use of the environment
- Conduct activities related to proper management of natural resources
- Issue statements concerning plans for change in the utilization of land

c. Poznan City

The following bodies in Poznan Municipality are involved in the execution of municipal waste management.

- The Department for Communal and Residential Affairs
- The Investment Department
- The Municipal Police
- The Department for Environmental Protection
- The Department for Urban Development, Architecture and Construction Supervision

Of these bodies, only the Department for Environmental Protection is actually directly involved in ISWM. This department is under reorganization.

d. The State Inspectorate of Environmental Protection

This body is recently transformed from a unit subordinated to the Provincial Government (Voivodeship) to a direct reference of the Ministry of Environmental Protection, Natural Resources and Forestry.

Also, the body issues certificates for industrial waste on the request of the industries. The purpose of the certificates is to determine the optimum way of disposal and allow operators of disposal sites to decide if they can fulfil the requirement and receive the waste or not.

e. The State Sanitary and Epidemiological Inspectorate (SANEPID)

SANEPID is an authority under the Ministry of Health and Social Assistance. SANEPID operates at three levels:

- National level
- Provincial level through Provincial (Voivodeship) SANEPID.
- Local level through Municipal SANEPID

SANEPID's area of responsibility is focused on environmental impact on health, including also occupational health.

The provincial SANEPID issues certificates for the disposal of industrial waste. In Poznan, the State Inspectorate of Environmental Protection issues the certificates.

2) Organization

Organizational aspects for the national and the provincial level are covered in previous sections. In this section, relevant remarks will be added on the local level for Poznan Municipality.

As for ISWM, Poznan Municipality has introduced a regulation on repair works in order to control the generation and disposal of construction waste.
Only a few of the industrial companies were observed to cooperate in the safe disposal of waste. It is very difficult to secure candidate sites for the disposal facilities due to protests of residents against localization. It is impossible to overrule the protests due to a lack of power to enforce localization even for the best interest of the whole population.

11.1.3 Generation

A study was conducted in industrial wastes generated in the City of Poznan in 1988 by the Engineering Institute of Zielona Gora, and some data were obtained in 1991 through questionnaire survey by the JICA Study Team.

The total amount of industrial waste discharged from 21 representative enterprises is about 229,107 t/year. 28% of the total amount is reutilized or recycled and 46% is stored in their own premises, although approximately 39,000 t/year is disposed of in Such Las disposal site or in other sites. In case of Garbary – Karolin, 596,000 tons of ashes and slags has been already stored in its own site.

11.1.4 Collection and Haulage

Most enterprises independently transport their waste to the disposal site or require contractors to do so. However, waste to be reused in other factories is collected and transported by their own staff and trucks. One enterprise especially transports industrial waste in containers to another industry by train. There are also some industries who pay SANITECH for the collection and transportation of their wastes.

3) Industrial Waste Disposal Method

Large amount of industrial waste is transported to Suchy Las disposal site. "Others" in the questionnaires include other sites and companies such as SURMET, CPN and factories which reuse waste.

11.1.5 Processing and Recycling

1) Processing

Three of seven enterprises which generate used oil neutralize it. Two enterprises treat it by oil-separation method. All three enterprises which generate water-oil emulsion treat waste by oil-separation method. Some uses the drying and burning method. All four enterprises which generate galvanic sediment adopt the method of neutralization and dehydration. Painting waste, plastic waste and sawdust are burned for treatment.

Most of the representative enterprises treat waste with the basic process. However, the treatment facilities are old and need to be improved.

2) Recycling

Most of the main enterprises in Poznan City reutilize industrial waste. However, the amount reutilized is less than 28% of the whole waste amount. The reutilization or recycling of waste is either conducted by the enterprise which produces the waste or by other enterprises.

11.1.6 Final Disposal

At present, there is no disposal site for industrial waste inside Poznan City. Suchy Las disposal site, located next to the boundary of the City, is not prepared to accommodate industrial waste.

A disposal site "inside Poznan City" refers to some illegal dump sites, and the site "outside Poznan City" refers to Suchy Las disposal site. More than 60% of the representative enterprises use the municipal disposal site to dispose of their industrial waste.

It seems that the industrial waste collected by "SANITECH" is treated at Suchy Las disposal site. Almost all types of industrial waste, such as glass ceramic, hazardous waste and sediments including heavy metal and asbestos, are disposed of at the site.

There are many illegal dumping places in Poznan.

11.1.7 Financial Situation

The Act on Environmental Protection and Modeling describes "economic means of environmental protection" which includes the method for raising funds, objectives of these funds and their allocation.

These funds shall be raised from payments for the use of the environment and from fines imposed on environmental violations. These funds shall then be divided between the provincial and central governments.

Provincial government (voivodeship) is earmarked to support the construction of environmental protection facilities especially important for the area. This shall be done through subsidies. The fund in Poznan in 1992 is only 100 billion Zl., although 70 projects are planned. Of these 70 projects, 25 are on solid waste and includes the construction or expansion of landfill sites, purchase of containers for recycling and preparation of a disposal site for industrial waste. The 1991 budget for solid waste management was 2.1 billion Zl., and is estimated to reach 10 billion Zl in 1992.

The National Fund for Environmental Protection and Management shall come from provincial funds. 100% of the charge for NO_X and 40% of the charge for SO_2 which goes to the provincial fund shall be transferred to the national fund, but 90% of these will be reimbursed in the form of interest payable loans for provincial projects.

The municipality of Poznan has not apporopriated a budet for industrial waste management. The "Warta River Basin" Project was the only project privately subsidized. EC financed it with 500,000 ECU (about 800,000 US$) to formurate a master plan for wastershed management and to identify immediate projects. The latter led to teh formuration of some candidate projects for solid waste management.

11.2 Issues and Problems

1) Laws and Regulations

In EC, laws related to the discharge of industrial wastes have been strengthened to reduce the amount of discharge, increase recyclable resources and enable the implementation of appropriate treatment methods. In addition, a new policy on industrial waste from an economical point of view was also formulated. Likewise, the same strategies are also necessary in Poland.

2) Administration and organization

In Poland, the administration and organization of industrial wastes are explained hereunder.

On the national level, the ministry in charge of industrial waste management is the Ministry of Environmental Protection, National Resources and Forestry.

This Ministry is responsible for the following activities:

- Presentation of environmental policy
- Lawmaking for natural environmental protection and preparation of guidelines
- Monitoring and control through the State Inspectorate of Environmental Protection in the national and provincial level

In the provincial level, the department in charge of industrial waste management is the Department for Environmental Protection. The department prepares programs and plans that promote the implementation of national policies on a provincial scale.

The department is also responsible for issuing licenses to factories wanting to use the environment.

Their duties also include the following:

- Decide on the fees for the use of the environment
- Fee collection for the utilization of the environment
- Conduct activities for the proper handling of natural resources

. Formulation of reports on plans for modification of land utilization
. Formulation of reports on planned disposal site.

The amount of the fee to be paid for the use of the environment will depend on the data penned in the application paper. The fees shall be collected by the department.

The administrative and organizational conditions in Poland and Japan are almost the same.

However, in spite of established laws, administration and organizational structure, things do not seem to work well enough. This may be attributed to the following observations made during interviews with enterprises and administration.

- The provincial government does not supervise the activities of each enterprise, nor have any plans concerning industrial waste disposal.

- The provincial government only assigns one staff to supervise industrial waste management.

3) Enterprises and contractors

Only a very few number of enterprises and contractors were found to keep records on industrial waste storage, and only a rough estimate of the weight of generated waste was found in the data.

Enterprises must conduct data storage, especially since a data base is not difficult to set up and maintain.

Illegal dumping of industrial waste leads to environmental deterioration, therefore, enterprises and contractors must formulate a corporate policy regarding the proper discharge of waste. If proper measures are not taken, the administration should conduct factory inspections and impose compulsory regulations and court actions as the occasion demands.

4) Recycling

The typical methods of recycling industrial wastes in 1991 are summarized below.

Slag ..... Road construction enterprises

Used oil ..... Recycling at CPN
Sawdust ..... Used as fuel by other enterprises
Carbide residue .... Used by other enterprises
Scrap metal ..... Sold to steel factories works
Glass waste ..... Sold to glass factories works
Food waste ..... Sold to feed traders

Nevertheless, through further consideration of the industrial wastes of each enterprise, there are still factors that would enable an increase in the recycling ratio.

Some enterprises take sawdust and glass wastes to the disposal site directly through contractors. These wastes can also be recycled. Polfa makes use of rubber and cork wastes in making sound absorbers.

5) Disposal Site

Dischargers are responsible for the disposal of industrial waste. However, they cannot treat and dispose of the entire industrial waste since they have no disposal site. Some wastes are stored in their own site and some are dumped illegally. Therefore, it is important for the disposal site for industrial waste to be constructed and an appropriate disposal system to be established.
An organization, PASTICHE, for the disposal of industrial waste in Poznan City was jointly established by 9 dischargers (seven from Poznan). Presently, the organization is trying to acquire land to be used as a disposal site.
Approximately 20ha of land is being required for the construction of a disposal site that would accommodete the industrial wastes of all enterprises within the province.

11.3 General Recommendation

This section deals with the general recommendations on the ISWM of Poznan City;

1) Laws and Regulations

Primarily laws and regulations should be established in keeping with the EC legislations and guidelines. It is necessary not only to treat industrial wastes, but also to control the generation and discharge of waste, and further to reduce the amount through recycling.