Chapter 3

Fact Finding Surveys

3 Fact Finding Surveys

In order to understand the current industrial waste management (IWM) in the study area the following surveys were carried out.

- Factory survey.
- Survey on non-HW collection/transport organizations.
- Survey on waste reuse/recycling/treatment companies.
- Survey on associations of industries, waste collection/transport companies, and waste reuse/recycling/treatment companies.
- Survey on municipal waste management.
- Public opinion survey.

3.1 Factory Survey

3.1.1 Objectives and Waste Flow

a. Objectives

The objectives of the survey are:

1. To obtain basic data for the estimation of current non-hazardous waste (non-HW) generation and the forecast of future non-HW generation in order to formulate non-HW management master plan (M/P);
2. To identify current non-HW management at generation sources, i.e. **on-site**: storage, reuse, recycling, waste exchange, treatment and disposal, and **off-site**: collection/transportation, reuse, recycling, waste exchange, treatment and disposal;
3. To find out current reuse, recycling and waste exchange of hazardous waste (HW) both on-site and off-site in order to formulate an action plan (A/P) on HW management concentrating in the area of waste reuse/recycling, industrial cluster and zero emission;
4. To research needs of reuse/recycling and waste exchange of non-HW/HW according to the categories of industries and/or industrial wastes (IWs); and
5. To understand opinions of factories (generation sources) regarding non-HW/HW management, environmental protection, industrial cluster and zero emission.

b. Waste Flow

Through this factory survey, generation amount, on-site reuse/recycling and treatment/disposal amount, collection/transportation amount and off-site reuse/recycling and treatment/disposal amount should be understood. A non-HW flow should then be developed as shown in Figure 3-1.

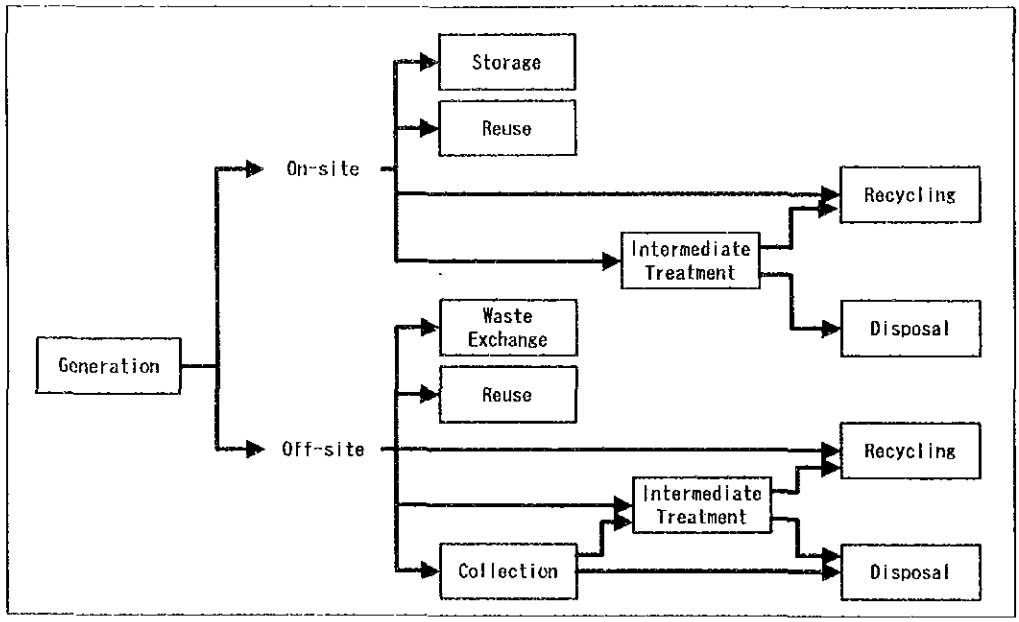

Figure 3-1: non-HW Flow

c. Work Flow

Taking the above objectives into consideration, the team discussed target industries/factories for the factory survey with DIW. For facilitating the discussion the team presented a flow chart for the factory survey below and it was agreed.

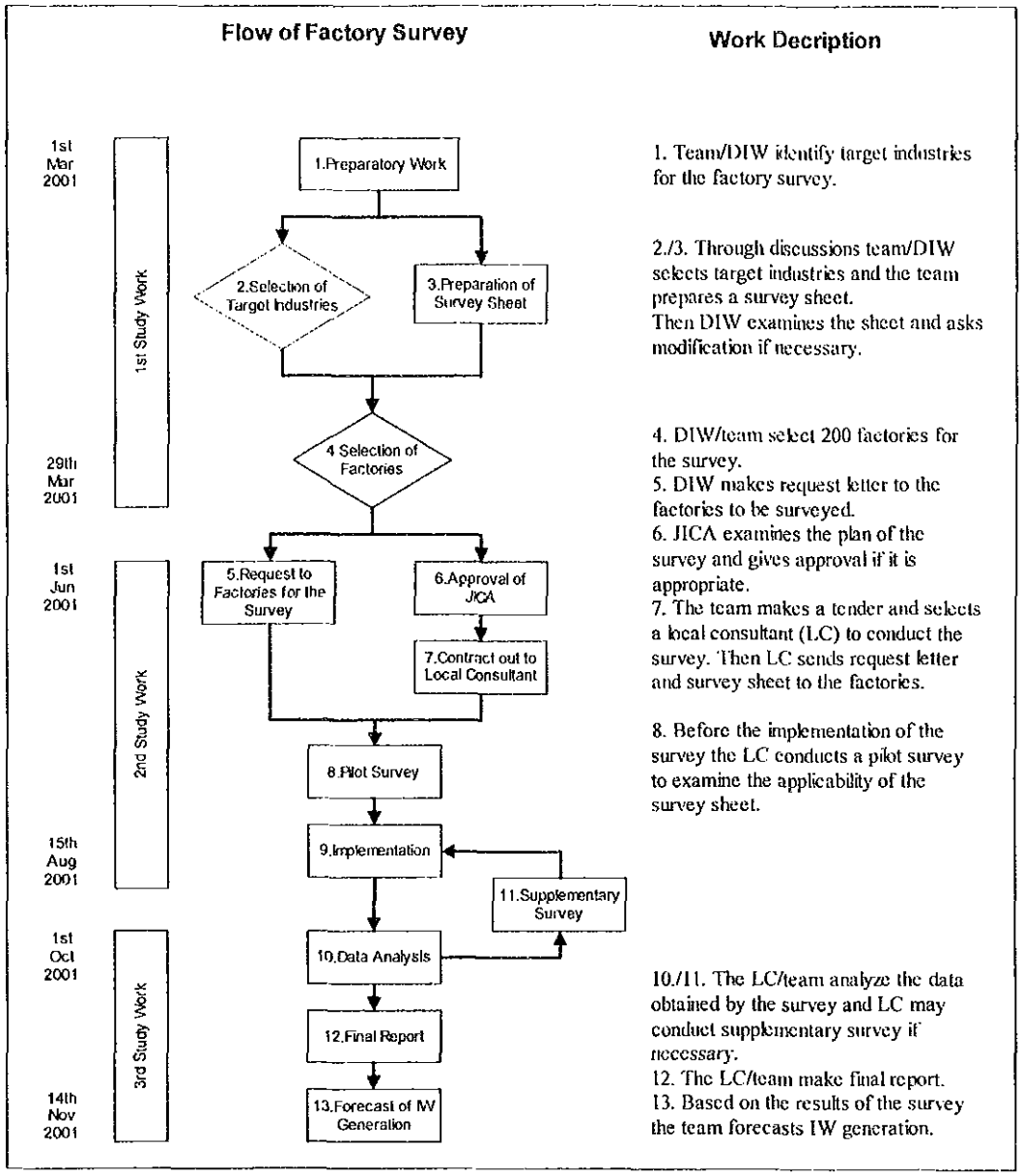

Figure 3-2: Flow Chart of Factory Survey

3.1.2 Preparation of the Survey

a. *Classification of IW*

a.1 Non-HW

List of characteristics of waste and unusable materials attached to the Notification of Ministry of Industry No. 1 (B.E. 2541 or A.D. 1998) classified non-HW into 2 groups; i.e. Group 1: Non-HW characterized by type and Group 2: Waste from specific industrial processes (See Section 5.2.3).

Since the main objective of the survey is to obtain basic data for the estimation of current non-HW generation, the team simplify the above-mentioned classification of wastes to 14 categories of non-HW as shown in the table below and applied them to the survey.

Table 3-1: Classification of Non-HW Applied to the Factory Survey

MOI Notification No 1 (1998)	Non-HW Code for the Study	Descriptions
Group 1 - 1	C01-01	Parts of plants such as roots, barks and leave
Group 1 – 1	C01-02	Parts of animals such as bones, skins, hair and excreta
Group 1 – 2	C02	Parts of wood
Group 1 – 3	C03	Paper wastes
Group 1 – 4	C04	Plastics or synthetic rubbers
Group 1 – 5	C05	Cloth, thread and fabric
Group 1 – 6	C06	Animal's fat and oil and vegetable oil
Group 1 – 7	C07	Natural rubbers
Group 1 – 8	C08	Metals and metal alloys (not in salt form)
Group 1 – 9	C09-01	Ceramics
Group 1 – 9	C09-02	Glasses
Group 1 - 10	C10	Stone, cement, sand or materials consisting of clay, sand or stone e.g. tile, brick gypsum and concrete
None	C11	Mixed waste
Group 2	C12	Others

a.2 HW

The MOI Notification No. 6 B.E. 2540 (1997) issued pursuant to the Factory Act B.E. 2535 (1992) classifies hazardous industrial waste into 4 groups.

Group 1: Ignitable substance, corrosive substances, reactive substances, toxic substances and leachable substances,

Group 2: Hazardous waste from non-specific or specific sources,

Group 3: Expired or discarded chemical product, off-specification chemicals, unusable chemicals remain in containers and cleaning materials which contaminate with spillage chemicals.

Group 4: Chemical waste.

In this survey, however, the team applied the classification of HW (24 categories of HW) as shown in Table 3-3. The reasons are as follows:

- The classification of the Notification No.6 appears to be difficult to apply to this kind of survey because of complicatedness.
- There is a previous study on HW conducted in the study area in 1999, Preparation of Register on Hazardous Waste Generation & GIS Application for the Province Samut Prakarn (called as GTZ HW Study). If this study follows the classification of HW applied to the GTZ HW Study, it is expected to share and compare the data obtained by the previous study.

- The team intended to use the same waste categorization to the pilot projects of waste exchange (Chapter 8), but for this purpose, part of the GTZ Study code was too broad. Therefore, the team subdivided some of the categories. The basic idea of subdivision is shown as follows.

Table 3-2: Idea of Subdivision of GTZ HW Code

Type of HW	HW Code for the Study	Description
Acid	W01-01 W01-02	At factories, various types of acids are used. The number of types of inorganic acids is limited, while more various types of organic acids are used. Therefore, it is better to distinguish inorganic acids from organic acids. 1. Inorganic acid: hydrochloric acid, sulfuric acid, nitric acid, phosphoric acid, hydro cyanic acid, fluoric acid, and so on. 2. Organic acid: acetic acid, oxalic acid, chloroacetic acid, formic acid, and so on Organic acid is composed of some elements such as carbon, hydrogen, and oxygen, and always weak acid. On the other hand, inorganic acid varies, ranging from strong acid such as hydrochloric acid, nitric acid, sulfuric acid, to very weak acid such as cyanide acid. Many of inorganic acids can be dissolved in water as ions and this makes these acids storing acid. On the other hand, since organic acid is dissolved as molecules in water and ions reach equilibrium with molecules, organic acids are always weak acids.
Alkalis	W02	The number of types of alkali used at factories is limited. In particular, in the case of organic alkali, only the limited types are used and the volume is small. When it comes to alkalis, they usually indicate sodium hydroxide (caustic soda), potassium hydroxide (caustic potash), and calcium hydroxide (slaked lime). Therefore, there is no need to subdivide alkalis. Alkalis that are used at factories are shown as follows. • sodium hydroxide, potassium hydroxide, calcium hydroxide、ammonia, and so on. Waste Alkalis usually mean basic liquids, such as caustic soda, caustic potash, and slaked lime, discharged from factories. Chemically, alkali is a substance, which shows alkalinity in water and indicates a hydroxide such as alkali metal (Na, K and so on) and alkali-earth metal (Ca, Ba and so on). Therefore all the metal oxides are alkalis, but they are normally classified as sludge or others in the waste code. As an example of organic alkalis (organic base), amine compounds are given. They behave as alkalis in water, but are always weak alkalis. In consequence, there is no need to distinguish inorganic alkalis from organic alkalis as waste alkalis.

Heavy Metal Compounds	W03-01 W03-02 W03-03	Heavy metal compounds are divided into three groups: toxic salts; less toxic salts; and compounds other than salts. The team had no problems to analyze waste data.
Liquid Inorganic Compounds	W04-01 W04-02	High-risk substances such as plating waste and cyanide are put in one group and separated from the other compounds which are classified in the other group.
Solid Inorganic Compounds	W05	Same as GTZ code
Organic Compounds	W06-01 W06-02 W06-03	Organic compounds are classified for convenience to make it easier to search target waste at the time of waste exchange.
Polymer Materials	W07-01 W07-02 W07-03	Polymer materials are also classified on the same purpose of the previous item.
Fuel, Oil and Grease	W08-01 W08-02 W08-03	Fuel, Oil and Grease are also classified on the same purpose of the previous item.
Fine Chemicals and Biocides	W09	Same as GTZ code
Picking Waste	W10	Same as GTZ code
Filter Materials, Treatment Sludge	W11-01 W11-02	Since contents of sludge are different between organic and inorganic matters, filter materials and sludge are divided into two groups.
Other Toxic substance (besides W01-W11)	W12-01 W12-02 W12-03	Other toxic substances are divided into three groups to make it easier to implement waste exchange program. It should be noted that it would have been better to make one more group, "the other" of other toxic substances.

Table 3-3: Classification of HW Applied to the Factory Survey

Code/Type of HW applied to the GTZ HW Study	HW Code for the Study	Description	Detail Description
W01: Inorganic and Organic acid	W01-01	Inorganic acid	Sulfuric acid (H_2SO_4), Hydrochloric acid (HCl), Nitric acid (HNO_3), Phosphoric acid (H_3PO_4), Other inorganic acids
	W01-02	Organic acid	Acetic acid (CH_3COOH), Formic acid (HCOOH), Other organic acids
W02: Alkalis	W02	Alkalis	Caustic soda (NaOH), Ammonia (NH_3), Sodium carbonate (Na_2CO_3), Other alkaline materials
W03: Heavy Metal Compounds	W03-01	Heavy Metal Compounds	Salts
	W03-02		Toxic salts (Hg, As, Cd, Pb, Cr)
	W03-03		Heavy metal other than the above
W04: Liquid Inorganic Compounds	W04-01	Liquid Inorganic Compounds	Plating wastes, Cyanides
	W04-02		Liquid inorganic compounds other than the above
W05:	W05	Solid	Asbestos, Slag, Silt

Solid Inorganic Compounds		Inorganic Compounds	
W06: Organic Compounds	W06-01	Organic Compounds	Reactive chemical wastes (Oxidizing agents, Reducing agents, etc)
	W06-02		Solvents
	W06-03		Organic compounds other than the above
W07: Polymer Materials	W07-01	Polymer Materials	Epoxy resin, Chelate resin, Polyurethan resin
	W07-02		Latex rubber
	W07-03		Polymer materials other than the above
W08: Fuel, Oil and Grease	W08-01	Fuel, Oil and Grease	Lubricating oil (Engine oil, Grease, etc)
	W08-02		Chlorinated solvents (Trichloroethylene, Methyl chloride, etc)
	W08-03		Oil waste other than the above
W09: Fine Chemicals and Biocides	W09	Fine Chemicals and Biocides	Pesticide, Medicine
W10: Picking Waste	W10	Picking Waste	---
W11: Filter Materials, Treatment Sludge	W11-01	Filter Materials, Treatment Sludge	Inorganic sludge
	W11-02		Organic sludge
W12: Other Toxic substance (besides W01-W11)	W12-01	Other Toxic substance (besides W01-W11)	Non-HW mixed or contaminated with HW according to MOI Notification No. 6 (Year 1997) pursuant to the Factory Act.
	W12-02		Waste from specific industrial processes
	W12-03		Chemical dust, Chemical container etc.

b. Preparation of Survey Sheet

The survey should clarify current generation, reuse/recycling and treatment/disposal. The contents of the questionnaire of the survey are listed in the table below and the survey sheet is prepared both in English and Thai as shown in the Annex 3.1.

Table 3-4: Main Contents of the Factory Survey

Subject	Content
1.General information	(1) Name of company
	(2) Type of Industry and Factory code
	(3) Factory registration No.
	(4) Capital amount and shares
	(5) Number of employees
	(6) Total house power as permitted
	(7) Annual sales amount
	(8) Major products
	(9) Major raw materials
	(10) Water/energy demands
2.Non-HW management	(1) Separation of non-HW from HW
	(2) Separation of non-HW of process from that of domestic sources
	(3) Generation amount of non-HW

	(4) Type and amount of reused/recycled material and its method
	(5) Collection and disposal
	(6) Future plan of non-HW management
3.HW management	(1) Generation amount of non-HW
	(2) Type and amount of reused/recycled material and its method
4.Waste exchange	(1) Awareness to waste exchange
	(2) Current approach to waste exchange
	(3) Possibility of waste exchange

3.1.3 Selection of Factory

a. Industrial Category and Code

There are three industry categories used in Thailand as shown below.

1. MOI categories and code;
2. TSIC (Thailand Standard Industrial Classification); and
3. ISIC (International Standard Industrial Classification).

Since this study covers industrial waste (IW) that generates at factories regulated by the Factory Act, B.E. 2535 (1992) and MOI categories and code of industry is based on the Act, the team decided to apply the MOI categories and code to the factory survey.

b. Study Code

The MOI categorizes factories into 104 codes[1] with 302 sub-codes. In order to identify the current IWM in accordance with the categories of factories, the team simplified 104 codes of factories and made 33 codes. Simplification by the following criteria resulted in 33 new categories.

i Leave a category as an individual group if the numbers of factories in the category are 2 times more than the average numbers of factories (32,741factories in DIW factory registration database/ 104 categories x 2 = 628 factories in one category).

ii Form a group with several DIW categories based on the similar nature of industries such as food, chemicals, metals, and so on.

iii Leave a category as an individual group if the category is not fallen into any of above groups.

A list of 33 categories applied to the factory survey, compared to the MOI 104 code, with description of industries is shown in the table below.

[1] The amendment of a ministerial regulation (No.15 BE 2544, 2001) pursuant to the Factory Act was enacted in December 2001 and the number is 106 at present.

Table 3-5: Study Code and MOI Code of Factories

Study Code	MOI Code	Description of Industries
G01	001 – 002, 004 – 009	Food (agricultural product, non-aquatic animals, aquatic animals etc.)
G02	010 – 015	Food (flour, sugar, tea, ice etc.)
G03	016 – 021	Drink, Beverage
G04	022	Textile, Thread, Fibre
G05	023 – 027	Textile product (Clothes, mats etc.)
G06	028	Wearing Apparel
G07	029 – 033	Hide, Fur, Footwear
G08	034	Woodwork (any or many items)
G09	035 – 036	Woodwork (bamboo, rattan, straw, cork etc.)
G10	037	Furniture
G11	038 – 040	Paper, Cardboard
G12	041	Printed matter
G13	042 – 050	Chemical matter, Petroleum
G14	051 – 052	Rubber
G15	053	Plastic product
G16	054 – 058	Glassware, Ceramics, non-Metallic Matter
G17	059 – 060	Steel basic industries, non-ferrous metal basic industries
G18	061 – 062	Metal product (tools, appliances, household furniture, building interior etc.)
G19	063	Metal product (construction, installation)
G20	064	Metal product (others)
G21	065 – 066	Machines (Engines, Turbines, Machinery)
G22	067	Machines (for producing metal or wood products)
G23	068	Machines (for paper, chemical, food, textile etc.)
G24	069 – 070	Machines (calculating machines, Accounting machines, Water pumps, air or gas compressors etc.)
G25	071 – 073	Electric product (Machines or Product under No.70, Radio set, Electric instruments or appliances etc.)
G26	074	Electric product (Electric Equipment)
G27	075 – 077	Transportation machines (Ship, Trains, Streetcars, Cars or Trailers)
G28	078 – 080	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles etc.)
G29	081 – 084	Precision machinery
G30	085 – 087	Others (Musical instruments, Sport, Toys etc.)
G31	088 – 094	Others (Electric power, Gas, Packaging, Cold storage etc.)
G32	095	Others (Engine-driven for vehicles or motorcycles etc.
G33	003, 096 – 104	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt etc.)

c. Data of Factory Registration in the Study Area

There are the following kinds of factories registration databases in the study area:

1. DIW;
2. IEAT; and
3. Industrial areas not under the IEAT (i.e. industrial zones, industrial communities and industrial parks, described in Section 5.1.2.b).

c.1 DIW Factory Registration Data

DIW factory registration data is the biggest database. The team sorted the number of the factories registered in the DIW database in the study area by provinces, which helped to select the factories to be surveyed. Although this database includes registration data of factories in IEAT, it is not updated. Therefore the team excludes these data from our database for the calculation of IW generation in order to avoid double account. The number of factories registered in the DIW database excluding the factories registered in IEAT database in the study area is shown in the table below.

Table 3-6: Number of Factories Registered in DIW Database

	Number of Factories in Accordance with the Number of Employee						
Province	1. N/A	2. 1-50	3. 51-200	4. 201-500	5. 501-1000	6. > 1000	Total
Bangkok	359	18,311	1,457	229	59	34	20,449
Nonthaburi	9	1,126	141	42	8	8	1,334
Pathum Thani	53	1,296	394	127	46	41	1,957
Samut Prakarn	41	4,375	1,127	308	93	35	5,979
Samut Sakorn	8	2,317	544	131	37	24	3,061
Total	470	27,425	3,663	837	243	142	32,780

*N/A: Lack of information on the number of employees.
Source: DIW

c.2 IEAT Factory Registration Data

The number of factories registered in the IEAT database in the study area, which were obtained by the team August 2001, is shown in the table below.

Table 3-7: Number of Factories Registered in IEAT Database

Province	Number of Factories in Accordance with the Number of Employee						
	1. N/A	2. 1-50	3. 51-200	4. 201-500	5. 501-1000	6. > 1000	Total
Bangkok	51	87	115	64	23	8	348
Samut Prakarn	81	180	215	75	19	8	578
Total	132	267	330	139	42	16	926

*N/A: Lack of information on the number of employees.
Source: IEAT

c.3 Factory Registration Data of Industrial Zones, Communities and Parks

The DIW factories registration database is supposed to have the factory registration data of industrial zones, communities and parks, which are not under the IEAT, but it does not. The team obtained registration data on these industrial settlements from the One Stop Services Center of DIW and tabulated below. The team inquired each developer (who applied registration.) as well as each provincial industrial office of DIW whether they have data on the number of employees or not, which is the base of the estimation of IW generation. The replies were No. The team gave up to consider the generation of IW from these industrial settlements in this study.

Table 3-8: Registration Data on Industrial Zones, Communities and Parks not under the Control of IEAT in the Study Area

	Bangkok		Samut Prakarn		Nonthaburi		Pathum Thani		Samut Sakhon	
	Area (rai)	Number of Factories	Area (rai)	Number of Factories	Area (rai)	Number of Factories	Area (rai)	Number of Factories	Area (rai)	Number of Factories
Industrial Zone (updated 2 Oct 2000)										
1. Tanning Factory Industrial Zone			910	135						
2. Buengklo Intercity Corporation Ind. Zone	141	13								
3. Thai Summit Ind. Zone			171	6	-					
4. LPN Industrial Zone			186	5						
5. Bangbon Minifactory*1		NA								
6. Wongvan Chachawan Ind. Zone	327	226								
7. Thai Suzuki Ind. Zone							199	1		
8. L.P.N. Minifactory			49	NA						
Sob-total	539	239+?	1,316	146+?			199	1		
Industrial Community (updated 31 Dec 2000)										
1. Bangna Industrial Zone*2			101	NA						
2. Chainan Bangpli Industrial Zone*2			300	NA						
Sob-total			401	NA						
Industrial Park										
1. Namgrai Industrial Zone	570	18								
2. Jongsatit Industrial Park									650	2
3. Thepatak Industrial Estate			523	NA						
4. Nawa Nakorn Industrial Zone			-				6,000	160		
5. Bang Gradee Industrial Park							1,174	47		
Sob-total	570	18	523	NA			6,000	160	650	2
Total	1,109	257+?	2,240	146+?			6,199	161	650	2

Source: One Stop Services Center, DIW

*1 the project is postponed

*2 the project has not been operated

c.4 Number of Factories Counted in the Study

Since the study requires the following basic data of the factories registered, those factories that do not have the data are not counted in the study:

- MOI factory code number; and
- Number of employees.

The table below shows the number of factories and their employees counted in the study.

Table 3-9: Number of Factories Counted in the Study

		Number of Factories Excluded				Number of Factories Counted	Total Number
		Lack of MOI code	Duplicated with IEAT DB	Lack of Number of Employees	Lack of Both Numbers		
DIW DB	Nos. of Factories	---	725	470	---	32,310*1	33,505
	Nos. of Employees	---	108,830	NA	---	1,441,397	1,550,227
IEAT DB	Nos. of Factories	12	---	98	34	782*2	926
	Nos. of Employees	1,433	---	NA	NA	143,385	144,818
Total (DIW + IEAT)	Nos. of Factories	12	725	568	34	33,092	34,431
	Nos. of Employees	1,433	108,830	NA	NA	1,584,782	1,695,045

Note *1 = 32,780 (total number of factories from Table 3-6) – 470 (factories without data of number of employees)

*2 = 926 (total number of factories from Table 3-7) – (98 + 34) (factories without data of number of employees) – 12 (factories without MOI code)

d. Selection of Factories

d.1 Preliminary Selection

In this survey, the following selection criteria were adopted after the several discussions between the team and C/P.

1. From each 33 category, 5 factories were selected as follows (5 factories x 33 categories = 165 factories).

   i Divide factories into 3 groups, A: small, B: medium and C: large scale according to the number of employees.

   - Group A (small scale): Less than 51 employees
   - Group B (medium scale): 51 – 200 employees
   - Group C (large scale): More than 200 employees

   ii Select 1, 2 and 2 factories from Group A, B and C respectively.

2. The rest of factories (200 – 165 = 35 factories) were allocated to the categories, which include large-scale companies with the employees more than 200, considering the whole balance.

i Allocate 2 more factories to the categories, which include more than 40 large-scale factories with employees more than 200.

ii Allocate one more factory to the categories that include 15-40 large-scale factories.

Prior to the survey the team selected 411 factories, considering the number of factories in each study code, the number of employees of individual factories and the possibility of the rejection of interview from some factories or of no response due to the move or closure of factories. Then the questionnaires with the DIW cover letter were sent to theses factories by mail. 411 factories included 312 factories selected from the DIW database and 99 factories recommended by FTI. Among 99 factories FTI recommended, 54 factories were registered at DIW, while other 45 factories were not.

d.2 Final Selection

Through the confirmation made by phone 215 factories as shown in the table below were surveyed.

Table 3-10: Number of Factories Surveyed

Study Code	MOI code	Description of Industries	Number of Factories Surveyed According to Number of Employees			
			1.<50	2.51-200	3.>200	Total
G01	001 – 002, 004 – 009	Food (agricultural product, non-aquatic animals, aquatic animals etc.)	1	3	3	7
G02	010 – 015	Food (flour, sugar, tea, ice etc.)	2	3	1	6
G03	016 – 021	Drink, Beverage		2	5	7
G04	022	Textile, Thread, Fibre		1	6	7
G05	023 – 027	Textile product (Clothes, mats etc.)		2	6	8
G06	028	Wearing Apparel	1	2	6	9
G07	029 – 033	Hide, Fur, Footwear	3	2	2	7
G08	034	Woodwork (any or many items)	1	3	3	7
G09	035 – 036	Woodwork (bamboo, rattan, straw, cork etc.)	1	2	2	5
G10	037	Furniture		2	5	7
G11	038 – 040	Paper, Cardboard	1	3	2	6
G12	041	Printed matter	2	2	2	6
G13	042 – 050	Chemical matter, Petroleum		4	3	7
G14	051 – 052	Rubber		3	3	6
G15	053	Plastic product	2	3	3	8
G16	054 – 058	Glassware, Ceramics, non-Metallic Matter	2	3	1	6
G17	059 – 060	Steel basic industries, non-ferrous metal basic industries		6		6
G18	061 – 062	Metal product (tools, appliances, household furniture, building interior etc.)	1	4		5
G19	063	Metal product (construction, installation)	2	3		5
G20	064	Metal product (others)		2	6	8
G21	065 – 066	Machines (Engines, Turbines, Machinery)		2	3	5
G22	067	Machines (for producing metal or wood products)	1	4	1	6
G23	068	Machines (for paper, chemical, food, textile etc.)	1	3	1	5
G24	069 – 070	Machines (calculating machines, Accounting machines, Water	2	1	3	6

		pumps, air or gas compressors etc.)				
G25	071 – 073	Electric product (Machines or Product under No.70, Radio set, Electric instruments or appliances etc.)	1	4	5	10
G26	074	*Electric product (Electric Equipment)*		2	4	6
G27	075 – 077	Transportation machines (Ship, Trains, Streetcars, Cars or Trailers)	1	2	5	8
G28	078 – 080	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles etc.)		3	3	6
G29	081 – 084	Precision machinery	1	2	4	7
G30	085 – 087	Others (Musical instruments, Sport, Toys etc.)		2	5	7
G31	088 – 094	Others (Electric power, Gas, Packaging, Cold storage etc.)	1	1	4	6
G32	095	Others (Engine-driven for vehicles or motorcycles etc.	2	3		5
G33	003, 096 – 104	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt etc.)	1	1	3	5
Total			30 (33)	85 (66)	100(101)	215 (200)

(Note) The figure in parentheses is the one intended by the preliminary selection; i.e. the preliminary number of factories is 200 while 215 finally surveyed.

The number of small-scale factories surveyed is less than the number preliminary selected. The team considered the decrease was caused by the 18 % increase in the actual number of employees informed by the factories surveyed comparing with it in DIW database.

e. Survey Method

The survey was carried out by interviewing each factory. The questionnaires were sent to all the factories prior to the interview, and the interviewers of a local consulting firm filled in them on the visits. When wrong or misleading answers were found when the data were analysed, the local consulting firm called to the factories for confirmation.

3.1.4 Findings of the Survey

The results of the survey are presented in the Annex 3.2. This section describes findings through the examination of the results.

a. Current Industrial Waste Management (IWM)

a.1 Waste Separation

a.1.1 Separation of Non-HW and HW

65 among 215 factories surveyed replied they do not separately discharge non-HW and HW. However since 52 of 65 factories do not generate HW, it indicates 6.0 % (65– 52= 13) do not separately discharge non-HW and HW. The reasons of no separation other than "no generation of HW" are in the following order:

1. *Don't know the difference between Non-HW and HW.* 3.3 % of total
2. No ways to utilize non-HW and HW. 2.8 % of total
3. Difficult to separate non-HW and HW. 2.3 % of total
4. Volume of waste is too small to separate. 2.3 % of total

Since 24 among 215 factories replied they discharge partly separated non-HW and HW, it may say 17.2 % (13 + 24 = 37) of factories discharge mixed wastes of HW and non-HW.

There is some difference observed in the scale of factories regarding separate discharge of non-HW and HW and larger scale of factory more strictly conduct separate discharge.

a.1.2 Separation of non-HW generated at production process from the other sources

As for the Question, "Is non-HW generated at the production process separated from that generated at other sections such as office in your factory?", 24.6 % (53) of 215 factories, with the breakdown of no separation 5.1% (11) plus partly separation 19.5% (42), do not strictly separate non-HW generated at the production process from domestic/office waste. The reasons of no separation are mainly small generation, less need to separate and no ways for utilization.

There is no significant difference observed in the scale and types of factories regarding separation of non-HW from production process and domestic sources.

a.2 Waste Generation

Regarding the waste generation 206 factories (96%) of factories gave the valid replies. The breakdowns of replies are 469 wastes from 187 factories (87%) for non-HW and 272 wastes from 134 factories (62%) for HW. Annual generations of non-HW and HW at the replied factories are 118,904 ton and 27,349 ton respectively. These data are used for the estimation of current IW generation in the study area.

The table below summarizes the number of factories that replied this question.

Table 3-11: Number of Factories Replied to Question on Waste Generation

Items	Nos. of Factories	Rate to 215 (%)
Number of Factories Surveyed	215	100
Number of Factories with Valid Replies	206	96
Number of Factories with No Replies	7	3
Number of Factories with Invalid Replies	2	1
Number of Factories with Non-HW	187	87
Number of Factories with HW	134	62
Number of Factories with HW/Non-HW	115	53
Number of Factories with only Non-HW	62	33
Number of Factories with only HW	19	9

a.3 Storage

33.5 % (72) of factories do not store IW inside their factories and there is significant difference in the scale of factories regarding storage of IW in the factory; i.e. the rate of factories that have storage of IW in their compound increases in accordance with the number of employees.

As for 66% of factories (142) that have storage of IW in their compound, 95.8 % (136) of 142 factories separately store IW. 69.8 % (95) of 136 factories classify IW into more than two categories.

The purpose of on-site storage of the 142 factories is mainly for temporary storage before collection (93.7%). The purposes of temporary storage for on-site reuse/recycling and for on-site treatment/disposal are very limited and 2.1% and 2.8% respectively.

a.4 Intermediate Treatment and Recycling

a.4.1 On-site treatment

14.9 % (32) of factories have on-site treatment of IW and there is a tendency; the rate of factories that have on-site treatment increases in accordance with the scale, i.e. the number of employees.

a.4.2 On-site recycling

23.3 % (50) of factories conduct on-site reuse or recycling of IW and the rate of factories that have on-site reuse or recycling of IW increases in accordance with the scale, the number of employees.

10.2 % (22) of factories have on-site reuse/recycle plan of IW and the rate of factories that have on-site reuse/recycling plan of IW increases in accordance with the scale, the number of employees. The subjects for reuse/recycling plan differ by factories and types of industry.

a.5 Collection

The most common collection service provider is private company contracted by factories (54%), followed by waste buyers (*Pho Kha Khong Kao* in Thai) (50%) and municipality (21%). However municipal collection service is more frequent than private one as shown in the table below.

Table 3-12: Collection Service Providers

Service Provider	Private Company Contracted by Factories		Municipality		Pho Kha Khong Kao	
Service Frequency	Answer	%	Answer	%	Answer	%
1. Every day	8	6.9	9	19.6	7	5.6
2. 3 - 6 times a week	7	6.0	7	15.2	3	2.4
3. 1 - 2 times a week	10	8.6	26	56.5	24	19.4
4. 2 - 3 times a month	16	13.8	1	2.2	14	11.3
5. Once a month	22	19.0	0	0.0	22	17.7
6. 2 - 10 times a year	23	19.9	2	4.3	18	14.5
7. Others	5	4.3	1	2.2	2	1.6
8. Irregular	21	18.1	0	0.0	31	25.1
9. No Answer	4	3.4	0	0.0	3	2.4
Total	116	100.0	46	100.0	124	100.0

a.6 Off-site Treatment and Reuse/Recycling and Disposal

Almost all (96.3 % (207)) factories answered they know off-site treatment/disposal of their IW.

207 factories replied the method of off-site disposal (treatment, reuse/recycling, or disposal) and responsible company or person according to the classification of IW. The results are analyzed in accordance with study factory code and waste code respectively, and used for the estimation of IW flow together with IW generation amount.

a.7 Waste Flows of Factories Surveyed

Based on the valid answers from 206 factories among 215, the team elaborates various kinds of waste flows, which are to be used as a baseline for the identification of current IWM of the study area as well as formulation of non-HWM M/P and HW A/P. Figures below present non-HW flow and HW flow of 206 factories surveyed, respectively. In addition waste flows for each category of non-HW and HW are presented in Annex 3.3.

These figures bring the following findings:

1. **IW generation:** Non-HW generation amount is 4.35 times more than HW.
2. **On-site disposal[2]:** The on-site disposal rate of HW (48%) is much higher than that of non-HW (28%). This is due to very high rate (34.0 + 12 = 46%) of on-site HW treatment/disposal compare with the rate (0.9 + 8 = 8.9%) of non-HW.
3. **Waste reduction:** The on-site waste reduction rate of HW (25.9%) is much higher than that of non-HW (0.4%).
4. **Reuse/recycling:** The total reuse/recycling (on-site + off-site) rate (86.5%) of non-HW is much higher than that (33.3%) of HW. However, the breakdown of off-site reuse/recycling clearly indicates large portion of reuse/recycling wastes received by the waste buyers (Por Kha Khong Gao), who pay certain amount of money to the discharging factories. The wastes reuse/recycling rate of non-HW, 86.5% is incredible high compare with Japan (42% in 1997).
5. **HW flow:** The HW flow indicates 4.8% of HW generated in 215 factories surveyed is disposed of at municipal landfills. However, 4.4% of that is treated on-site, so that hazardous or not is not sure.

The above-mentioned findings with further investigation/analysis are fully reflected for the estimation of current waste flow and the planning of non-HW M/P and HW A/P.

[2] On-site disposal covers long-term storage, reuse/recycling, treatment and final disposal of IW at the generation sources, i.e. factories.

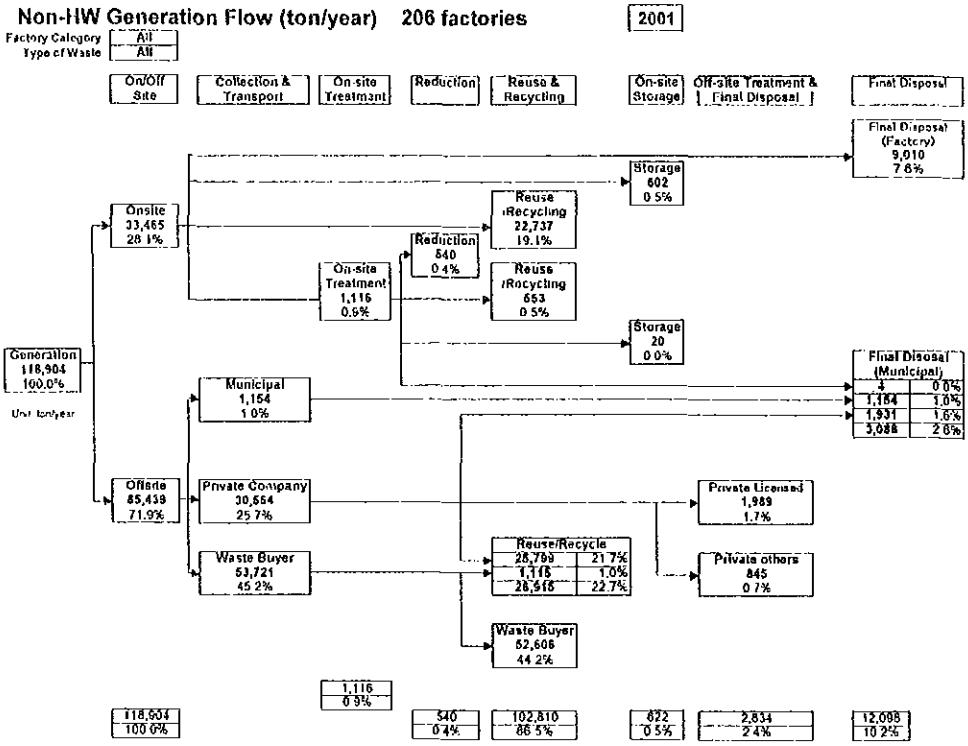

Figure 3-3: Non-HW Flow of 206 Factories Surveyed

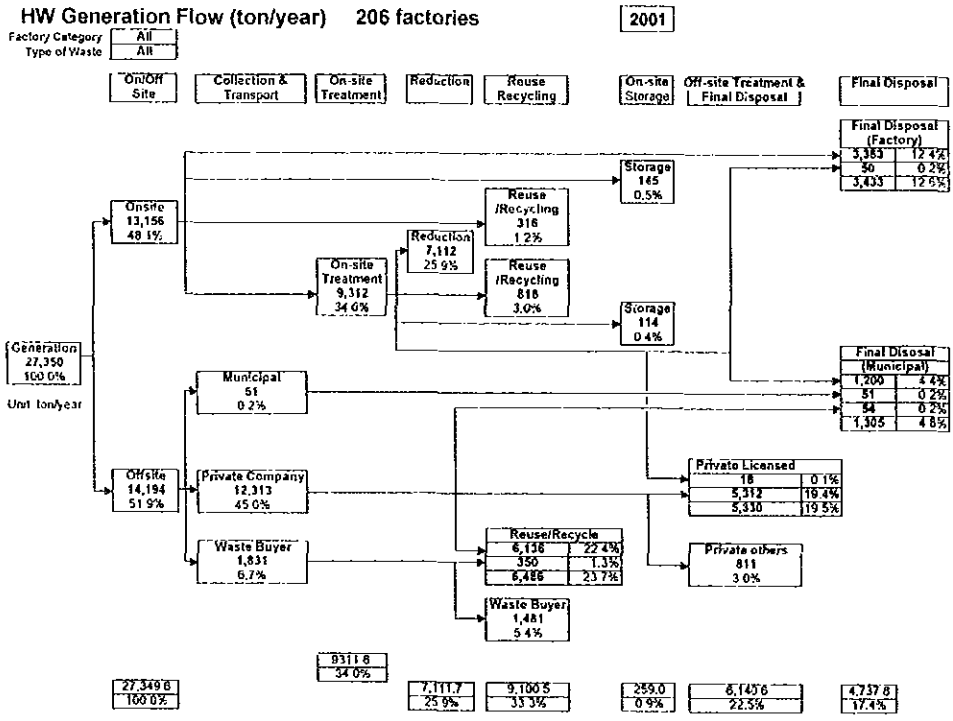

Figure 3-4: HW Flow of 206 Factories Surveyed

b. Future Management of IW

b.1 Future Waste Generation

About half (47.9 % (103)) of factories answered IW will not increase so much and more than 1/4 (27.9 % (60)) replied decrease due to the improvement of on-site IWM. Only 12.6 % (27) replied, "increase".

There is significant difference in the scale of factories regarding the answer of "decrease"; i.e. the rate of factories that answered, "decrease" increases in accordance with the number of employees. This indicates larger factories have plans to decrease IW by improving their production processes, etc.

b.2 Future IW Reduction and Recycling

Majority of factories (67 % (144)) will basically maintain the current IW management. The factories that expressed "the intention for improvement but lack of specific plans of it" are 25 % (54) and those have "specific plans" are only 8% (17). The larger factories have more intentions and plans to reduce and recycle IW on-site.

b.3 Future IW Treatment and Disposal

Most of factories (93.9 % (202)) do not have plans to improve treatment and final disposal on-site. This indicates most of factories prefer to off-site treatment/disposal in future.

b.4 Impact of Disposal Cost Rise

As for the rise in disposal cost of IW more than half of factories (52.5 % (113)) replied there would be little impacts by the increase of disposal costs. But 18.6 % (22 + 18 = 40) replied it would be "significant or threat" and 25.6% (55) will "bear the cost for improvement of current IWM".

There is some difference in the scale of factories regarding the answer of "bear the cost for improvement of current IWM"; i.e. the rate of large-scale factories that answered, "bear the cost for improvement of current IWM" is more than small/medium scale. This indicates large-scale factories will bear the increase of disposal cost in order to obtain environmentally friendly image of products if it improves current IWM.

c. Waste Exchange

As for the interest on waste exchange program most of factories, 81 % ("very much " 54 plus "to some extent " 120 = 174), expressed their interests on the program and large/medium scale factories are more interested in waste exchange program.

Regarding the involvement in waste exchange program most of factories (75.8 % (163)) are now involved in the program at present. The results are supported by the results of 1,014 factories survey on waste exchange database; 62.5 % (634) involved in the program at present.

For the introduction or expansion plan of waste exchange program most of factories (83.7 % (180)) do not have plans to introduce or expand the program. However the rate of larger factories that have plans to introduce or expand the waste exchange program is more than it of smaller.

On the target of waste exchange program about half of factories (47.4 % (102)) have wastes that would be possible IW for the program.

For the promotion of waste exchange program the most important issue raised by the factories is, " Provision of information on quantity and quality of waste" (60.1 %), followed by, "Subsidy programs or technical assistance" (53.5%) and, "legal framework (legislation and regulations of waste exchange program)" (38.5 %).

d. Financial Matter

d.1 Collection Cost

d.1.1 Rate of waste management cost to production cost

Each factory spends 499,000 Baht/year in average for IWM, which is equivalent to 0.13% of the production cost. However, when referring to these figures it should be noted on the following aspects:

- Only 27.0% (58) of factories gave the answers; and
- The annual IWM expenditure ranges between 96 to 6,000,000 Baht/year.

d.1.2 Annual expenditure for collection services

The average expenditure of 82 factories, which is 38.1% of 215 factories, is 229,000 Baht/year. It might say the collection expenditure (which might include off-site treatment/disposal cost.) shares 60% of IWM cost (229,000/382,000).

d.1.3 Unit collection cost

The unit collection costs on 51 wastes from 27 factories are obtained and tabulated in the Annex 3.2 (see Q29). The costs are ranging from 70 to 8,226 Baht/ton.

d.1.4 Increase of collection fee

Even if the quality of collection service is improved, only 22.8 % (49) of factories can accept increase of collection fee while 38.6 % (83) refuse.

d.2 On-site treatment cost

The annual on-site treatment cost is 400,483 Baht/year in average. However, when referring to this figure it should be noted on the following aspects:

- Only 3.7% (8) of factories gave the answers; and
- The annual on-site treatment expenditure ranges between 600 Baht/year to 2,400,000.

Although the unit on-site treatment costs obtained are of ten (10) wastes from only 6 factories, they range from free to 7,000 Baht/ton.

d.3 Final disposal Cost

The unit final disposal cost of 96 wastes from 36 factories is obtained. It ranges between free and 16,700 Baht/ton and tabulated in the Annex 3.2 (see Q34).

e. Evaluation of the Present IWM System

According to the evaluation of 215 factories on the current IWM about half (47.4 % (102)) of factories have some problems on it. The large-scale factories recognize more problems than medium and small scale.

The most significant problem 102 factories face now on IWM is "High IW treatment cost" (29% of 102 factories), followed by "No or limited services available for treatment" (27%) and "Lack or limited reuse and recycling of IW" (14%).

As for the necessary measures and actions to solve the problems 111 factories (52%) in total replied this question. The most significant measures and actions factories need to solve the problems on IWM is "Development of the waste reuse and recycle market" (66% of 111factories), followed by "Guidance on proper IWM to the factories (generators)" (55%) and "Development of the intermediate treatment facilities for industrial waste" (51%).

3.2 Survey on Non-HW Collection and Transportation Organizations

3.2.1 Objectives and Method

The objective of the survey is to understand how non-HW from industries is collected in the Study Area. Currently, factory waste is collected by the following three parties.

- Local Administration (District or Municipality Offices)
- Private company of waste collection and transportation
- Waste buyer *Por Kha Khong Gao* (as found in the answers to the Factory Survey)

The waste buyer is a kind of private body but it is quite different from the transportation company, as it seems to be a small business based on an individual or a family.

a. Local Administration

In Bangkok, the district offices of the Bangkok Metropolitan Authority (BMA) are in charge of municipal waste collection. At present, the district offices collect waste from factories according to the Agreement made on 22 January 1997 between the BMA and the DIW which stipulates that the BMA should tentatively collect waste from factories except for hazardous one until private companies or independent organizations are ready to collect non-HW, though principally the DIW is responsible for monitoring and controlling waste from factories.

In Pathum Thani, Nonthaburi, Samut Sakhon and Samut Prakarn, the municipality offices under provincial authorities are in charge of municipal waste collection, and currently they collect industrial waste as a customary practice except for hazardous waste, though no legal stipulation has been made.

The team distributed questionnaires to these district offices and municipality offices to collect information on industrial waste collection. The number of the districts and municipalities are shown in the following table.

In addition, the team visited 10 districts or municipalities and interviewed them to know more detailed situation. The districts and the municipalities were selected with respect to the following aspects.

- Districts in Bangkok: The districts in Bangkok can be divided into 6 blocks for the land use. One district is selected for each block and in total 6 districts were selected.
- Municipalities in the surrounding provinces: Municipalities in which many factories are located were selected.

Names of the selected districts/municipalities are also shown in the table below.

Table 3-13: Number of Districts and Municipalities in the Study Area

Province	Nos. of districts/municipalities	Interviewed districts (blocks) /municipalities	
Bangkok	50 districts	Bang Suu	(Rattana Kosin)
		Lat Phrao	(Puraphaa)
		Prawet	(Srinakarin)
		Bang Kho Laem	(Chaophraya)
		Bang Bon	(Krungthon Tai)
		Pasi Charoen	(Kurungthon Nua)
Pathum Thani	13 municipalities	Khlong Luang	
Nonthaburi	9 municipalities	Muang Nonthaburi	
Samut Sakhon	7 municipalities	Nakorn Samut Sakhon	
Samut Prakarn	15 municipalities	Phrapradaeng	

b. Private Company

The team selected private companies of waste collection and transportation by reviewing the transport permit stored in the DIW. The team also tried to select the companies among those found in answers to the questionnaires for Factory Survey mentioned in the previous section, but it was difficult to identify the companies.

c. Waste Buyer

The team found many "Pho Kha Khong Kao" or "Waste Buyers" in the answers to the questionnaires for Factory Survey. Though their individual name has not been specified, they collect more than 48.5 % of the non-HW from the factories subjected to the survey. It was supposed that they collect waste from factories directly. The team could identified some of them and visited to know their real activities.

3.2.2 Contents of the Survey

a. Local Administration

The questionnaires to the districts and municipalities contained the following questions.

- Provider of collection services
- Number of Employees
- Type and number of collection vehicles
- Total quantity of waste collected
- Quantity of waste from households, commercial shops, markets, offices and factories of small, medium or large factories.

- Fee rate of collection services
- Name of site and location to which waste is transported.

b. Private Company

The interview to the private collection/transportation companies contained the following questions.

- Main activity of the company
- Year of establishment
- Number of employees
- Type and number of collection vehicles
- Vehicle stations
- Affiliated companies
- Major customers
- Kind of waste dealt with, and the quantity
- Service fee rate
- Distance of transportation
- Reporting to the customers, or manifest system
- Instruction and training to the employees
- Working hours, shifts and wage system
- Legal constraints
- Opinions or requests to the government
- Current problems in doing the business

c. Waste buyer

The interview to the waste buyers contained the following questions.

- Type and quantity of the factory waste they collect
- Type and quantity of the factory waste they sell
- Price of waste
- Residue disposal method
- Destination of the residue

3.2.3 Execution of the Survey

a. Local Administration

a.1 Districts of Bangkok

The team distributed the questionnaire to the representatives of the public cleansing sections of all the district offices at the meeting held at the Public Cleansing Department of the BMA on 20th June 2001. The team explained the purpose of the questionnaire and asked all the participants to fill out the questionnaires and send them back to the BMA office by the end of June. All the answers have been sent back to the team by the end of July.

a.2 Municipalities of the vicinal provinces

The same questionnaires as distributed to the districts of Bangkok were sent by mail to the public cleansing sections of each municipal office. The team asked them to send the answers back to the team's office until 13th July. The team called and asked

them again to send the answers back if the municipalities did not. All the municipalities sent back the answers by the end of July.

a.3 Interview to the districts/municipalities

Six districts among those in Bangkok and four municipalities were selected with respect to the number of factories. The team member visited and interviewed the officers in charge of waste collection services in each districts/municipalities in July 2001

b. Private Company

The team member visited the following three private companies which collect and transport waste from factories on contract. All their offices are located in Bangkok.

- SITA-THAI Waste Management Services Ltd.
- BYL Environmental Services Co., Ltd.
- Nature Trans Company Co., Ltd.

The team member visited these companies during June and July in 2001. In addition, the team tried to interview with Waste Exchange Company Ltd., but the request was not accepted.

c. Waste buyer

The team member visited six waste buyers in November 2001 to understand their activities. One of them was the waste buyer who bought waste from the factory directly (to be referred to primary buyer), while others were secondary buyers who buy waste from primary buyers.

3.2.4 Findings

a. Quantity of Factory Waste

In the area of BMA, the public cleansing sections of each district administration office collect municipal waste such as those from households, shops, restaurants, offices, public markets and so on. Waste from factories is also collected together with municipal waste. The district offices could answer total quantity of waste they collected, but do not know quantity of waste by generation sources.

Only 11 districts could answer the quantity of factory waste they collected, though it might be estimation.

Some of the districts declared that they did not collect industrial waste, but it seemed not true. Such districts seemed to misunderstand that industrial waste meant hazardous waste from the factories.

In the provinces around Bangkok, the public cleansing sections of each municipality collect waste from factories as a customary practice except for hazardous waste. Among these municipalities, 2 in Samut Prakarn, 1 in Nonthaburi, 4 in Pathum Thani and 3 in Samut Sarkorn could answer the estimated quantity of factory waste. In addition, 1 municipality in Pathum Thani and another in Samut Sarkorn where the team visited could give us the estimated proportion of factory waste to total.

The proportion of factory waste to total municipal waste was assumed for each block in Bangkok and each province of its vicinal provinces. The assumption was made

based on the answers to the questionnaire and the interview to the district offices. The number of the factories and land use purpose of each block or each province was also taken into consideration.

As for Bangkok, the quantity of IW in each block was estimated by the calculation as below, and total quantity was calculated by summing the waste quantity of 6 blocks.

- IW quantity in each block = Total quantity of the municipal waste in each block x proportion of industrial waste to the total
- Total IW quantity in Bangkok = Sum of IW quantity of all the blocks

The quantity of factory waste by each block of Bangkok is shown in the following table, indicated in ton/day. The proportion corresponding to the total quantity is an average of the proportion calculated from the total quantity

Table 3-14: Assumed Share and Estimated Quantity of Industrial Waste Collected Daily for Each Block of the Districts in Bangkok

Block	Block Name	Proportion of Industrial Waste to Municipal Waste	Total Quantity of Municipal Waste	Estimated Quantity of Industrial Waste
		%	ton/day	ton/day
Block 1	Rattana Kosin	1	1,757	18
Block 2	Puraphaa	2	1,493	30
Block 3	Sinakarin	4	1,005	40
Block 4	Chaophraya	10	1,915	191
Block 5	Krungthon Tai	10	1,376	138
Block 6	Krungthon Nua	4	1,024	41
TOTAL		5.3	8,567	458

The following table indicates the proportion of the factory waste and quantity of factory waste in Bangkok in total and in the vicinal provinces. The following points should be noticed.

- The "Quantity" in the table means that the quantity of the factory waste collected by the districts/municipalities.
- The factory waste may contain not only industrial waste generated by the industrial process but also waste from daily operation of the factories. Paper waste from administrative sections and kitchen waste from canteens in the factories are the examples.

Table 3-15: Estimated Quantity of Factory Waste Collected Daily by the Districts and Municipalities

	Proportion of Industrial Waste to Municipal Waste	Total Quantity of Municipal Waste	Estimated Quantity of Industrial Waste
Province	%	ton/day	ton/day
Bangkok	5.3	8,567	458
Samut Prakarn	10	809	81

Nonthaburi	2	787	16
Pathumu Thani	2	368	7
Samut Sakhon	5	350	18
TOTAL	5.3	10,881	580

Table 3-16: Estimated Quantity of Factory Waste Collected Annually by the Districts and Municipalities

	Proportion of Industrial Waste to Municipal Waste	Total Quantity of Municipal Waste	Estimated Quantity of Industrial Waste
Province	%	ton/year	ton/ year
Bangkok	5.3	3,126,968	167,013
Samut Prakarn	10	295,245	29,526
Nonthaburi	2	287,150	5,743
Pathumu Thani	2	134,380	2,687
Samut Sakhon	5	127,770	6,388
TOTAL	5.3	3,971,513	211,357

The quantity of waste collected by the municipality is 211,357 ton/year in this survey, while 34,975 ton/year according to the Factory Survey. This means that the result of this survey is 6 times larger than that of the Factory Survey. The difference may be attributed to the two possible reasons as follows.

- The estimation of this survey just depends on the observation of the municipality officials. There may be some over-estimation.
- The waste buyers may discharge some of residues after sorting the factory waste to the municipalities. It may be natural to consider so, as it is impossible to recycle waste at 100 %. On this assumption, it turns out that waste of 176,382 tons (= 211,357 – 34,975) out of 1,148 thousand tons, the non-HW amount received by the waste buyers from the factories, was discharged as non-recyclable waste. The recyclable waste recovery rate at 84.5% is fairly reasonable.

b. *Problems with Factory Waste Collection*

The team asked the districts and municipalities about accidental cases or problems in collecting factory waste.

Some injury cases were reported at some of the districts and municipalities. Inflammation and irritation on skin are the common cases due to contact with the irritative agents contained in factory waste.

The collection workers wear nothing but gloves for protection, because such dangerous cases are not thought of in the daily collection work, although it can not be predicted what kinds of dangerous substances are contained in factory waste. Fortunately, no serious cases have occurred.

c. Illegal Dumping

Many of the districts and the municipalities suffer the illegal dumping of waste into the public vacant spaces, but most of them are not caused with industrial waste but municipal waste from the adjacent communities. The team tried to identify the location of the illegal dumps but no clear answer was obtained. It seemed that nobody wants to speak about the reality of illegal dumping.

d. Collection by the Private Companies

BYL Environmental Services Co., Ltd. is a consulting firm of environmental services and offer waste collection and treatment services among technical consultation. BYL is promoting waste use as raw materials or fuel at the cement kiln in the plant of Siam City Cement in Saraburi. BYL contracted out the collection services from the customer to the Nature Trams which owns 88 vehicles in total.

SITA-THAI Waste Management Services Ltd. is also promoting the application of waste at a cement kiln. SITA-THAI collects waste from the factories of Siam Cement group and transport it to the cement kiln of the Siam Cement. SITA THAI also uses Nature Trans as a sub-contractor for waste collection.

Currently, these companies collect waste as shown in the table.

Table 3-17: Waste Collection of Private Companies

Company's Name	Year of Establishment	Waste Type	Quantity (ton/year)	Destination
SITA-THAI	1998	Liquid Waste	7,000	Siam Cement
BYL Environment	2000	Oil and solvents	20,000	Siam City Cement

Source: Interviews to the companies

Apart from these companies, there seems to be many transporters who might not be specialized for waste collection services. 862 cases were applied of the Transport Permit to the DIW during a year since November 2000 till October 2001. The total quantity of waste applied for the permit was 193,688 tons. Though wastewater might be included in this figure, this suggests that there might be other transporting companies.

e. Collection by the Waste buyers

"Waste buyers" buy waste directly from the factories and sell it to the recyclers or to the secondary waste buyers. Thus, waste may be carried into the recyclers via several steps.

The waste buyers may buy sole kind of the industrial or several kinds as well. In the latter case, the waste buyers sell waste to the recyclers by the kind of waste. The waste buyers offer the price when they buy waste. The waste buyers may be selected through a bidding. Some waste may be demanded at high prices while others may not. The factories ask the waste buyers to buy such waste together.

Even if waste is composed of a sole kind, the waste buyers often separate them again if the separation may increase the price.

It was difficult to interview the primary waste buyers. The waste buyers did not answer even if they are interviewed at the recycler. The name of factories from which they buy waste and its price seem to be a top secret. It is even difficult to identify the

address of the waste buyers as their business is not to do it in a fixed site but to buy waste and sell it to another.

The primary buyers deal with several kinds of waste such as carton boards, wooden pallets, plastic products and plastic bag, textile and iron, while the second buyers are specialized for the category of waste they deal with such as paper, textile, iron and so on. Some buyers deal with electronic circuit boards to recover precious metals. The primary buyers deal with hundreds kg to a few tons of waste a day, while the second buyers handle more than a hundred tons a day.

3.3 Survey on Waste Reuse/Recycling/Treatment Companies

3.3.1 Objectives and Method

a. Objectives

Objectives of the survey on waste reuse/recycling/treatment companies were:

- to review the current system of non-HW reuse, recycling and treatment.
- to collect information useful to describe the current waste stream of non-HW in the study area.

b. Method

The team member in charge visited and interviewed companies of reuse, recycling and treatment with local assistants.

3.3.2 Execution of the Survey

The team identified and visited waste reuse, recycling, and treatment companies in the following manner.

a. General Factories Doing Waste Reuse/Recycling

According to the DIW factory categorization valid until December 2001, waste reuse/recycling business is not a specific category with a code number. Factories which reuse or recycle waste have been categorized according to their products as in the case of other general factories. Therefore, it was not easy to find out factories doing waste reuse/recycling from the factory registration database. Instead, the team examined the transport permits issued by DIW. The destination might be the waste reuse/recycling companies. The team made the list of such companies from the transport permits. After consultation with the C/Ps, the study team identified factories to be visited.

The factories visited were 16 in total including 9 waste shops, 4 recyclers and 3 final users.

Waste Shop: Factories that pre-treat collected non-HW and HW and send it to recyclers.

Pre-treatment: Sorting, cutting, pressing, agglomerating, crushing and other treatment.

Recycler : Factories that treat collected recyclable wastes (non-HW and HW) to make raw material for final users.

Final user : Factories that fabricate and/or produce the final product using a recycled material.

b. Factories with DIW Authorization as Waste Business Enterprises

Factories that treat and/or dispose of industrial waste have been registered with DIW as the Code 101 factories until December 2001. Since current Code 101 also includes the recycling company of solvents, it dose not arranged well. DIW introduced the new factory registration codes, Code 105 and 106 on December 2001.

- Code 105: Waste sorting and/or landfilling factory
- Code 106: Waste reuse/recycling factory

As stated above, except for a few factories with Code 101, factories doing waste reuse/recycling have been categorized in a particular code depending on what they produce. By introducing the new codes 105 and 106, DIW intends to clearly distinguish factories dealing with waste from others. The factory registration process of these codes has just started, and DIW announced "the list of factories engaged in waste treatment, recycling, or final disposal" under the Factory Act on April 24, 2002. The list includes all factories categorized in Code 101, and newly introduced Code 105 and Code 106. The number of factories of codes 101, 105 and 106 has been gradually increasing as shown in the table below, which compares the number of factories as of November 2001 (as reported in DF/R(1)), April 24, 2002 (as in the aforementioned list), and August 6, 2002 (as in the latest list available for the team during the final field study work in Thailand). The study on waste business enterprises carried out by the team was based on the list of April 24.

Table 3-18: Number of Factories with DIW Authorization as Waste Business Enterprises

Type of Waste Dealt With and MOI Code	August 6, 2002	April 24, 2002	Nov. 2001
HW, 101	10*1	8*1	5
HW, 105	1	1	-
HW, 106	3	2	-
HW total	14	11	5
Non-HW, 101	6	6	7
Non-HW, 105	5	2	-
Non-HW, 106	1	1	-
Non-HW total	12	9	7
Total	**26**	**20**	**12**

Note *1: The Rachaburi Landfill, which is considered as a facility attached to the DIW's Samae Dum Center and does not have its own factory registration number, was not included in the list on April 24, but regarded as one facility in this table.

The study team requested an interview survey to all the factories in the list of April 24. All but two factories accepted the team's visit or telephone interview.

3.3.3 Findings

a. Waste Reuse/Recycling Activities

Findings at each factory that was visited are in Annex 3.4. Here is the description of recycling activities of several recyclable waste. PCD of MOSTE studied the situation of recycle of iron scrap, paper, aluminum scrap, plastics, glass and tires in major part[3] of the country. In this study, generation source includes not only factories but also households, shops, offices and others. Material flows developed in this study, reported in "The Strategy for Waste Minimization through Re-use and Recycle: A Study on Prevention and Identification of Solution to Problems of Solid Waste and Hazardous Waste" (March 1998) are also shown below.

a.1 Iron Scrap

In Thailand, there are ten iron scrap waste shops with machinery such as hydraulic press. About 70% of iron scrap is derived from households, communities and the like while the remaining 30% is generated from the industries. In many cases, the former is recovered by small-scale enterprises and individual junkmen and brought to waste shops rather than being collected by these waste shops. In the waste shop where we visited, most of iron scrap is sold to electric furnace steel producers for the production of construction materials (reinforcing iron bars). It is said that, in Thailand, 80% to 90% of all reinforcing iron bars are made from recycled iron. In the waste shop, punched metal sheets and wires, which can be pressed without any pretreatment, are pressed into cubes with approximately 50 cm side. Small pieces of iron scrap are transported in containers such as drums. Long pieces of iron scrap are cut into easy-to-handle size with cutting torches in preparation for transportation. In the case of iron scrap in powder form, the scrap is shaped into cylindrical masses using oil as a binder in advance of being forwarded to electric furnaces. In general, an electric furnace factory generates dust that comes to 2% of fed iron scrap. This dust usually contains 20% of zinc. Because there is no recycling system and facilities of electric furnace dust in Thailand, the dust is just dumped.

The remaining iron scrap is sold to re-users owning cupolas for cast iron to be used in the manufacture of engines for automobiles and other kinds of equipment. On the other hand, cast-iron scrap is recycled to manufacture cast-iron products (such as gas-oven heads and wheels for carts and materials-transporting wagons).

In Japan, waste cars are recycled as iron scrap, but in Thailand, iron scrap business using waste cars is not common. One of the reasons is that there exists no car inspection system in Thailand, and cars are tend to be used longer than in Japan. Instead, car components/parts are recycled thoroughly. Cars that have no way to treat are exported to neighboring countries. There may be cases where dilapidated cars are illegally dumped.

Table 3-19 shows the production and consumption of steel and the collection of iron scrap all over Thailand from 1991 to 1996. This study was done by NEDO in 1999. The consumption ranged between approximately 10 and 15 million tons/year. The amount of production ranged from three to six million tons/year. The import of iron scrap varied depending on the year. 500 to 2,000 thousand tons/year of iron scrap is

[3] Bangkok, Chiang Mai, Nakorn Sawan, Khon Kaen, Chonburi, Pattaya, Ratchaburi, Kanchanaburi, Songkla, Had yai and Phuket and etc.

imported in Thailand. The amount of collection of iron scrap also has been fluctuating year by year from 800 to 3,700 thousand tons/year. According to the hearing survey, currently 2 or 2.5 million tons/year of iron scrap is estimated to be recycled.

Table 3-19: Quantity of Iron and Iron Scrap (1991-1996)

Unit: Thousand ton/year

Year	Amount Produced	Amount Imported	Domestic Consumption	Imported Scrap Iron	Scrap Iron Collected Domestically
1991	2,900	6,600	9,200	500	1,300
1992	3,500	8,200	11,400	900	1,100
1993	3,800	8,700	12,100	1,500	800
1994	4,700	10,900	15,100	1,900	1,800
1995	5,400	10,100	13,200	1,000	2,800
1996	5,900	5,200	10,500	6[#1]	3,700

Source: "Trend of Industrial Waste Recycling in Thailand" NEDO, March 2001
Note #1: It is an erroneous value.

Figure 3-5 illustrates the material flow of iron products in 1994. According to this figure, 1,839 thousand ton/year of iron scrap is collected from several generators, like households, factories, construction sites, shops and son on for recycling. About 13 million of iron scrap is scattered and not yet recycled. Thus the recycling rate is about 12 %.

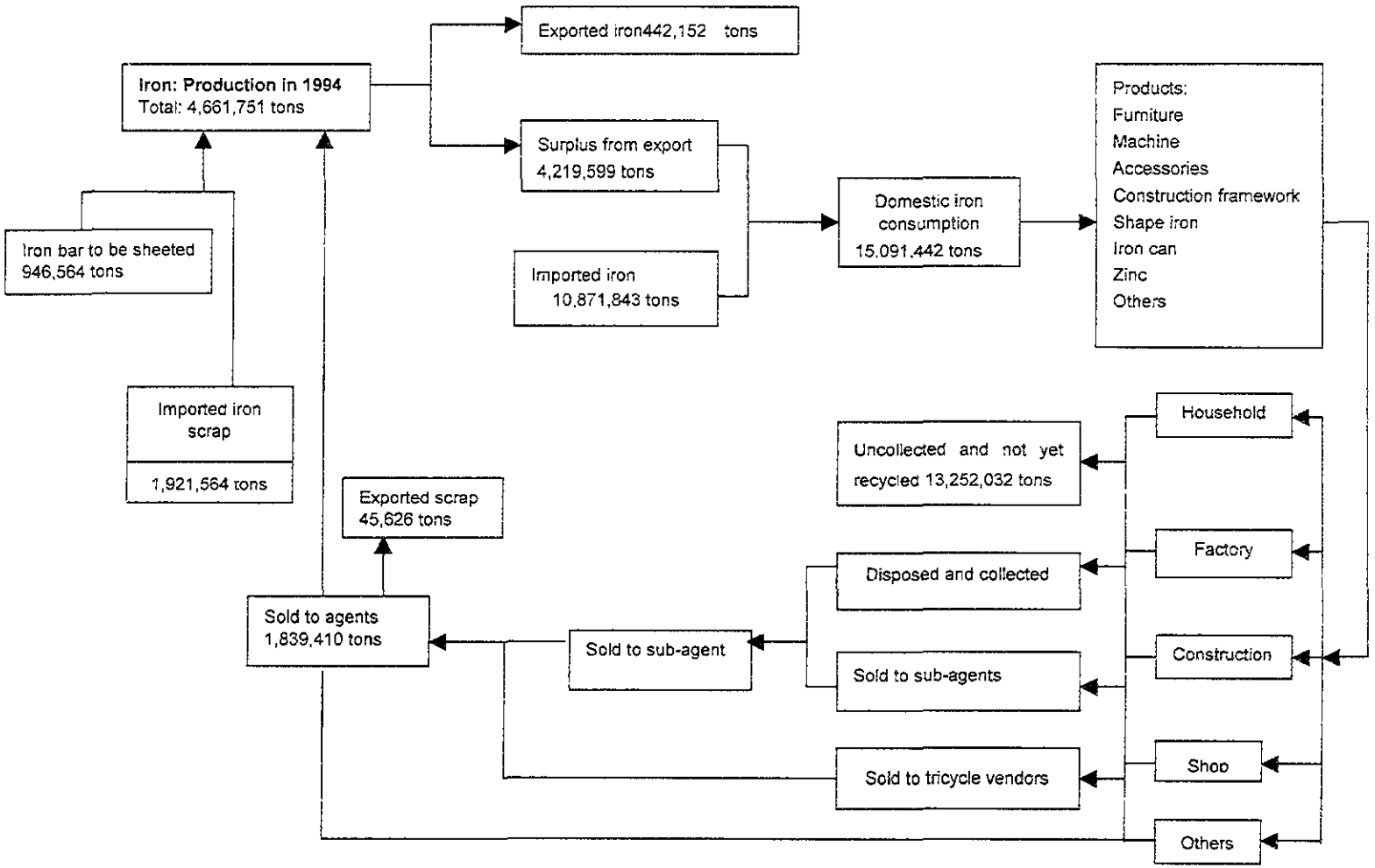

Figure 3-5: Material Flow of Iron Products in 1994

Source: "The Strategy for Waste Minimization through Re-use and Recycle: A Study on Prevention and Identification of Solution to Problems of Solid Waste and Hazardous Waste", PCD, March 1998

a.2 Aluminum Scrap

Aluminum scrap includes parts/components of two-wheeled and four-wheeled vehicles, radiators, and various machine parts, stamped aluminum sheet, tableware, aluminum cans, and aluminum foil.

Aluminum scrap is not recycled to manufacture aluminum cans since manufacturing of aluminum cans, either using virgin material or aluminum scrap, requires advanced technology and there is no aluminum can manufacturer in Thailand.

In some cases, the secondary aluminum factories use aluminum cans as the raw material to manufacture automotive components/parts for two-wheeled motorcycles and four-wheeled automobiles. However, they limit the use of aluminum cans because the magnesium content of aluminum cans is regulated 1% or less but that of aluminum ingots to be used by automobiles industries is even more stringently limited at 0.3%.

The production processes of the factory which we visited are as follows: Receiving delivered aluminum scrap ==> Assaying ==> Selection of raw materials (aluminum scrap) to be melted ==>Melting ==>Assaying ==>Adjustment of contents ==>Degassing ==>Tapping ==>Casting ==>Packing, and so on. Aluminum dross in the melting process is subject to a slag processing process (which corresponds to a primary ash extraction process) where it is mechanically agitated for separation into the primary ash and aluminum components. The aluminum component is returned to the melting process for recovery of aluminum. On the other hand, the primary ash is sold to the local aluminum re-users (corresponding to the secondary ash extraction process) as valuables. Recovered aluminum is purchased from these re-users. In the local secondary aluminum recycling, IW is not managed properly. For example, it is common that they simply dump HW generated in the process of aluminum waste treatment without environmental consideration.

Figure 3-6 illustrates the material flow of aluminum products in 1994. According to this figure, domestic production, import, and domestic consumption were approximately 174,000, 5,000, and 398,000 ton/year, respectively. The aluminum production from aluminum scrap is 120 thousand ton/year. Presently, the aluminum production from aluminum scrap has been decreasing because of the recession of Thai economy. Now it is estimated at 60 thousand ton/year. The collection of aluminum scrap domestically is below 20 thousand ton/year. Thus the import amount of aluminum scrap increased from 5 to 40 thousand ton/year.

a.3 Waste Paper

The team visited the factory that produces white paper for the material of paper package. The production of white paper is 2,400 ton/month. The usage amount of waste paper is 2,200 ton/month. The virgin pulp is imported from Indonesia, United States and New Zealand.

White paper is divided into layers: the surface layer (printed side), sub-surface layer, middle layer, the backside and so on. These layers of white paper is manufactured individually and pressed together to make a sheet of white paper. Depending on the required strength of white paper, the number of layers is changed. For the surface, sub-surface and middle layer, punched waste paper from printing office or waste paper box (rejected, disused, or expired box) is used. On the other hand, waste paper such as newspaper is used on the backside layer of white paper.

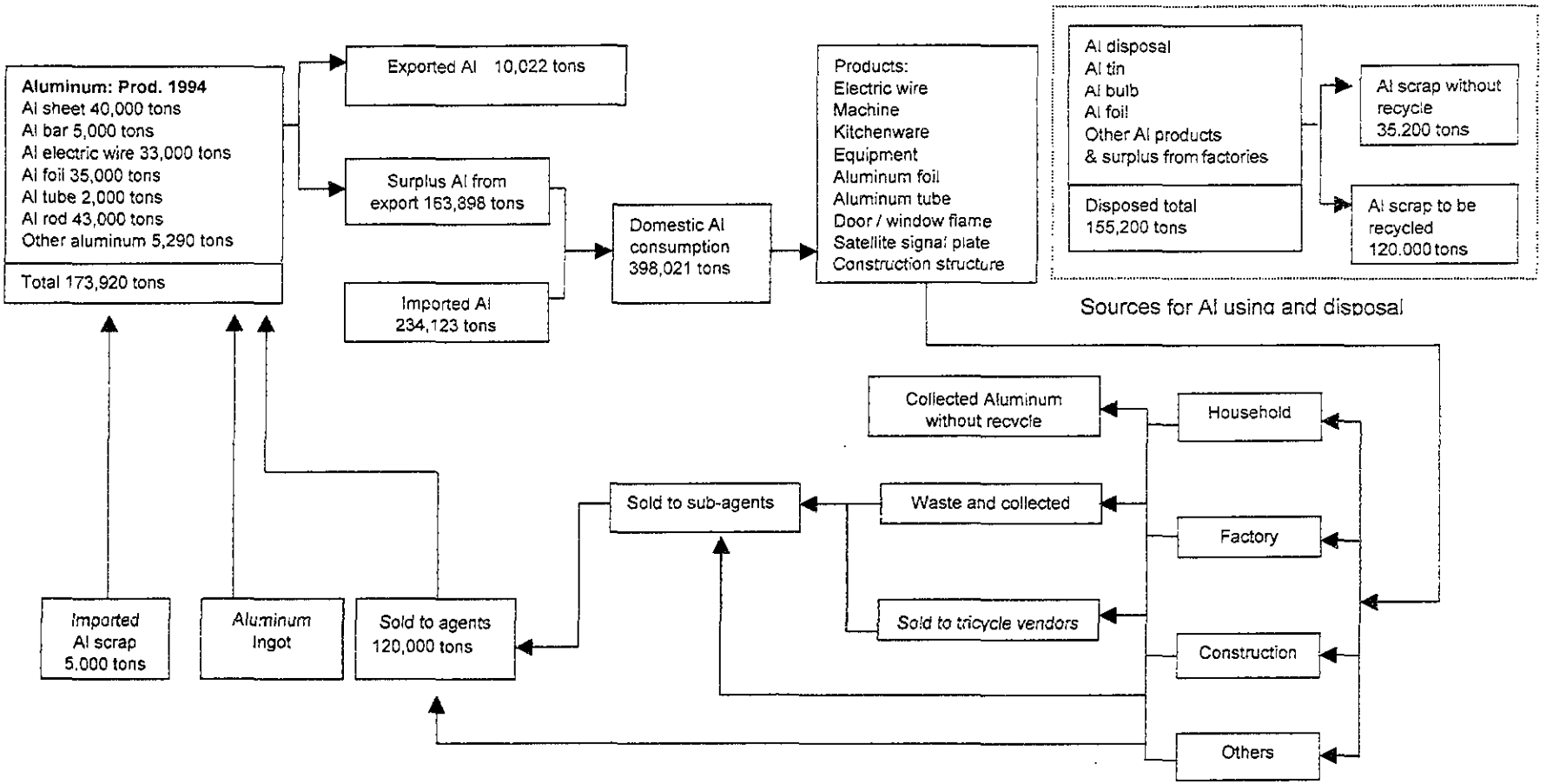

Figure 3-6: Material Flow of Aluminum Products in 1994

Source: "The Strategy for Waste Minimization through Re-use and Recycle: A Study on Prevention and Identification of Solution to Problems of Solid Waste and Hazardous Waste", PCD, March 1998

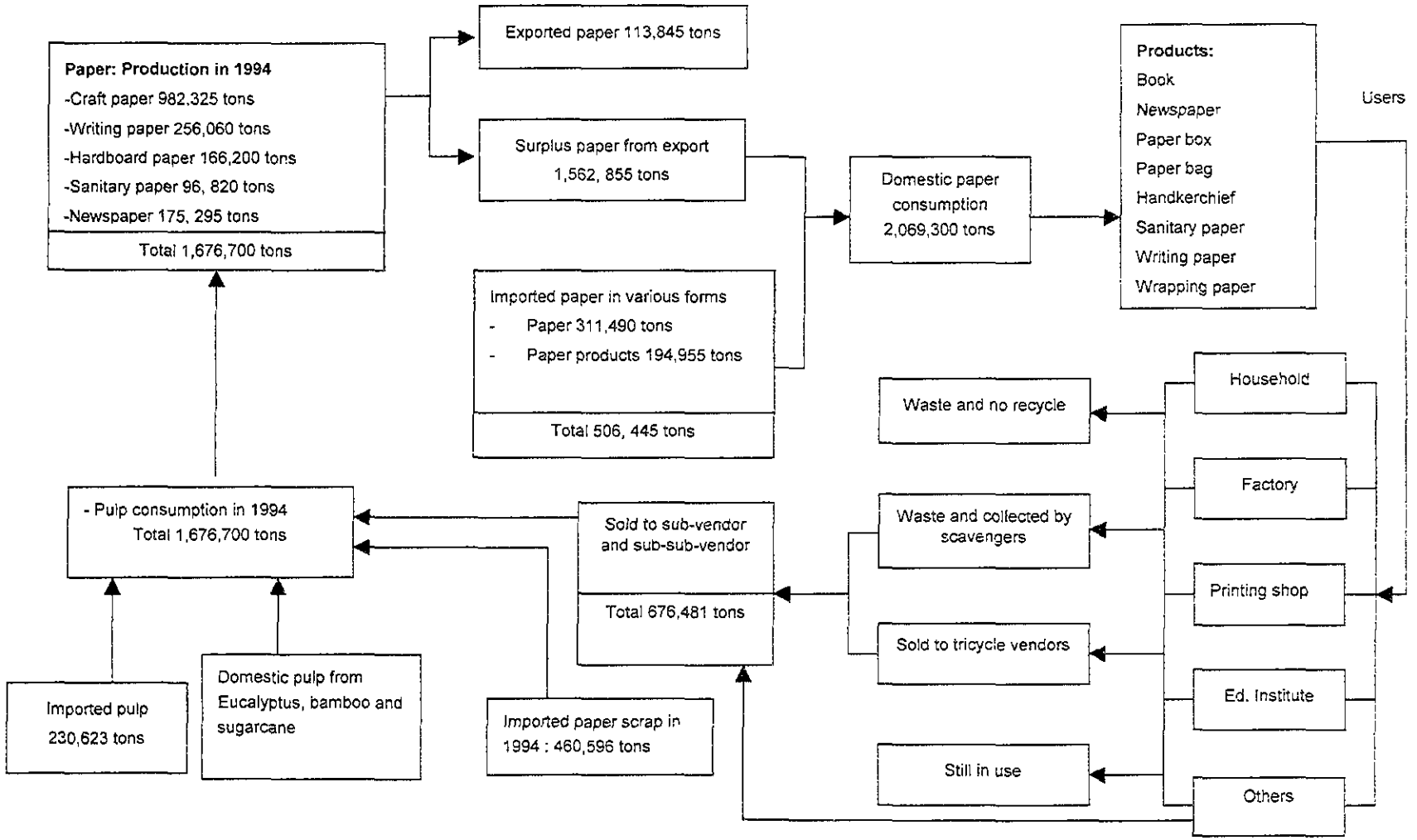

Figure 3-7: Material Flow of Paper products in 1994

Source: "The Strategy for Waste Minimization through Re-use and Recycle: A Study on Prevention and Identification of Solution to Problems of Solid Waste and Hazardous Waste", PCD, March 1998

a.4 Glass Bottle

Figure 3-8 illustrates the life cycle of glass bottle. Glass containers are transported from glass bottle manufacturers to bottling companies for bottling. Glass bottles broken during the transport or the bottling process are returned to glass factories as cullet. Bottled goods are delivered to consumers via wholesalers. Bottles broken on their way to consumers are sold as cullet to intermediate dealers. The intermediate dealers collect consumed glass bottles in the process of being sent to a disposal site. In some cases, intermediate dealers may collect it directly from consumers. Empty bottles are collected to large dealers through several stages of different dealers. Less dirty bottles among the collected empty bottles are returned to bottling companies to be reused. Dirty bottles and broken bottles are returned to the glass bottle manufacturers as cullet to be reused as raw material.

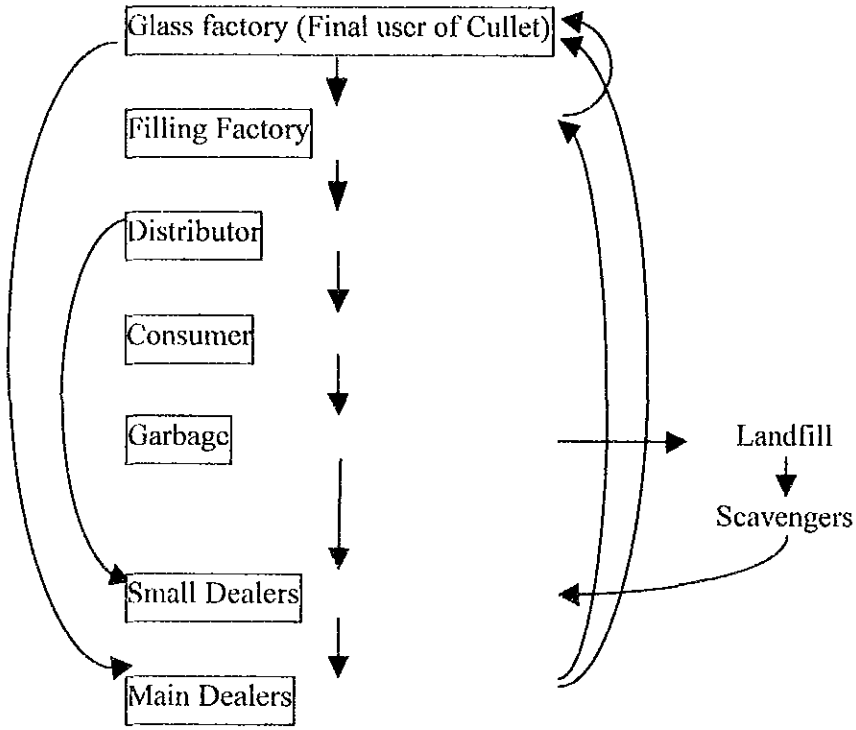

Figure 3-8: Life Cycle of Glass

The glass bottle manufacturing company where the team visited has six glass melting furnaces and it is one of the major companies in Thailand. This company constructed its own waste glass (cullet) separation plant to remove the foreign articles from the cullet. This cullet separation plant was constructed in 1992. This is the only cullet separation factory in Thailand and is the oldest cullet separation plant in Southeast Asia. This cullet separation plant is composed of the flint cullet separation factory and amber cullet separation factory. The capacity of the flint cullet separation factory for transparent glass bottles is 200 t/d and that of the amber cullet separation factory for brown glass bottles is 400 t/d. In this factory, cullet is transported by collectors to the factory, and sieved and washed to remove powdery and small cullet. Subsequently, after iron caps and other foreign objects are taken out by magnetic separation, aluminum and plastic are removed by hand picking. Ceramics are removed by the color separation technique using a difference in intensity of

transmitted light. Although the separation is normally performed by hand picking in other glass bottle manufacturing companies, this factory is automated based on a mineral separation technique adopted in mines. Through the process above, less dirty cullet almost free from foreign objects can be obtained.

A general problem with glass cullet recycling in Thailand is a shortage in terms of volume. The rate of recycling in Thailand is about 35 to 40%, which is lower than that in Western industrialized nations. Cullet is also imported to make up a shortfall

Figure 3-9 illustrates the cycle of glass products in 1994.

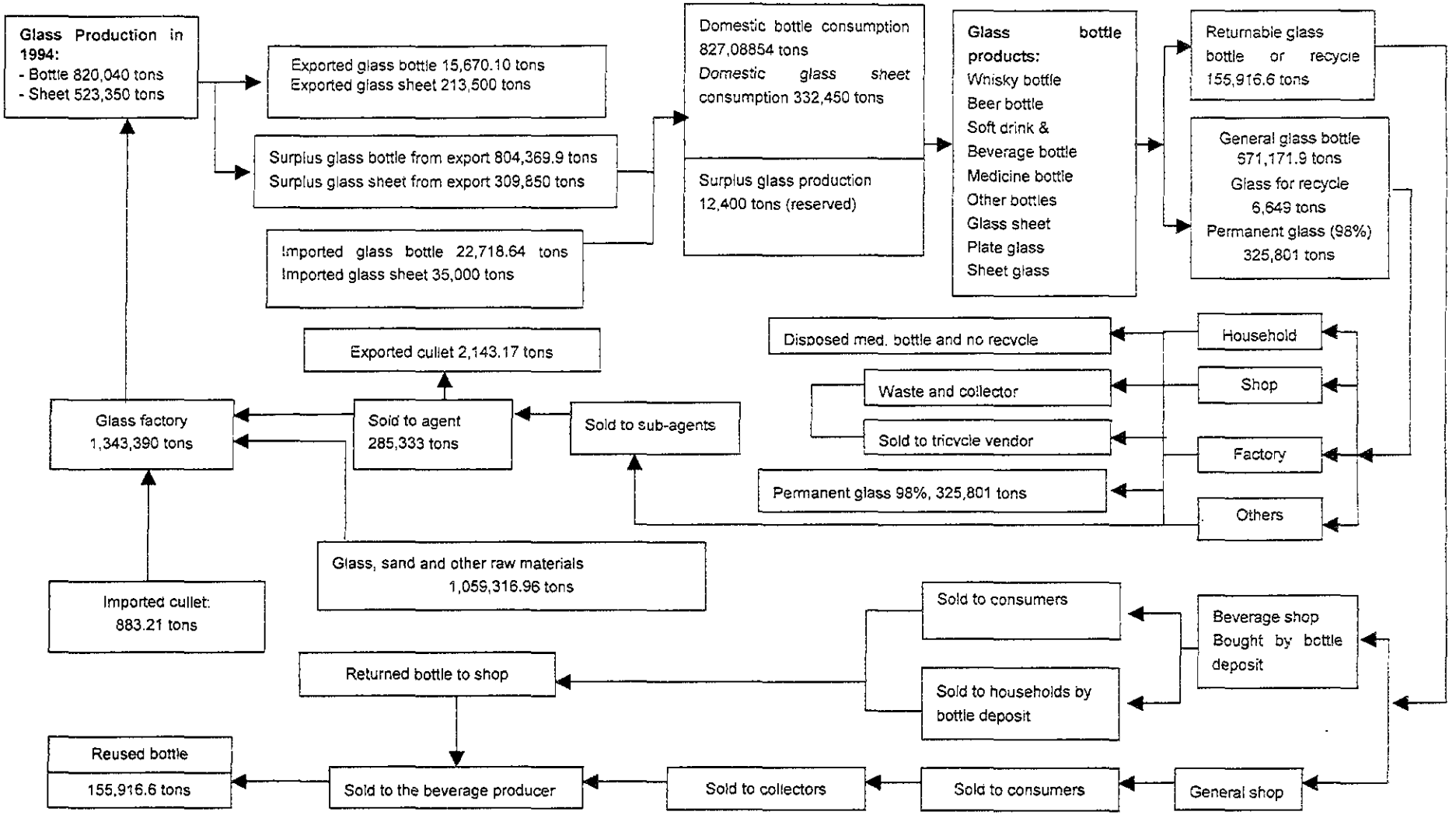

Figure 3-9: Material Flow of Glass Products in 1994

Source: "The Strategy for Waste Minimization through Re-use and Recycle: A Study on Prevention and Identification of Solution to Problems of Solid Waste and Hazardous Waste", PCD, March 1998

a.5 Waste Plastic

We visited Styrofoam recycling company in this survey. The domestic production of Styrofoam is 2,800~3,000ton/month. Approximately 1,500ton/month is consumed domestically, and the rest is exported. Styrofoam is usually disposed of by land filling. This company started its recycling in 2000. In this factory, after being crushed, Styrofoam is converted into pellets or cords by two types of methods and sold as the raw material of the Styrofoam. Although its capacity of Styrofoam treatment equipment is about 750 ton/month, the current amount of recycling is approximately only 200 ton/month. One reason is that since waste plastic including Styrofoam is sent to China in many cases, Styrofoam cannot be collected to the full capacity of this factory. Last year, 20,000 ton/month of waste plastic was exported to China.

According to NEDO report introduced earlier, the plastic industry used a total of 1,760 thousand tons of plastic pellets in 1996. Of this total, 1,370 thousand tons were manufactured domestically while other 390 thousand tons were imported.

The entire amount of recycled waste plastics totaled 235,500 tons or about 17% of total plastic consumption of 1,360 thousand tons. Plastic being collected and recycled includes (1) Wasted plastics from factories (52,800 tons); (2) Plastics collected from garbage trucks (55,600 tons); (3) Plastics colleted from used and discarded dealer (105,400 tons); and (4) Plastics gathered from scavengers (21,700 tons). Figure 3-10 illustrate the material flow of plastic products in 1995~1996.

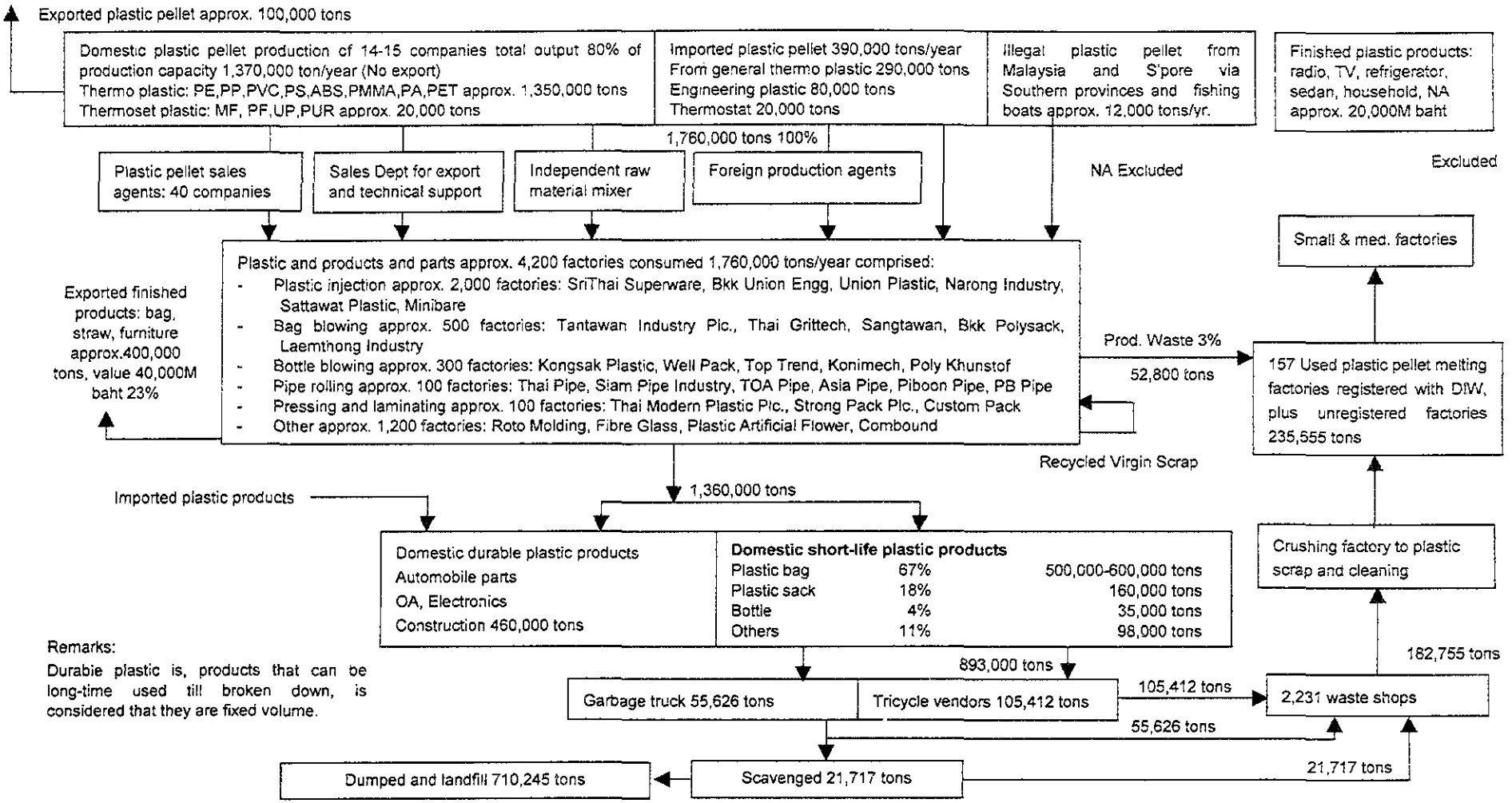

Figure 3-10: Material Flow of Plastic Products in 1995~1996

Source: "The Strategy for Waste Minimization through Re-use and Recycle: A Study on Prevention and Identification of Solution to Problems of Solid Waste and Hazardous Waste", PCD, March 1998

a.6 Waste Recycling in the Cement Industry

In Thailand, the recycle and treatment of industrial wastes in the cement industry has started. The Kaeng Khoi Co.,Ltd, which is an affiliate of SIAM CEMENT GROUP, acquired the CODE 101 registration at DIW in April 2001. In addition, SIAM CITY CEMENT Co.,Ltd got the license of CODE 101 factories. In the Kaeng Khoi Co.,Ltd, the recycle and treatment of industrial wastes are the application of the waste oil and waste solvent as the alternative fuel and the application of solid industrial waste for substitution of raw material or ingredient adjustment material of cement products. The operations to reuse waste oil in the Kaeng Khoi Factory such as collection, quality check, quality adjustment, and mixture are subcontracted to a private company. Waste oil is purchased from factories. The price of waste oil depends on its calorific value. The subcontractor receives a small amount of sample and analyzes it to judge whether waste oil can be treated before making an agreement, and at the same time makes budget estimation for purchase. It also analyzes the sample lot by lot and determines the mixing procedure and the proportion.

In Kaeng Khoi Co., Ltd, industrial wastes are recycled by applying waste oil and waste solvents as alternative fuel, and by substituting raw material or material adjustment ingredient with solid industrial waste. The operations to reuse waste oil in Kaeng Khoi Factory such as collection, quality check, quality adjustment, and mixture are subcontracted to a private company. Waste oil is purchased from factories. The price of waste oil depends on its calorific value. The subcontractor receives a small amount of sample and analyzes it to judge whether waste oil can be treated before making an agreement, and at the same time makes budget estimation for purchase. It also analyzes samples lot by lot and determines the mixing procedure and proportion.

The Kaeng Khoi Factory mixes raw material and solid waste including iron and silica necessary for cement manufacturing in the raw material stockyard to treat them as raw material substitute. Major industrial waste is composed of wastewater sludge from the steel industry (including CaO_2 and Fe as main components) and EP dust. The quantity of these wastes is still small. This is because the factory treats waste while studying how mixed solid waste affects upon products and exhaust gas. For example, chlorine is a component that presents a problem. It is difficult to accept waste with a high concentration of chlorine. The cement kilns in Japan are equipped with so-called "chlorine bypass" in order to limit the chlorine content in products so that wide range of waste can be accepted. The Siam Cement Kaeng Koi Factory has a total of 19,200 t/d of clinker calcinations capacity. However, presently they recycles less than 100 t/d of solid wastes.

For the liquid wastes treatment as the alternative fuel, the monitoring of the emission from stack is essential In this case, it is necessary to monitor such components as HCl, dust, SO_2, NO_X, and heavy metal in the emission gas. The Siam Cement conducted a comparison test with standard oil, waste oil, tire, and lignite before full-scale operation

As a pilot project, the Kaeng Khoi Factory receives off-spec/rejected tires from tire manufacturers and uses them as alternative fuel. They intend to increase the usage of waste tire in the future.

Many cement plants including the Kaeng Khoi Factory are situated in Saraburi Province where limestone and shale of good quality, a raw material for cement, are

abundant. It takes about one and a half hours from the Bangkok, and it is not far from the Eastern Seaboard Areas including Chonburi and Rayong Provinces where newly emerged industrial parks are located. SIAM Cement treats industrial waste mainly in its Kaeng Khoi Factory. However, as it has just begun, both the amount and the number of types of liquid and solid waste recycled in this factory are still small. They are expected to increase in the future.

a.7 Tire

The surveyed company recycles bias tires of large vehicles like buss and tracks for the material of rubber product. When the tread part of bias tires is worn out, it is replaced once. If the replaced tread is abraded, the whole tire is regarded as worn out and is discarded. This is the end of its safe useful life. The useful life of a new product is about four or five months. It is quite shorter than the life in Japan, because the road condition in Thailand is severe than the condition in Japan.

Discarded tires may be temporarily kept by tread dealers and collected by collectors. Since a regular collection route of used tires has not been established, collectors sometimes have to pick up tires discarded from any places even from the dumping site.

Collectors cut out bead wires and remove nylon fabrics. Nylon fabric parts are only recycled into bags, handicrafts, and other things in small quantities.

Although waste tires of trucks and buses are recycled, those of ordinal passenger cars are not recycled for the following reasons.

1) Since tires of passenger car are small, a recyclable portion is limited.

2) Recycling is difficult because waste tires of a passenger car are different in material from those of a truck or a bus.

3) Tires of the passenger car are usually radial tires. The recycling of the radial tires is troublesome because steel is used inside.

The recycle rate of radial tire is only a few percent. Almost all of them are illegally dumped. Figure 3-11 illustrates material flow of tire in 1994.

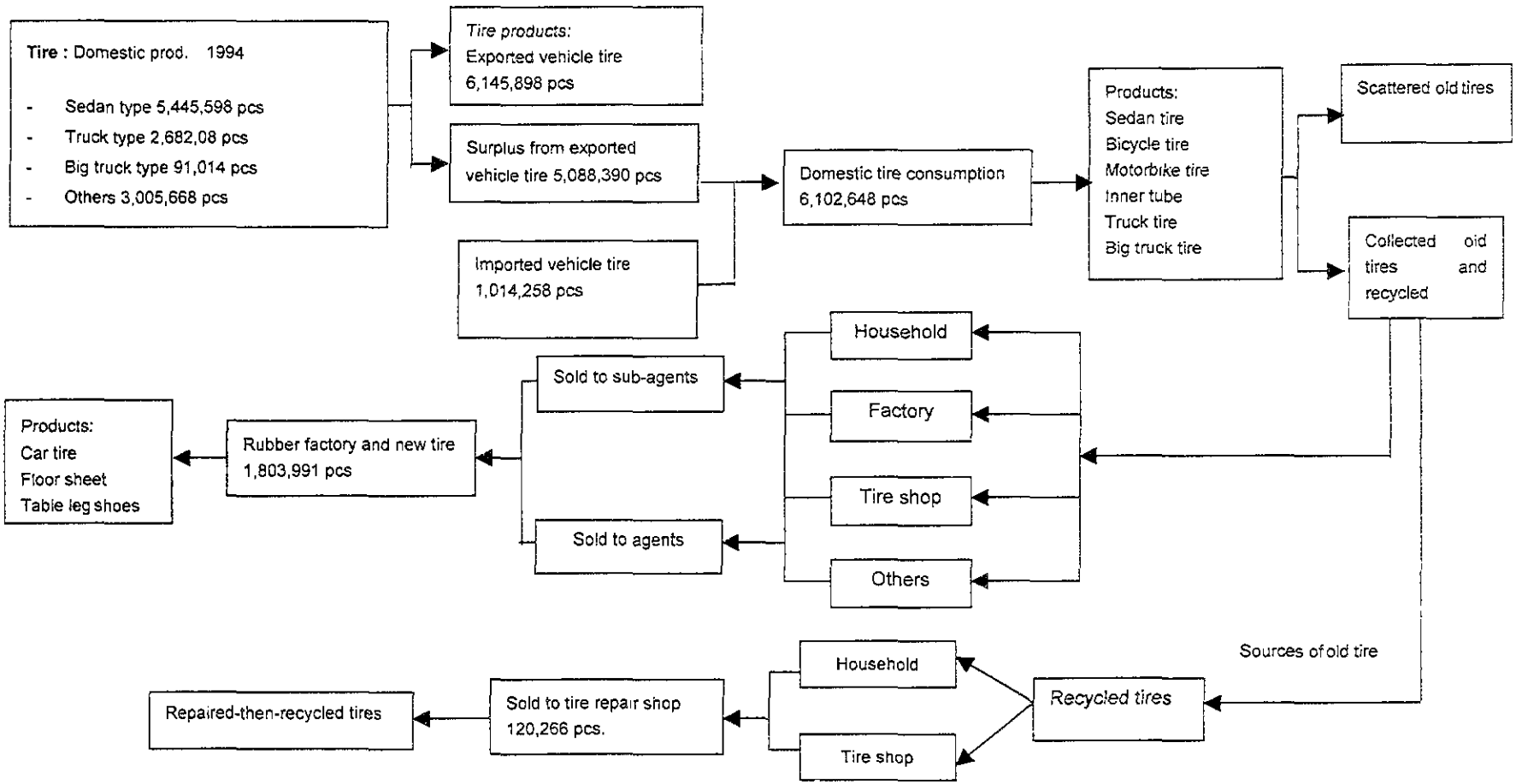

Figure 3-11: Material Flow of Tire in 1994

Source: "The Strategy for Waste Minimization through Re-use and Recycle: A Study on Prevention and Identification of Solution to Problems of Solid Waste and Hazardous Waste", PCD, March 1998

a.8 Summary of Reuse/Recycling Activities

- There seems to be enough facilities to receive most types of non-hazardous reusable/recyclable waste for reuse/recycle purposes.
- However, the amount of some types of recyclable waste which is collected to such reuse/recycling facilities within the country is not enough. Nearly 70% of aluminium scrap is imported and substantial portion of PET bottles are exported to China for recycling.
- As for the reuse/recycling of HW, it seems to be limited to such waste as waste oil, waste solvent and waste solder (for lead recovery).
- The use of cement factories as a reuse/recycling facility is effective to promote HW reuse/recycling, but it is still at the starting point. It first started at Siam Cement Kaeng Koi plant in April 2001 followed by another, Siam city cement plc. As of February 2002, there are these two factories with code 101 registrations.
- There are many stakeholders in a reuse/recycling process. The real situation of their activities is not yet well known.
- New factory codes 105 for waste sorting and landfill and 106 for waste reuse/recycling were created in December 2001, but a system to control reuse/recycling industry including waste buyers is not yet adequately developed.

b. Factories with DIW Authorization as Waste Business Enterprises

The result of the survey of factories with DIW authorization as waste business enterprises, which were listed on the list of April 24, is summarized in the next table. Their location is shown in Figure 3-12. Annex 3.5 also presents the details of each of these factories.

The DIW, however, announced on August 6th 2002 the following 6 factories were given DIW authorization as waste business enterprises.

Name of Factory	HW or Non-HW	MOI Code	Location	Main Services
TPI Polene	HW	101	Saraburi	Treatment/disposal
Siam Cement (Thaluang)	HW	101	Saraburi	Treatment/disposal
Uni Copper Trade	HW	106	Samut Sakhon	Recycling of electronic parts
Recycle and Environmental Conservation	Non-HW	105	Chonburi	Sorting
Siam Waste Management Consultant	Non-HW	105	Saraburi	Sorting
Environmental Conservative Service	Non-HW	105	Rayong	Sorting

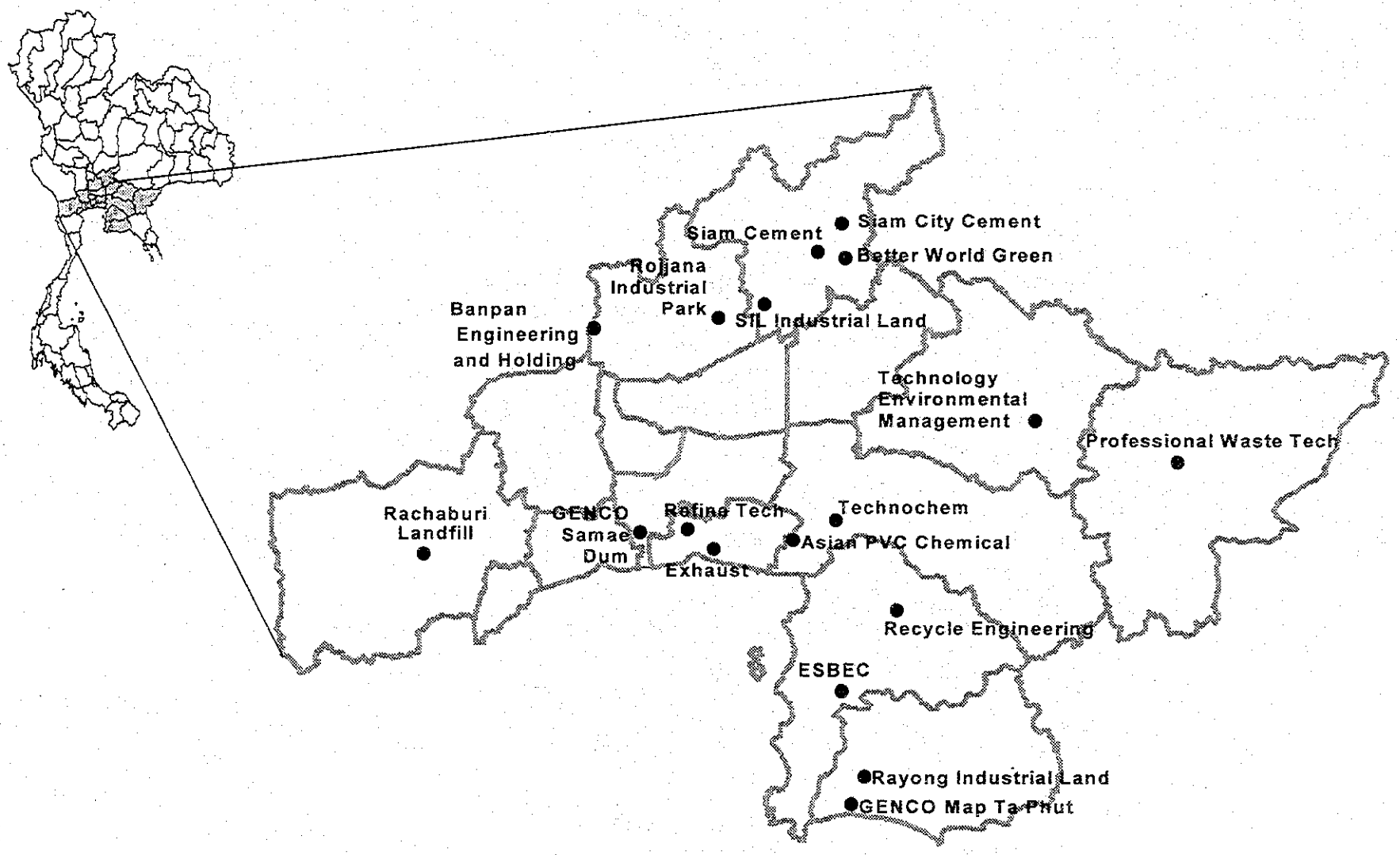

Figure 3-12: Location of Factories with DIW Authorization as Waste Business Enterprises

Table 3-20: Factories with DIW Authorization as Waste Business Enterprises (HW)

	Name	Province	Code, Factory Registration Number and Date of Registration	Visited or not	Time of Information Acquisition	Type of Business	Design Capacity (Actual Result in Parenthesis)	Contact Persons and Contact Numbers	Notes
HW 101-1	GENCO Map ta phut Facility	RY	**101** Nor3-101-1/40 RY (1997)	Visited	June, 2002	1. Fuel blending of waste oil and waste solvent for cement industry 2. Sludge stabilization 3. Landfill	1. 200 t/d 2. 600 t/d 3. 500 t/y	Mr. Sripop Sarasas Chief Executive Officer Mr. Tanong Promma Public Relations Manager TEL:02-651-8812～22 FAX:02-651-8832～33	Located in the Map Ta Phut Industrial Estates directly under IEAT. A new landfill site is under construction within the same estate (*area: 85 rai (13.6 ha), to be operated* from December 2002) and facilities for sludge stabilization and the recycle of batteries, IC parts, etc. are planned in the same plot of land.
HW 101-2	GENCO Samae Dum Treatment Plant	BKK	**101** Nor3-101-2/38 (1995)	Visited	Feb., 2002	1. Wastewater treatment 2. Sludge stabilization	1. (110,000 t/y) 2. (30,000 t/y)	Mr. Amornsak Benchaplaporn General Manager TEL:02-415-3728 FAX:02-415-3817	The facility owned by DIW and *operated by GENCO, a* sub-contractor. After stabilized, sludge is disposed of at the Ratchaburi landfill of DIW. The wastewater treatment facility mainly receives waste from the plating industry, dying industry and textile industry.

HW 101-3	GENCO Rachaburi Landfill	RA	**101** Nor3-101-2/38 (1995)	Visited	May, 2002	Landfill	(30,000 t/y)	Mr. Chanwut Hawwattanapanitch TEL:0-1830-2564	The facility owned by DIW and operated by GENCO, a sub-contractor. Area total: 48 ha, area of landfilling: 24 ha. As of the end of May 2002, the second cell is finished and landfilling at the third cell started. The first cell has been already covered with soil. The second cell has not been covered yet since the efficient use of land between the second and third cells is under consideration. The landfill will be expanded to 96 ha (adjacent land already purchased).
HW 101-4	Technochem	CHA	**101** 3-101-1/35 CHA (1992)	Not visited	---	Organic solvent recycling	15,000 t/y (4,000 t/y)	--- TEL:0-2373-0028 FAX:0-2373-1457	The team has been requesting the visit, but it is not yet accepted as of June 27, 2002.
HW 101-5	Recycle Engineering	CHO	**101** 08/00 3-101-1/44 CHO (2001)	Visited	June, 2002	Organic solvent recycling	10,000 t/y (4,000 t/y)	Mr. Patikan Mahuttanaraks Managing Director Office; TEL: 02-749-8522~3 FAX:02-749-8973	It also carries out fuel blending for the cement industry. Clients spread all over the country. It purchases waste solvent at 500 ~ 800 Bahts/drum.
HW 101-6	Siam Cement Industry (Kaeng Koi)	SRB	**101** 3-101-1/44 SRB (2001)	Visited	July, 2001	1. Liquid waste treatment (used as alternative fuel) 2. Solid waste treatment (used as aiternative raw material)	Actual result from Jan to Sep 2001: 1. 20,000 t 2. 26,000 t	Mr. Pipope Siripatananont Director, Engineering Division Mr. Suwat Tuppavong Energy Manager TEL:02-586-5670 FAX:02-586-3098	A fuel blending facility is installed (operated by Sita-Thai). A tire feeder is installed and being tested.

HW 101-7	Siam City Cement Plc	SRB	**101** 11/01 3-101-2/44 SRB 3-101-3/44 SRB (2001)	Visited	June, 2002	1. Liquid waste treatment (used as alternative fuel) 2. Solid waste treatment (used as alternative raw material)	Actual result from Jan to Apr. 2002: Total Waste Received 192,029t Including Waste oil 241t, Wax oil 610t, Carbon/Resin/Mold 142t, Fly ash 133,133t	Mr. Choompon Lertchuwongsa TEL:0-3635-7180 FAX:0-3635-7181	Test started in the beginning of this year. The promotion of waste business has just started. A waste oil blending facility is installed.
HW 101-8	Professional Waste Technology (1999)	SKW	**101** 03/02 3-101-1/45 SKW (2002)	Visited	June, 2002	Landfill	The facility is under construction.	Mr. Shane Aimpoolsub TEL:0-2246-7372 FAX:0-2246-4149	Facilities for waste landfill and waste recycling are planned. Landfills for Non-HW and HW are currently being prepared.
HW 105-1	Professional Waste Technology (1999)	SKW	**105** 03/02 3-101-1/45 SKW (2002)	Visited	June, 2002	Recyclable waste recovery	The facility is under construction.	Mr. Shane Aimpoolsub TEL:0-2246-7372 FAX:0-2246-4149	Facilities for waste landfill and waste recycling are planned. HW and Non-HW will be accepted.
HW 106-1	Refine Tech	SP	**106** 04/02 3-106-1/45 SP (2002)	Visited	May, 2002	Organic solvent (IPA) recycling	5 m^3/d 1,800 m^3/y	Mr. Somchai Auttavoothispia Technical Service Manager Mr. Chalor Suansamut TEL:02-817-8568～9 FAX:02-817-8569	It started it business recently and the total waste amount accepted is still small. It is specialized in the recycling of IPA (Isopropyl Alcohol). Waste IPA is received without payment.

HW 106-2	Asian PVS Chemical	CHA	**106** 03/02 Nor42(1)-16/ 2537 (2002)	Visited	June, 2002	$FeCl_3$ Production (coagulant for water treatment)	3,000 t/m (1,000 t/m)	Ms.Karen Wiebelhaus General Manager Mr. Sompong Chanprasuitr TEL:038-570-155,038-570-705 FAX:038-570-441	Located in the Wellgrow industrial estate under IEAT. It produces FeCl3 from FeCl2 in waste acid from the ferrous metal finishing process.

BKK: Bangkok, SP: Samut Prakarn, SRB: Saraburi, AY: Ayudhaya, RY: Rayong, NST: Nakohn Si Thammarat, LP: Lampang, CHA: Chachoengsao, CHO: Chonburi, SKW: Sakaew, PRC; Prachinburi, RA: Rachaburi

Table 3-21: Factories with DiW Authorization as Waste Business Enterprises (Non-HW)

	Name	Province	Code, Factory Registration Number and Date of Registration	Visited or not	Time of Information Acquisition	Type of Business	Design Capacity (Actual Result in Parenthesis)	Contact Persons and Contact Numbers	Notes
Non-HW 101-1	Better World Green	SRB	**101** Jor3-101-2/40 SRB (1997)	Not visited	—	Landfill	20,000 m^3	— TEL:0-2731-1125 FAX:0-2731-2574	The team has been requesting the visit, but it is not yet accepted as of June 27. 2002.
Non-HW 101-2	Exhaust	SP	**101** 3-101-1/39 SP (1996)	Interviewed over phone	June, 2002	Incineration*1	-	—	It obtained a license before constructing the facility.
Non-HW 101-3	Banpan Engineering & Holding	AY	**101** 01/98 3-101-1/40 AY (1998)	Visited	June, 2002	Incineration*1	500 kg/hour (7 ton/day)	Mr. Pongsathon Phansaeng TEL:2921641-3 FAX:2921644	Located in the Banpan Industry Park. It currently receives burnable waste from shoe factories in the park. It will receive burnable waste from outside of the park.
Non-HW 101-4	Rojjana Industrial Park	AY	**101** 3-101-1/41 AY (1998)	Interviewed over phone	June, 2002	Incineration*1	-	Mr. Suwat TEL:0-3533-0000	The incinerator is out of order and the operation has been stopped. At present waste is transferred to the public landfill in Pathum Thani for final disposal.
Non-HW 101-5	SIL Industrial Lands	SRB	**101** 02/97 3-101-/36 SRB (1997)	Visited	June, 2002	Incineration*1	200 t/month (200 m^3/month)	Mr. Pittaya Phetcharoen TEL: 0-3637-333 FAX:0-3637-3226	It is located in the industrial estate operated by the Siam Cement Group. It incinerates burnable waste from the estate. It also accepts burnable waste from outside of the estate.

Non-HW 101-6	Rayong Industrial Lands	RY	**101** 3-101-4/40 RY (1997)	Interviewed over phone	June, 2002	Incineration*1	(4 t/8 hours) 60 t/month	Mr. Passakorn TEL:0-3889-2222 FAX:0-3889-2224	The Siam Cement Group is the 100% share holder It incinerates waste from offices.
Non-HW 105-1	Eastern Seaboard Environmental Complex (ESBEC)	CHO	**105** Nor 105-1/2545 (2002)	Visited	June, 2002	Landfill	2,500 t/d (150 t/d)	Mr. John Hamiliton Site Manager Mr. Suchintana Virarat Sales & Customer Service Manager Mr. Anant Thamrakkid Senior Sales Representative TEL:038-346-364～7 FAX:038-346-368	It is located in the Chonburi Industrial Estate under the IEAT. The current total area is 75 rai (12 ha), but the expansion to the adjacent land is planned. It is now in Phase I. It plans to do waste recycling in Phase II and has a post-closure plan in Phase III. A recycling facility will be constructed in future. The structure of the landfill is good enough to receive HW. It plans to extend its business to HW.
Non-HW 105-2	Professional Waste Technology (1999)	SAK	**105** 03/02 3-101-1/45 SKW (2002)	Visited	June, 2002	Recyclable waste recovery	The facility is under construction.	Mr. Shane Aimpoolsub TEL:0-2246-7372 FAX:0-2246-4149	Facilities for waste landfill and waste recycling are planned. HW and Non-HW will be accepted.
Non-HW 106-1	Technology Environmental Management	PRC	**106** 3-106-1/45 PRC (2002)	Interviewed over phone	June, 2002	Recycling	The facility is under construction.	--- TEl:0-2246-8275 FAX:0-2247-6963	Operation will start in the year 2003.

*1: They are the developers or operators of private industrial estates.
BKK: Bangkok, SP: Samut Prakarn, SRB: Saraburi, AY: Ayudnaya, RY: Rayong, NST: Nakohn Si Thammarat, LP: Lampang, CHA: Chachoengsao, CHO: Chonburi, SKW: Sakaew, PRC; Prachinburi