3.4 Survey on Associations

3.4.1 Objectives and Method

Industrial association means a group, an association or a federation of companies manufacturing the same kind of products. Objective of the survey is to understand industrial association's activities to promote the industrial waste management or the pollution control, and then to know what kind of support the associations expect the DIW.

23 associations were found in Thailand. The Study Team selected 10 associations among them as the subject of this survey taking the DIW's advice into consideration. The associations subjected to the Survey are listed in Table 3-22.

3.4.2 Contents of the Survey

The survey was conducted during June and July in 2001. The questionnaire was prepared and sent to the secretary or the responsible person of the association in advance of making an appointment in order to help them understand the purpose of the survey.

The questionnaires to the associations are composed of the following questions. They can be categorized into a) general questions on the association, b) those on solid waste, c) those on the association's activities and d) promotion of the proper IWM.

- Purpose of the association
- Number of member companies
- Share of the production of the member companies in their industrial sector
- Type of the member's industry
- Associations' services to the member companies
- Typical waste of the industry
- Problem on IWM common among the members
- Pollution due to the solid waste so far
- Information on the waste collectors
- Help or support from the association to the member companies with respect to IWM
- Expectation to the government's support with respect to IWM
- Information needs
- Willingness to promote waste exchange

3.4.3 Execution of the Survey

The team could get answers to the questionnaire from 8 associations among 10. A study team member visited 6 associations out of those 8 and interviews concerning the associations' activities on IWM. The other 2 associations gave back the answers to the questionnaire by fax. Those associations are listed in the following table. The status indicates whether the team visited or not.

Table 3-22: Associations to be Surveyed

	Name of the associations	Status
1	Motorcycle Manufacturer Association	Rejected
2	Automobile Parts Manufacturer Association	Visited on July 31, 2001
3	Carton Paper Manufacturer Association	Not found
4	Thai Metal Association	Visited on July 18, 2001
5	Synthetic Fiber Manufacturers' Association	Visited on July 20, 2001
6	Thai Plastic Industry Association	Answered by fax
7	Thai Tanning Industry Association	Visited on July 13, 2001
8	Automobile Industry Association	Visited on July 18, 2001
9	Thai Textile Industry Association	Visited on July 27, 2001
10	Thai Steel Industry Association	Answered by fax

3.4.4 Findings

a. General Findings

Among 6 associations the team member visited, only Synthetic Fiber Manufacturers' Association and Thai Plastic Industry Association have the permanent secretary offices, while the others do not. The president of the major member company acts as the chairman of the association in turn in the association without a permanent secretary office. Most of the associations seem to pay much more attention to the production and sales promotion. For example, the Motorcycle Manufacturer Association declared that it works for the sales promotion but has nothing to do with IWM. That is the reason why it rejected the interview.

Generally, the industrial associations are not so much aware to IWM or pollution control. They are rather interested in the promotion of cleaner production (CP) technology.

b. Current Problems on IWM

Two of the associations gave answers to the question concerning problems of IWM. Their common answers are as follows.

- Since there are only a few companies which have an official permission to collect and treat waste, the market of waste treatment services is not competitive but is monopolized.
- Therefore the waste disposal cost has been increasing.

Good example of the waste recycled well is that of the synthetic fiber, because the that is chemically pure.

Waste from the textile industry is also well recycled. They are cotton yarn, small pieces of cloth and so on, and are used for a small handcrafts, padding of cushions, etc.

c. Associations' Activities on IWM Promotion

5 among 7 associations answered that they have been promoting the better management of solid waste and also help the member companies to solve the

problems due to industrial waste. 5 associations give technical support to the members concerning IWM by providing information on technology.

d. Promotion of Proper Management of the Solid Waste

3 of 8 associations answered that they expects the government to give information, advices, and solutions on IWM. All of 8 associations declared that they are willing to promote waste recycling. The member companies are trying to reduce the industrial waste and need the information on waste treatment technology.

The following 5 associations among 8 declared that they are willing to promote waste exchange between other industries.

- Automobile Parts Manufacturer Association
- Thai Metal Association
- Thai Plastic Industry Association
- Thai Tanning Industry Association
- Thai Textile Industry Association

3.5 Study on MWM

The questionnaires sent to the local administrations for the Survey on Non-HW Collection and Transportation Organizations (Section 3.2) also asked aboutg municipal waste management system.

3.5.1 Institutional System

a. Bangkok

Bangkok Metropolitan Administration (BMA) is responsible for public services in Bangkok. Formerly the Department of Public Cleansing (DPC) of the BMA controlled whole of municipal waste collection services, but the waste collection service has been decentralized to the district offices several years ago. Today the Public Cleansing Sections of the district offices collect waste, while the DPC engages in the policy making of public sanitation and budget management.

Principally, the district offices are responsible for the collection of municipal waste from households, restaurants, shops, offices, public institutions and markets, but they also collects non-HW according to the Memorandum of Agreement made between the DIW and the BMA on 22 January 1997.

This agreement stipulates that the BMA should tentatively be in charge of the collection of waste from factories except for hazardous one. It was expected that this duty was limited only for one or two years until companies or independent organizations became ready to collect non-HW, but the district offices of the BMA still collect it because such companies have not yet appeared.

b. Four Provinces adjacent to Bangkok

Municipal solid waste in provinces is mainly dealt with by municipal offices. In Nonthaburi, Pathum Thani, Samut Sakhon and Samut Prakarn, each municipal office has a Public Cleansing Section in charge of waste collection. There is no official statement on industrial waste collection but a Public Cleansing Section of each

municipality collects waste from factories so far as a customary practice except for hazardous waste.

3.5.2 Technical System

a. Waste Collection

The Public Cleansing Sections of the districts or municipalities collect waste mainly by compactors of 5 tons or 10 tons. Trucks in various loads are also used commonly. In some area, boats are used for waste transportation to advantage.

Table 3-23 shows the number of collection vehicles by type, drivers and waste collection workers.

Table 3-23: Number of collection vehicles by type, drivers and workers

	Bangkok	Samut Prakarn	Nonthaburi	Pathum Thani	Samut Sarkorn
20 t compactor	2	0	0	0	0
10 t compactor	86	19	34	13	11
5 t compactor	1,130	37	47	38	11
2 t compactor	35	0	0	5	2
1.5 t compactor	30	9	3	3	0
Truck (2 tons to 10 tons)	232	64	30	21	9
Others (including boats)	334	32	22	25	15
Number of Drivers	2,414	152	142	92	50
Number of Workers	9,462	468	384	325	187

Source: Answers of the districts/municipalities to the questionnaire made by the Study Team

According to the answers of the districts, in total 8,567 tons/day of waste is collected in Bangkok. Quantity of waste collected in 4 provinces are shown in the table.

Table 3-24: Quantity of Waste collected by the districts and municipalities

Province	ton/year	ton/day
Bangkok	3,126,968	8,567
Samut Prakarn	295,245	809
Nonthaburi	287,150	787
Pathumu Thani	134,380	368
Samut Sarkorn	127,770	350

Source: Answers of the districts/municipalities to the questionnaire made by the Study Team

The waste collected from the districts of Bangkok is transported to transfer station either in On Nuch, Nong Kaem or Tha Raeng. The daily quantity of waste carried into each transfer station is shown in the following table. These figures might be slightly different from those the BMA reported, as these figures are calculated by summing up the answers of the district.

Table 3-25: Quantity of Waste carried into each transfer station

Transfer Station	Quantity (ton/day)	Final Disposal Site (Destination)	Designed Capacity (ton/day)
On Nuch	3,918	Racha Thewa	1,500

Nong Khaem	2,959	Kam Paeng Saen	1,500
Tha Rang	1,690	Kam Paeng Saen	1,000
Total	8,567		4,000

Source: Answers of the districts/municipalities to the questionnaire made by the Study Team except for the right column, which was referred to JBIC (2001)[4].

As for the waste collection fee, BMA's Ordinance on waste collection fee enacted in 1978 (B.E. 2521) stipulates the unit fee of waste collection form factories. The fee rate is 40 Bahts/month for the first 1 cubic meter/day of waste plus 40 Bahts/ month for additional 1 cubic meter/day. In case of collection on request, it costs 25 Bahts for first 1 cubic meter and for additional 1 cubic meter. This tariff is far lower than the current cost for collection and disposal, as more than 20 years has passed since it was established in 1978.

In principle the factory is charged the fee according to the actual quantity of waste collected, but in reality a fixed rate for the averaged quantity of waste is charged to each factory. According to the answers of the districts of BMA to the questionnaire, the fee rates for small, medium and large sized factory are approximately 600, 800 and 2,000 Bahts/month, respectively. It is also common to apply the lowest fee rate at 40 Bahts/month to the small factories.

In Samut Prakarn, some cities charges a fixed rate of 1,500 Bahts/month regardless to the factory size. It might be because the definition of small factory may not be applicable to those located in this area where many large factories are located.

In Nonthaburi, the fee rate is low compared to that in other districts. The fee rate may be stable in low rate because Nonhtaburi Province Sanitary Management Organization has operated the public disposal site.

In Phatum thani, on the contrary, the fee rate is fairly high. 2,000 Bahts/month is charged in a certain municipality, and even the 5,000 Bahts/month is charged for the large factories.

In Samut Sakorn, the fee rate for the small and medium sized factories is similar to that in Samut Prakarn, or a little bit higher, though only one municipality charges 6,000 Bahts/month for the large factories.

Table 3-26: Average Waste Collection Fee by Size of Factories

Factory Size	Small	Medium	Large
BMA	600	800	2,000
Samut Prakarn	500	1,500	2,000
Nonthaburi	500	800	1,000
Pathum Thani	500	2,000	3,000
Samut Sakorn	500	1,500	2,000

Unit: Bahts/month

b. Disposal Sites

b.1 Bangkok

[4] SAPROF team, "JBIC special assistance for project formation (SAPROF phase 1) for solid waste management at On-Nuch", JBIC, February 2001.

Waste carried into the On Nuch transfer station is then transported to a landfill site in Racha Thewa in Samut Prakarn, southeastward of Bangkok, while waste carried into the Nong Kaem and Tha Raeng transfer station are transported to that in Kam Paeng Saen in Nakon Pathom Province. Both landfill sites are managed by private companies.

b.2 Samut Prakarn

A private sanitary landfill site was developed and started to fill waste since 1997. The site is located in Preksa Mai, north to Bang Poo Industrial Estate. It is well designed and well managed. 12 municipalities in Samut Prakarn carry their waste into this site at about 700 to 800 tons a day. The capacity of the site is estimated to be some 3 million cubic meter. Tariff is 1,000 Baht/car for a compactor and total revenue reaches 2 million baht/month from the municipalities.

b.3 Nonthaburi

Nonhtaburi Province Sanitary Management Organization under Nonthaburi Province Administration Organization owns and operates the landfill sites common to all the municipalities in Nonthaburi. It was developed in 1985 in Amphoe Sai Noi and has the area of 68 rai (108,800 m^2) (120 rai including leachate stabilization pond). It accepts 600 to 700 tons a day at a cost of 37 Baht/ton. It has served for 17 years and is already overloaded. There is already some 2 million tons of waste and the Organization plans to remove a half of them and to close the site. The leachate pond next to the current landfill site will serve for the landfill for the next phase. The Organization plans to raise the tariff to 150 Baht for the next phase.

b.4 Pathum Thani

Being funded by the Department of Public Works, the municipality of Muang Pathum Thani has constructed a sanitary landfill site in 1998, called Waste Treatment Center, in the western part of the province. The following 6 municipalities among 13 in Pathumthani province carry their waste into this site: Muang Pathum Thani, Bang Luang, Rahaeng, Lam Luuk Ka, Prachatipat and Nong Sua. In addition, 24 Obotho, 1 center and 8 private parties also carry waste into this site. The area is 118 rai (188,800 m^2) and the capacity is 817,000. It accepts 400 tons of waste a day at a cost of 100 to 150 Baht/ton for the municipalities and 200 Baht/ton for the private parties. It was planned at the beginning to serve for 20 years only receiving waste from Muang pathum Thani but the life might be shortened because other municipalities started to use it and the waste quantity has been increasing.

For eastern part of the province, private landfill site has been constructed halfway in Tambon Muang Ku Khot, but it was stopped in 2000 due to the people's opposition.

b.5 Samut Sakhon

All 7 municipalities belonging to Samut Prakarn province carry their waste into their landfill sites. Municipality of Om Noi and Bang Pla carry their waste into the private land, while other municipalities carry waste into their own land.

3.5.3 Current Issues

a. Unclear Responsibility for Collection of Industrial Waste

Before the MOI Notification No.1 B.E.2541 (1998) was issued, the local administration was responsible for even industrial waste except for the hazardous one. The issue of this notification means that DIW is responsible for the management of industrial waste either non-hazardous or hazardous one, but in fact, the local administrations still collect non-hazardous industrial waste. In case of the BMA, the district offices collect non-HW from factories according to the said memorandum. When the agreement was made, it was expected that private companies would appear soon which collect non-HW from the factory as their business, but yet no companies appear. Therefore, the district offices are still forced to collect non-HW and it goes to the municipal landfill sites, while DIW cannot promote the participation of the private sector in the non-HW management business.

The problem is that the local administrations collect industrial waste without bearing the responsibility of non-HW management, which is retained by DIW. It may discourage the municipality's effort. It is much better to entrust responsibility to the local administration in order to encourage their collection services.

b. Illegal Dumping

It is reported that there are illegal dumping sites in some of the districts and municipalities. It is said that most of them are waste discharged by the residents in the area nearby. This might indicate that waste collection frequency for the residents is insufficient. District and municipality offices should clarify the reason why illegal dumping occurs and should take necessary measures to improve the service quality for the residents.

3.5.4 MOSTE's Policy on MWM

MOSTE has a role to direct them toward appropriate waste management by presenting policies, while BMA and the provincial authorities are the implementation organizations of MWM.

MOSTE proposed the following policy, target measure and operational models for the improvement of MWM.

a. Policy for Improved MWM

MOSTE states the policy to improve the MWM as follows.

(1) Reduce waste generation

(2) Support the local administration organizations in budgeting, personal, and technology to deal with completed flow of waste management, i.e. collection, transport and treatment

(3) Promote cooperation and coordination among local organizations to manage a central waste treatment system

(4) Encourage the formulation of rules, regulations and standards for waste management which is practicable for agencies concerned

(5) Promote and support participation of non-governmental organization and people in solving waste management problems

b. Target of Improved MWM

(1) Daily waste generation rate per capita should not exceed 1 kilogram in B.E. 2544 (2001).

(2) Rate of waste reuse and recycling should not to be less than 10 percentage and 15 percentage in B.E. 2544 (2001) and B.E. 2549 (2006) respectively.

(3) Amount of waste which is not collected in municipal area should not exceed 10 % and 5 % of total waste generation in B.E. 2544 (2001) and B.E. 2549 (2006) respectively.

(4) Every province should prepare a program to have a central facility to sanitarily treat and/or dispose of waste. The number of constructed such facilities should not be less than 50 % of total number of province in B.E. 2549 (2006) (about 38 provinces).

c. MOSTE's Action

(1) To provide local municipalities with the central waste treatment plant for many communities

(2) To promote co-investment by private sector in waste treatment and recycling

(3) To encourage the private sector to start waste management business and to monitor their operation.

(4) To apply PPP (Polluter Pays Principle)

(5) To amend laws, regulations and rules regarding with service fee

(6) To develop youth's attitude by education and campaign, and also promote people participation

(7) To provide training for government official and the private sector

(8) To support research and development of treatment system for appropriate technology in a systematic way

d. Proposed Model of the Waste Treatment Facility

MOSTE proposes to construct centralized waste treatment facility which several communities can jointly use. A model of the centralized waste treatment facility which comply with environmental and safety standards has been studied and designed by applying appropriate technology. The model is able to cope with waste generated from many communities. It also can mitigate problems that occur when the communities run the waste treatment independently.

The local organizations are expected to operate and manage the facility while the central government provides financial and technical support conforming to the following principles.

(1) The waste treatment center, regardless the number of provinces to be served, must be able to accept at least 50 % of waste generated in the area. The local administrative authorities concerned should enter an agreement which specify the minimum quantity of waste to be carried, the service fee and so on.

(2) Local administrative authorities with high ability in good waste management, for instance, the provincial governments, the municipal offices, the BMA and

Phathaya city authority, are expected to be leaders for operation and management of the centralized waste treatment facilities.

(3) Local administrative authorities in the areas where waste transfer and treatment facilities are located should have an opportunity to participate in conducting and monitoring the project and should be able to enjoy benefit of the project.

(4) The state owned land for public use has a first priority to be a land for facility location. Cost of land must be considered in a capital investment of the project.

(5) Total project cost over the whole life-time including cost for future extension should be estimated. Available financial resource should be identified for every stage of the project.

(6) Local administrative authorities involved in the project are required to have a plan of waste collection and transport. Service fee collection and its system specified in the agreement is to be incorporated to a Provincial Action Plan.

(7) Local administrative authorities who own the project should have co-investor(s) selected from private and/or non-government organizations with appropriate proportion. The selection process of co-investors and expected partnership relations are to be clearly specified in order to have co-investor(s) who can participate throughout the project life-time.

(8) Local administrative authorities involved in the project should prescribe the relevant regulation and rate of service fee to be collected which will be given to the owner of the project.

(9) Local administrative authorities involved in the project should collect the service fee efficiently.

(10) Central government agencies (i.e. the Ministry of Interior and MOSTE) and communities involved in the project should establish a working group to monitor, control and evaluate the project operations.

3.6 Public Opinion Survey

3.6.1 Objectives and Work Flow

a. Objectives

The development of a mutual trust between the public and the government is essential for the establishment of sound Industrial Waste Management (IWM). A public opinion survey was carried out to find out appropriate approaches to establish cooperative relationship between the government and the public by asking the public their opinions regarding current situations of IWM and government policies and measures. The contents of the questionnaire and target areas for the questionnaire survey are subject to the objectives described below.

1. To determine how aware the public are of environmental issues, in particular IWM;

2. To find out people's opinion about government policies and measures of IWM;

3. To examine an appropriate approaches for the government to achieve a consensus about IWM with the public.

The samples of the questionnaire survey were selected randomly from the study area in accordance with the above objectives.

It is to be noted that the survey similar to this to ask the general public opinions on the environment and industrial waste management has not been done by DIW.

b. Work Flow

The procedure of implementing public opinion survey is illustrated in Figure 3-13.

3.6.2 Preparation of the survey

a. Design of Survey

The team and DIW came to an agreement with the method and outline of survey shown as follows.

1.	Method of Survey:	interview
2.	Target of Survey:	all people of 18 years old and over in the study area
3.	Number of samples:	400 valid samples
4.	Target area:	Bangkok, Samut Prakarn, Nonthaburi, Pathum Thani, and Samut Sakhon Provinces
5.	Number of questions:	about 40 questions subjects to objectives of survey.
6.	Subjects of Survey:	(1) awareness of general environmental issues; (2) awareness of industrial waste and its management; (3) opinion about preferable countermeasures to solve problems caused by inappropriate management of IW

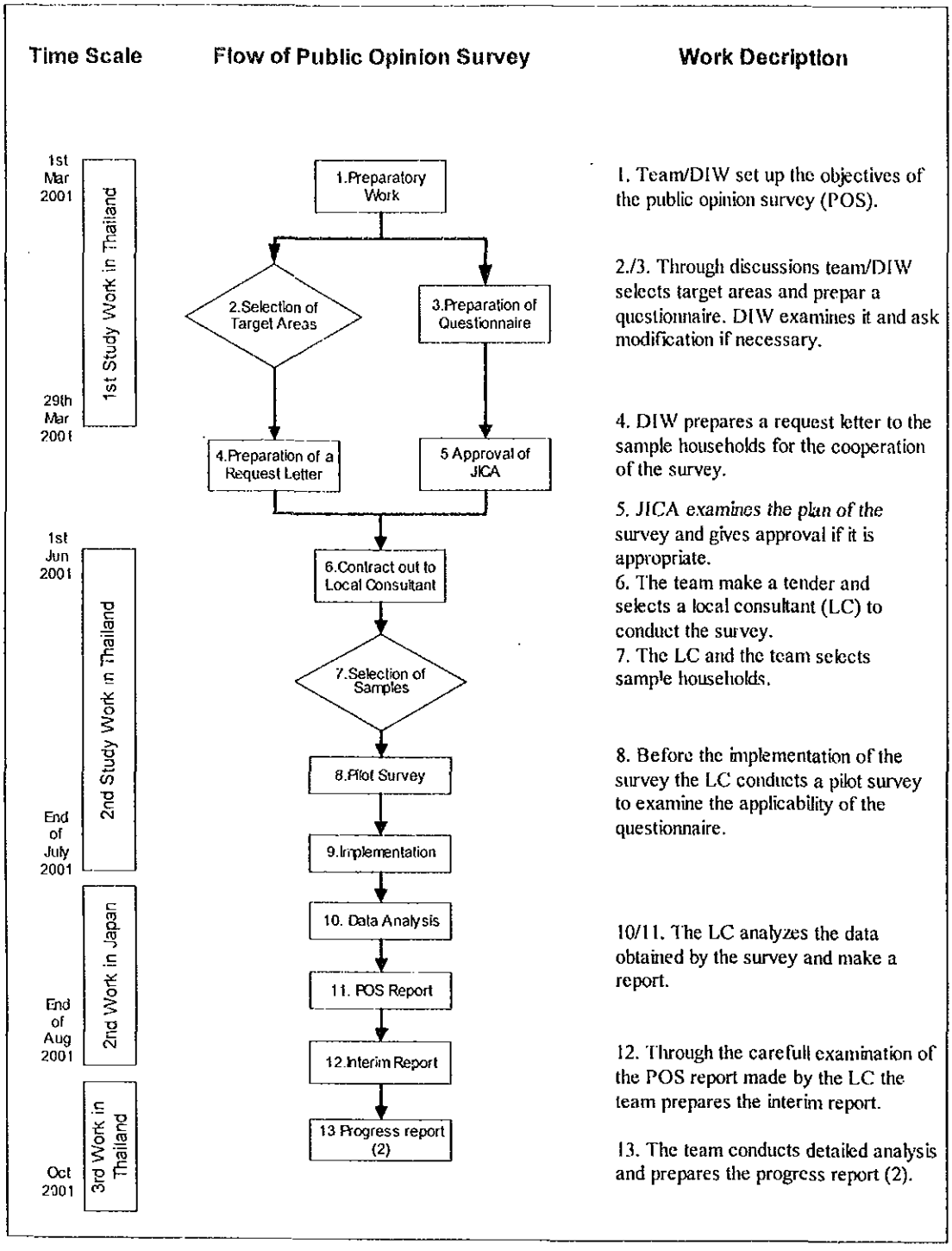


Figure 3-13: Work Flow of POS

b. Preparation of Questionnaire and Show Card

b.1 Questionnaire

The questionnaire is divided into 3 sections: (1) about general environment issues, (2) about IW and IW management, and (3) about the interviewee. The purpose and content of each section are summarized as below.

The content and expressions were modified based on the result of the pilot test and finalized in consultation with DIW. The questionnaire used in the survey is shown in Annex 3.6.

b.1.1 About Interviewee (From Q.34 to Q.42)

This section tried to gather personal information such as age, sex, and income to examine explanatory factors for the in-depth analysis.

In addition, the result was used to examine how selected samples represent the population, by comparing the distribution of samples in terms of sex, age, and income to other data, the population profile which the local subcontractor renew every year.

b.1.2 About General Environment Issues (From Q.1 to Q.12)

The primary purpose of the POS survey is to know how aware people in the study area are of IW and IW management issues. However, the questionnaire included questions about general environment issues as well as questions about IW and IW management, in order to know how much Thai people are interested in environment issues in general and what kinds of approach they prefer to solve environmental problems.

In addition, it is possible to analyze how people's awareness of environmental issues changed in the past decade, by comparing to the result of a similar public opinion surveys[5].

b.1.3 About IW and its Management

i. Awareness of IW and its Management (From Q.13 to Q.19)

The purpose of this sub-section is to know the level of knowledge people has about industrial waste and its management, setting 7 question about the term IW, the image of IW, the operation of existing waste disposal facilities, and so on.

ii. Appropriate IW Management and Countermeasures to solve problems caused by IW (From Q.20 to Q.24)

The aim of this sub-section is to know how much people grasp current problems caused by industrial wastes and what kinds of countermeasures people think should be taken to solve these problems.

iii. Waste Minimization (From Q.25 to Q.28)

The Thai government tries to promote reuse and recycle of IW, emphasizing the importance of waste minimization. This sub-section asks questions about current situations of reuse/recycle of IW and the government program in order to know how much people are aware of alternatives to treatment/disposal of IW, such as recycle and reuse of waste, and the government program to reduce the volume of industrial waste.

[5] The previous survey the team referred most is the public opinion survey on environment awareness conducted by Institute of developing economies, Japan, in 1994.

iv. Cost of Industrial Waste Management and those who bear the cost (From Q. 29 to Q.30)

This sub-section tries to know how much people agree that the appropriate IWM ends up with the increase in price of goods.

v. Establishment of Industrial Waste Treatment/Disposal Facilities (Q.31 to Q.33)

This sub-section asks about conditions to agree with the construction of new IW disposal facilities in order to know how people think about establishment of waste treatment/disposal facilities, current government policies and its approaches.

b.2 Show Card

For the interview survey, collection of answer lists, called Show Card, was prepared along with the questionnaire sheet. On the show card, are the lists of answers to each question, and at the time of interview, each interviewer showed the list of answers to the interviewee, while reading aloud questions slowly, so that the interviewee could ponder each question before choosing the most appropriate answer.

In this survey, the request letter issued by DIW was not sent in advance. In stead, the letter was printed on the first page of the show card, and at the time of interview survey, each interviewee decided to cooperate with the survey or not after reading the letter.

c. Sampling

c.1 Sampling Method

Sampling was one of the most crucial parts of the survey procedure. The team aimed to achieve the interval estimation of 5% with the confidence level of 90%. It is, however, a very difficult task with 400 samples because, unlike in Japan, there were no lists which cover the whole population in the study area. It can be said that 400 samples are the minimum number of samples to achieve the interval estimation of 5% with the confidence level of 90% by the one-stage random sampling. Usual method such as 2-stage or 3-stage random sampling method was not appropriate for this survey.

Due to such difficulty, not individuals but households were to be selected. In consultation with a statistician of the local subcontractor, ACNielsen, which won the team's tender for this survey, the team decided to adopt the 3-stage sampling method, 2-stage random sampling plus proportionate sampling, by using the Population Profile and detailed residence map which ACNielsen renews every year.

- First Stage: randomly select 56 Primary Sampling Units (PSUs). There are 100 Dwelling Units in each PSU.
- Second Stage: randomly select about 30 Dwelling Units (DUs) from each selected PSU.
- Third Stage: select the target respondents from each selected DU based on the population profile, conducted simultaneously with interview survey (Proportionate Sampling)

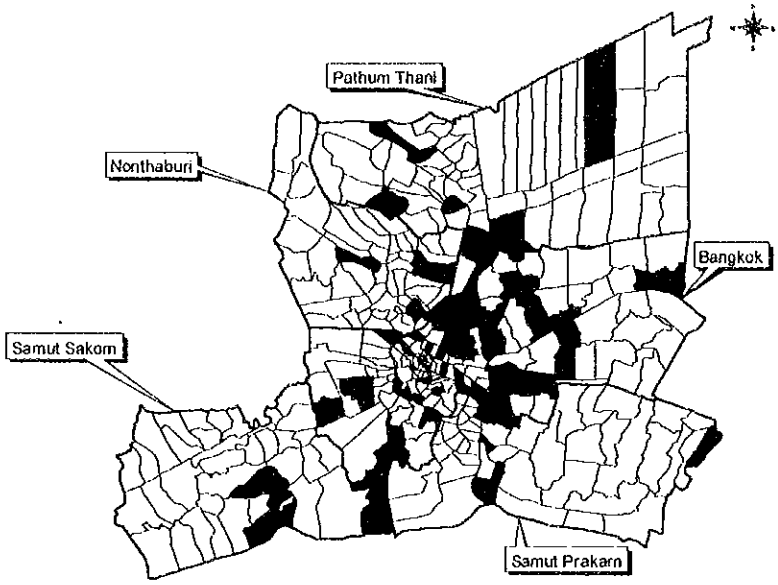


Figure 3-14: Districts where PSUs are located

As mentioned above, it is very difficult to select individuals randomly, because there are no lists such as the residence register in Japan. Therefore, in this survey households (DUs) were the target of random sampling. After the second stage sampling, 1,427 Dwelling Units were selected, including over samples, considering rejection or absence of interviewees.

The target respondents were selected during the period of the interview survey by interviewers from randomly selected households (DUs), but the selection of targets was strictly controlled by the responsible person of the local subcontractor, considering the distribution of the population in the study area in terms of sex and age and income, which are shown in the Population Profile of ACNielsen (Figure 3-16). During the period of interview survey, each interviewer was given an instruction about selection of target person from the responsible person according to the progress of the survey. The interview survey continues until the total number of sample who accepted interview reached 400.

3.6.3 Execution of the Survey

a. Recruitment of Interviewers

Twenty interviewers were arranged by ACNielsen from its list of interviewers. A briefing was arranged to provide an instruction to interviewers.

b. Sample Survey

The interview survey was conducted from July 17, 2001 to August 3, 2001. To guarantee the quality of survey, the following measures were taken.

- Setting rules for the sample survey.

If the target person is not at home, interviewers should visit at least three more times to reach to the person in the areas of upper income class and at least two more times in other areas.

- Quality Control Measures

The staff of the subcontractor witnesses the interviews regularly, check the progress of the survey, and so on.

- Control of samples from a statistical point of view

To make sure that the final distribution of samples is the same as the distribution of the population, the progress of the survey is checked time to time.

At the end of the interview survey, the local survey team obtained 410 valid samples, which show the similar distribution to that of the population in the study area, in terms of sex, age, and monthly household income.

3.6.4 Findings

At first, to evaluate the samples, the team analyzed the result of questions about interviewees, comparing to the Population Profile of ACNielsen.

Then, the team conducted the cross sectional analysis of the result of survey by age, sex, income, and educational background. The result of the cross sectional analysis showed that the educational background is the most decisive factor in many of the questions in the questionnaire. In this report, the result of survey was analyzed paying more attention to the educational factor.

People with higher educational background tend to be more interested in environmental issues, evaluate the current environmental situations stricter, and be more critical about government policies and measures. Since the ratio of people who go on to university is expected to continue to increase and people in general are expected to be more aware of environment issues in the future, it can be said that the opinion of the group with bachelor degree or higher can be used to expect future trend of public opinion about industrial waste and its management.

a. About Interviewees

The number of valid responds was 410. The distribution of respondents in terms of sex, age as well as monthly household is shown in Table 3-27 and Figure 3-15, while the distribution of the population in the study area obtained from the Population Profile is shown in Figure 3-16.

Table 3-27: Distribution of Respondents (Sex and Age)

Age	Male		Female		Total	
	Sample	Share	Sample	Share	Sample	Share
18-24	34	17%	34	16%	68	17%
25-29	30	15%	30	14%	60	15%
30-39	54	27%	59	29%	113	28%
40-49	41	20%	46	22%	87	21%
50 and older	44	22%	38	18%	82	20%
Total	203		207		410	

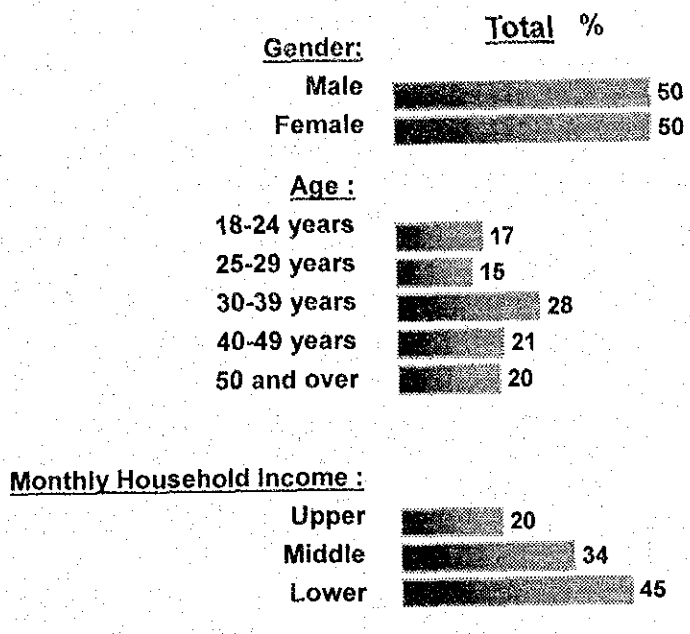


Figure 3-15: Distributions of Samples (Sex, Age and Income)

Gender

Male:	50%
Female:	50%

Age

18-24:	17%
25-29:	15%
30-39:	28%
40-49:	21%
50 or older:	20%

Household Income		Greater Bangkok	Samuthsakorn
Lower	45%	Less than 20,000 baht	Less than 10,000 baht
Middle	34%	20,000-39,999 baht	10,000-24,999 baht
Upper	20%	40,000 baht or more	25,000 baht or more

Figure 3-16: Distribution of Population from ACNielsen Media Index 2001

The distribution of respondents by area and educational background are shown in Table 3-28 and Table 3-29 respectively.

Table 3-28: Distribution of Respondents (2)

Area	Number of Samples	Share
BKK	235	57%
PATHUMTHANI	25	6%
NONTHABURI	50	12%
SAMUTPRAKAN	70	17%
SAMUTSAKORN	30	7%
Total	410	

Table 3-29: Distribution of Respondents (3)

Educational Background	Number of Samples	Share
Elementary School	124	30%
Junior High School	56	14%
High School	137	33%
Bachelor Degree or Higher	93	23%
Total	410	

There were a few questions about the life style of interviewees. The result of the question about possessions such as car and electric appliances is shown as bellows. Almost all the households in this survey have TV and refrigerator, and about half the households have car or motorbike. More than 70% of households who belong to the upper income group have air conditioner.

Table 3-30: List of Possessions

	Total	Upper Income	Middle Income	Lower Income
Car	49%	85%	55%	27%
Motorbike	45%	39%	53%	42%
TV	99%	99%	99%	99%
Video deck	75%	90%	85%	60%
Telephone (or Cellular phone)	79%	100%	82%	68%
Air conditioner	40%	76%	44%	19%
Refrigerator	94%	100%	97%	89%
Washing machine	62%	83%	71%	45%

b. Environment Awareness

b.1 Current Environment Situations

For people in the Bangkok Metropolitan area, pollution issues are not the primary problem, as shown in Figure 3-17. Due to the economic stagnation after the financial crisis in 1997 and the penetration of drug to young Thai people in the 1990s, environment problems became relatively smaller issues in the Thai society, but

people still keep a great interest in environment issues, as shown in Figure 3-18. Most of respondents (94%) are interested in environmental issue in some degree. The highly educated respondents are relatively more interested in this issue.

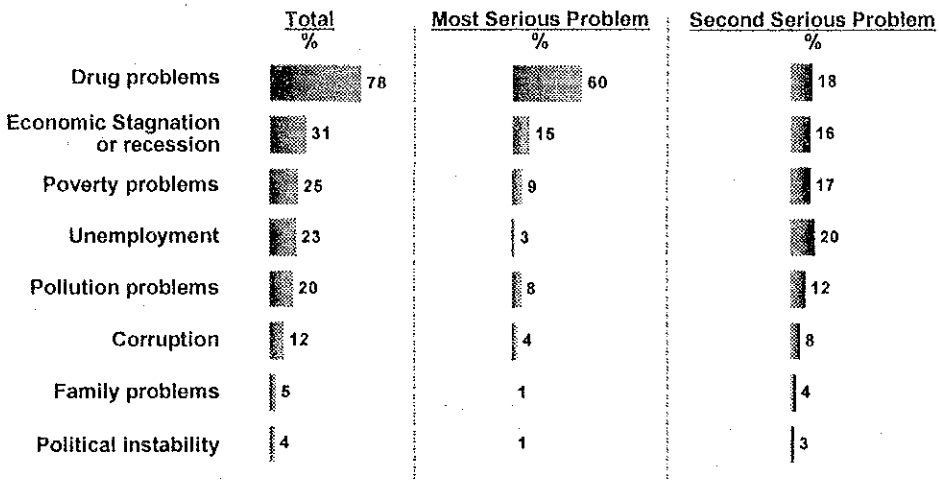


Figure 3-17: Problems in Thai Society (Q.1)

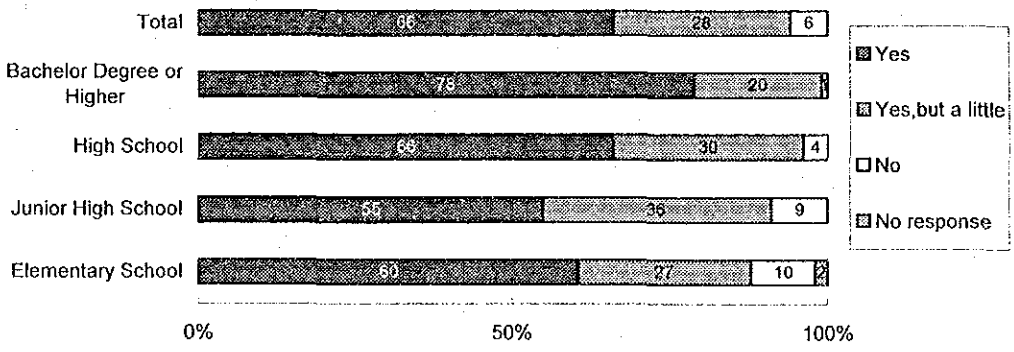
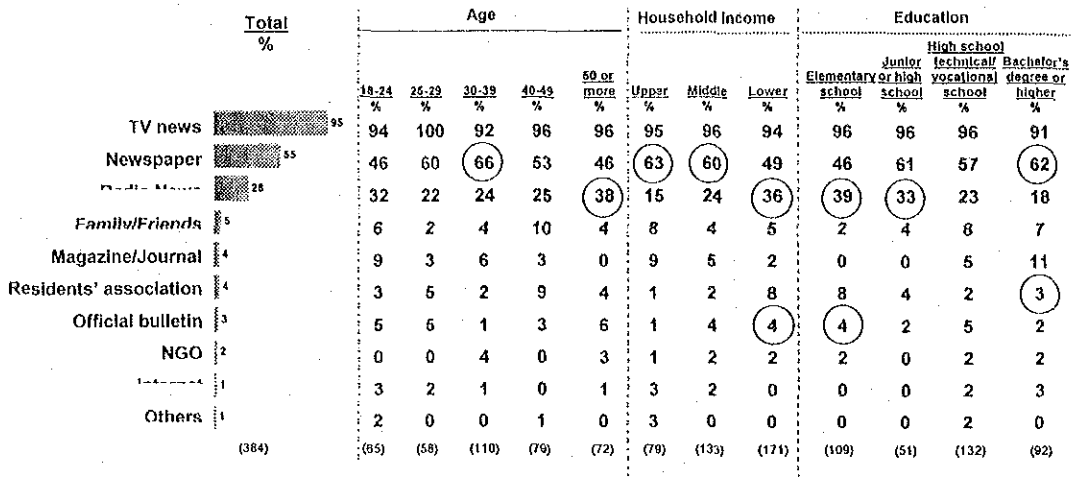


Figure 3-18: Interest in Environment Issues (Q.2-1)

Figure 3-19 shows that the main sources of information on environment issues are TV news and Newspaper. Radio news is popular among older people with lower income and education whereas newspaper is more common among middle/upper income and higher educated group.



	Total %	Age					Household Income			Education			
		18-24 %	25-29 %	30-39 %	40-49 %	50 or more %	Upper %	Middle %	Lower %	Elementary school %	Junior or high school %	High school (technical/ vocational) school %	Bachelor's degree or higher %
TV news	95	94	100	92	96	96	95	96	94	96	96	96	91
Newspaper	55	46	60	66	53	46	63	60	49	46	61	57	62
[illegible]	28	32	22	24	25	38	15	24	36	39	33	23	18
Family/Friends	5	6	2	4	10	4	8	4	5	2	4	8	7
Magazine/Journal	4	9	3	6	3	0	9	5	2	0	0	5	11
Residents' association	4	3	5	2	9	4	1	2	8	8	4	2	3
Official bulletin	3	5	5	1	3	6	1	4	4	4	2	5	2
NGO	2	0	0	4	0	3	1	2	2	2	0	2	2
[illegible]	1	3	2	1	0	1	3	2	0	0	0	2	3
Others	1	2	0	0	1	0	3	0	0	0	0	2	0
	(384)	(65)	(58)	(110)	(79)	(72)	(79)	(133)	(171)	(109)	(51)	(132)	(92)

Figure 3-19: Sources of Information of Environment Issues (Q.2-2)

Regarding environment problems, people living in Bangkok and its surrounding area mentioned that air pollution and deforestation are the top 2 problems with significantly higher seriousness level than other problems, as similar to the previous study "Environmental Awareness in Asia: Cases in Thailand and China" conducted by Institute of Developing Economies in 1994. Solid waste formed the second group along with water pollution and flood problems.

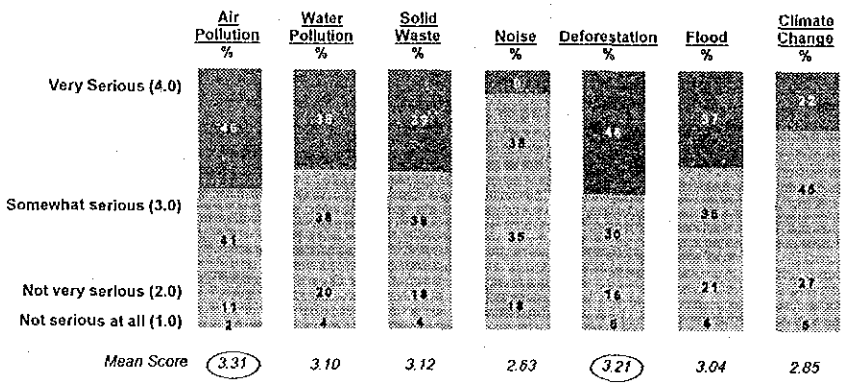


Figure 3-20: Seriousness of Environment Problems (Q.3)

More than 90% of respondents admitted that environment problems affected their life, as shown in Figure 3-21, but the ratio of person who answered "Environment problems causes serious problems" was 39%, lower than the previous study in 1994, 61%. Respondents with higher education tend to feel that environment degradation causes serious problems.

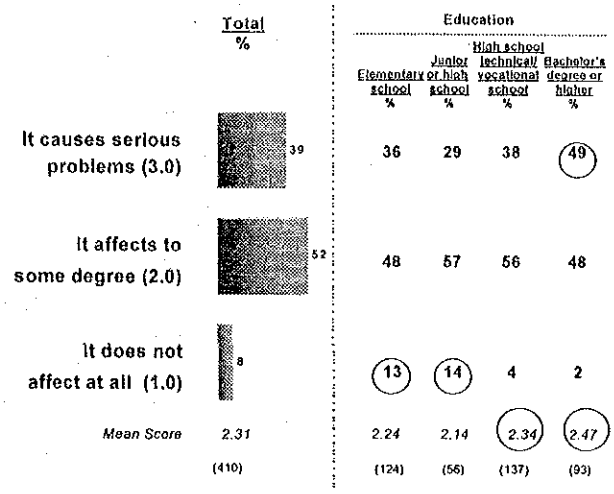


Figure 3-21: Effect from Environment Degradation (Q.4)

b.2 Environment Conservation From Economic Point of View

Compared to the result of the study in 1994, which asked the same question but presented smaller number of answers[6], the ratio of respondents who chose "environment conservation is more important" decreased from 59% to 14%, while the ratio of respondents who chose "both are equally important" and "economic development is more important" increased from 14% to 47% and from 25% to 38% respectively. Due to the current economic difficulties, people tend to be more concerned about economic development rather than environment conservation.

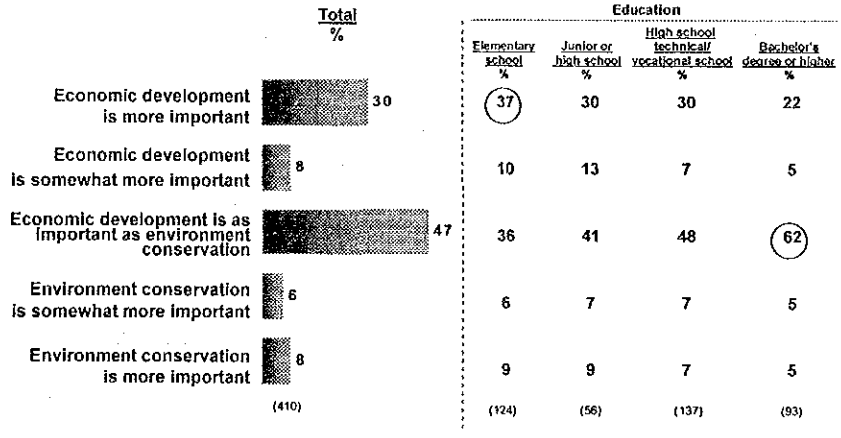


Figure 3-22: Environment Conservation VS Economic Development (Q.5)

[6] The number of answers shown in the questionnaire was only 3; (1) economic development is more important; (2) environment conservation is more important; and (3) both are equally important.

As for the Environment Conservation tax, about half of respondents agree on Environment Conservation tax. The older (40 or more) seem to disagree more than other age groups as shown in Figure 3-23.

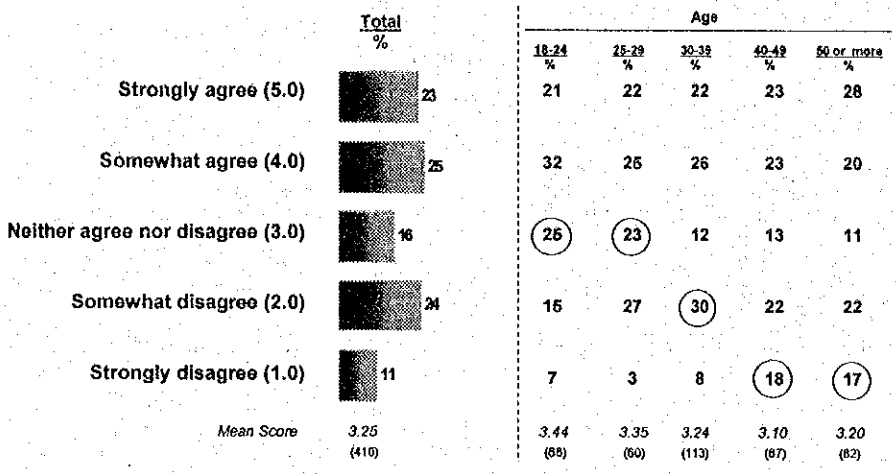


Figure 3-23: Opinion on Environment Conservation Tax (Q.6)

Almost all of the respondents (403 samples) save water and energy in some degree, and 60% of respondents try to always save water and energy as shown in Figure 3-24.

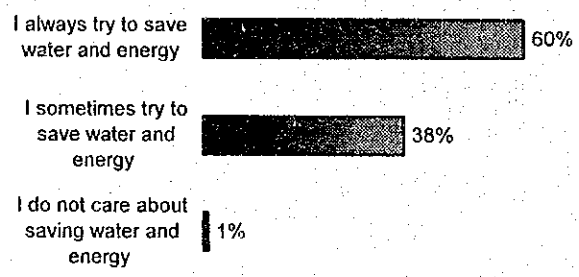


Figure 3-24: Habit of Saving Water and Energy (Q.7-1)

Figure 3-25 shows that the lower income group saves water and energy mainly because of economic reason. On the other hand, the well-educated upper income group takes environment into consideration.

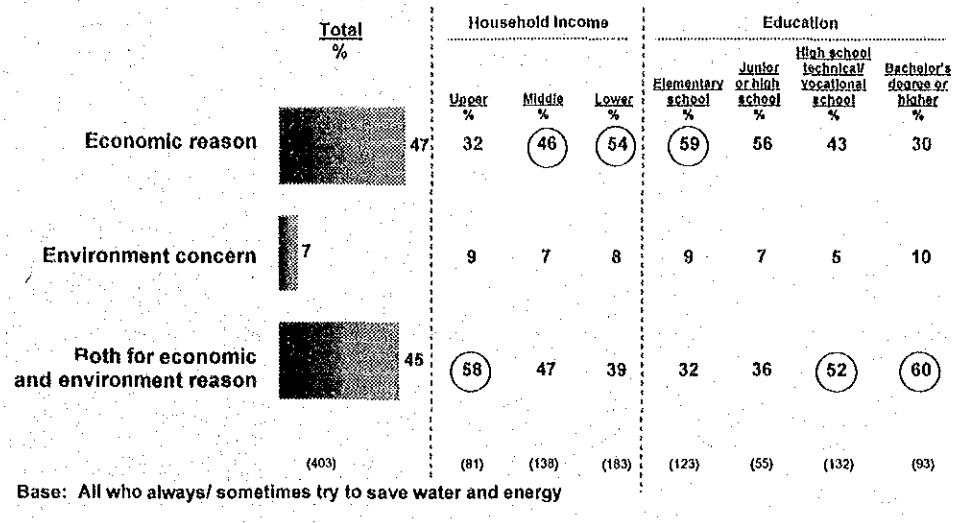


Figure 3-25: Reasons for Saving Water and Energy (Q.7-2)

b.3 Sources of Pollution and Countermeasures

As for the main source of air pollutants, 51% of respondents chose automobile, while 46% of respondents mentioned industries as the main source, shown in Figure 3-26. Majority of respondents indicated industry and household as main pollutant sources of water pollution and solid waste respectively. Since it is said that the main source of water pollutants is wastewater form household and generation source of solid waste is industry[7], recognition of many respondents is not right.

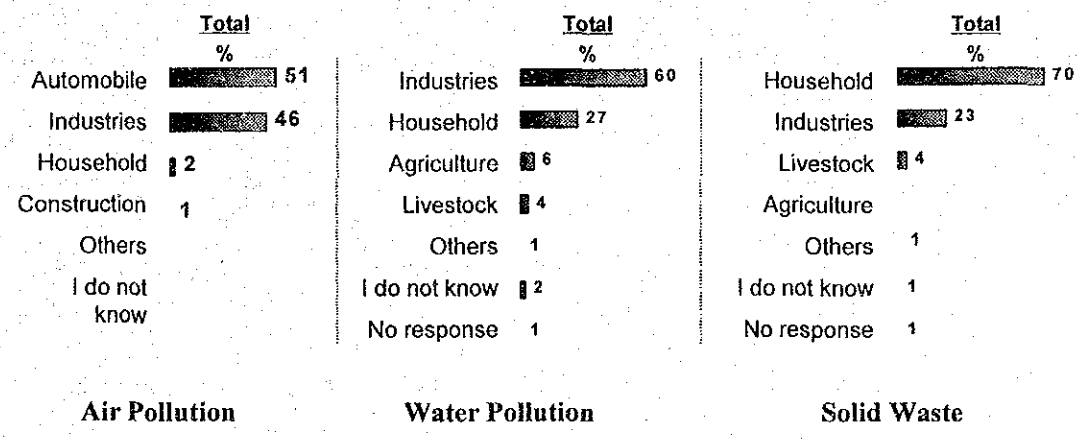


Figure 3-26: Source of Pollution (Q.8)

[7] Air pollution in the Bangkok metropolitan area is largely due to exhaust emission from motor vehicles, while the principal source of water pollution is the inflow of untreated household wastewater. According to "Overseas Environmental Measures of Japanese Companies (Thailand)" published by Global Environment Forum in March, 1999, it has been calculated that 75% of pollutant in the Chao Phraya River in terms of BOD loads comes from residential and commercial facilities, while remaining 25% is from industrial wastewater. On the other hand, only 22% of hazardous waste is generated from households and other business facilities such as gas stations, car cares, and hospitals, while 78% of hazardous waste are produced from industries (Pollution Control Department, Annual Report 1999).

Among 7 organizations including the central and local government, news media and NGOs, the central government and Thai NGO were regarded as the most reliable organizations in the field of environment issues, shown in Figure 3-27.

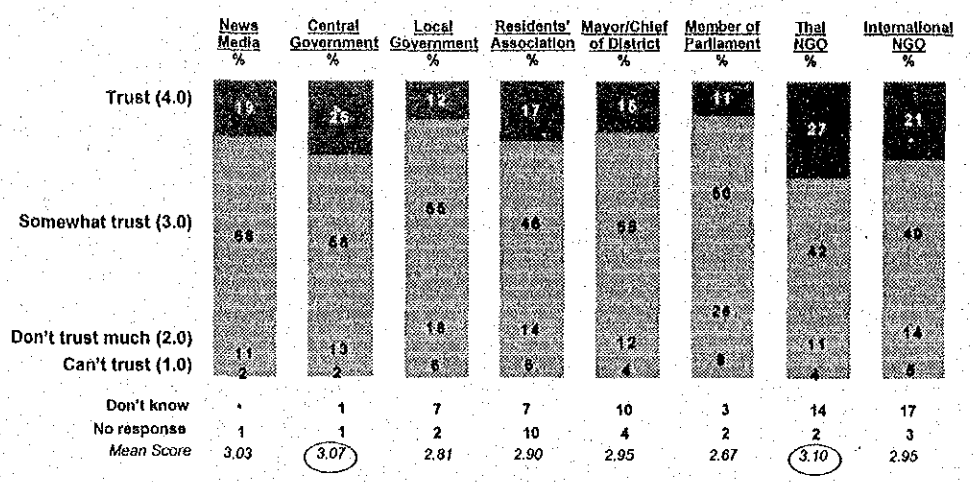


Figure 3-27: Reliability Rating of Organizations (Q.9)

To the question about obedience of environment regulation, the number of respondents who replied "Environment regulations are observed" and "Environment regulations are not observed" were almost the same. However, well-educated group tend to evaluate that environment regulations are not observed.

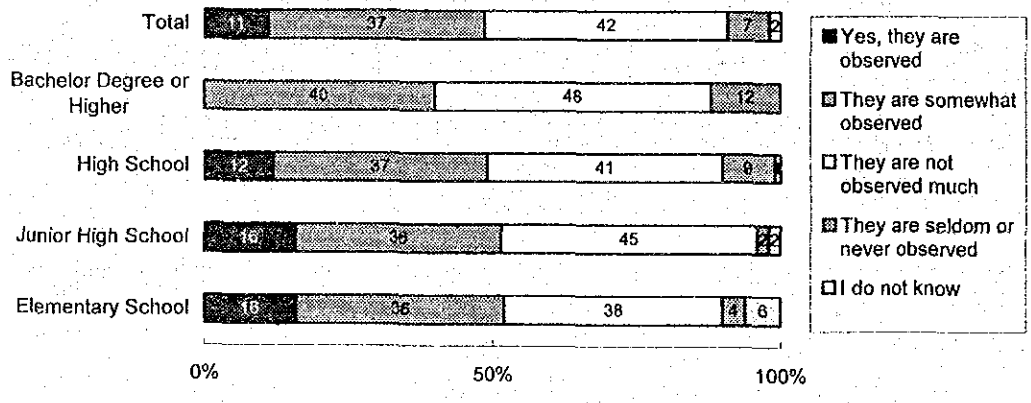


Figure 3-28: Whether Environment Regulations are Observed (Q.10)

Among the respondents who replied "Environment regulations are not observed much" (173 samples) or "Environment regulations are seldom or never observed" (30 samples), 64% chose "to tighten of control and increase in penalty by the Thai government" as the most effective measures to make regulations observed, as shown in Figure 3-29. Compared to the previous study in 1994, people tend to think that the government role to tighten its control on pollution problems, rather than public awareness of environment issues, is more critical to improve environment.

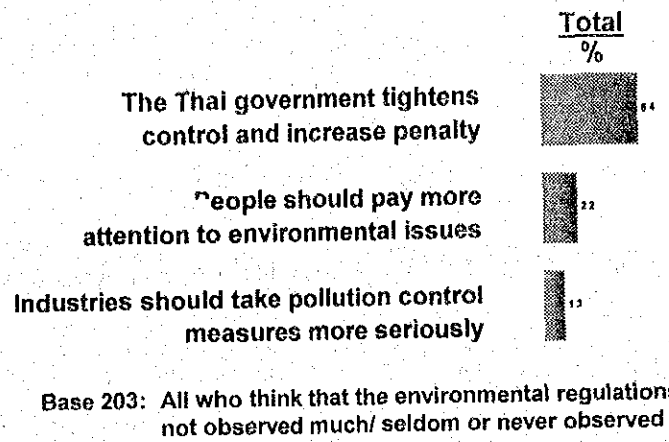


Figure 3-29: Most Effective Measures to Make Regulations Observed (Q.11)

Regarding the role of the government to improve environment (multiple answers up to 3), 58% of respondents wanted the government to tighten its control and increase penalty.

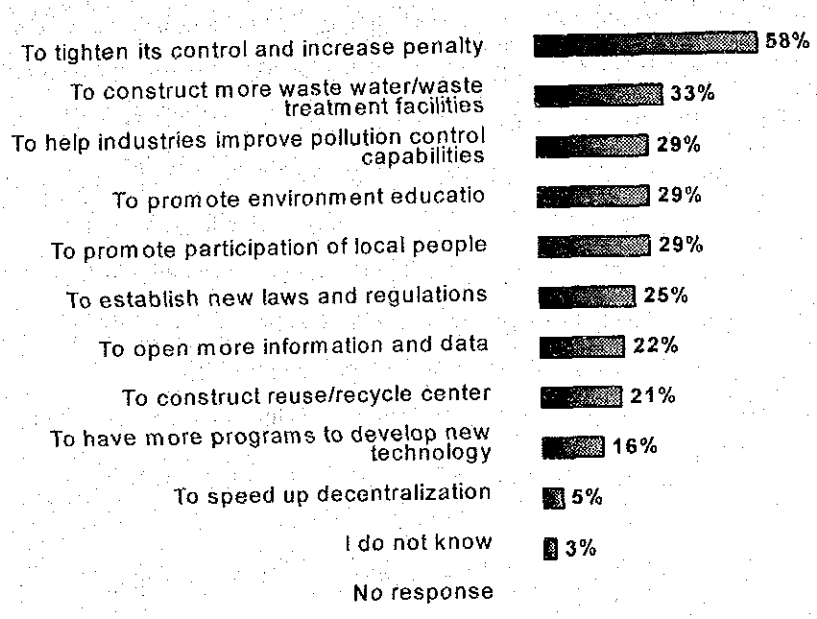


Figure 3-30: Things to Be Done by the Government to Improve Environment (Q.12)

c. IW and IW Management

c.1 Awareness of IW and its Management

More than 80% of respondents have often or sometimes heard IW, as shown in Figure 3-31. In the case of people with Bachelor degree or higher, the ratio was more than 90%.

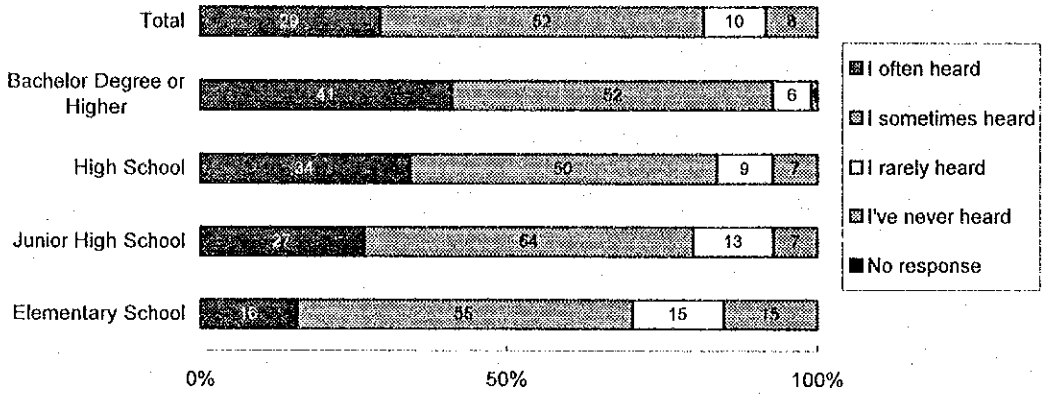
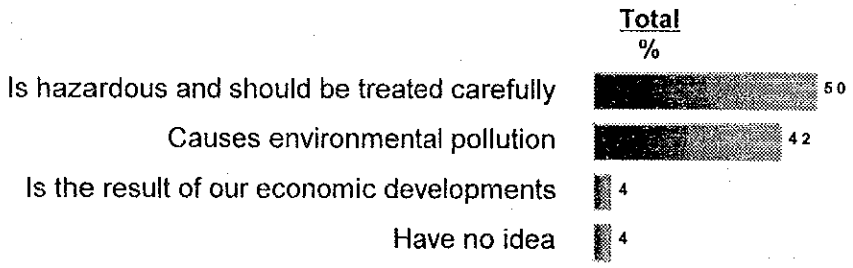


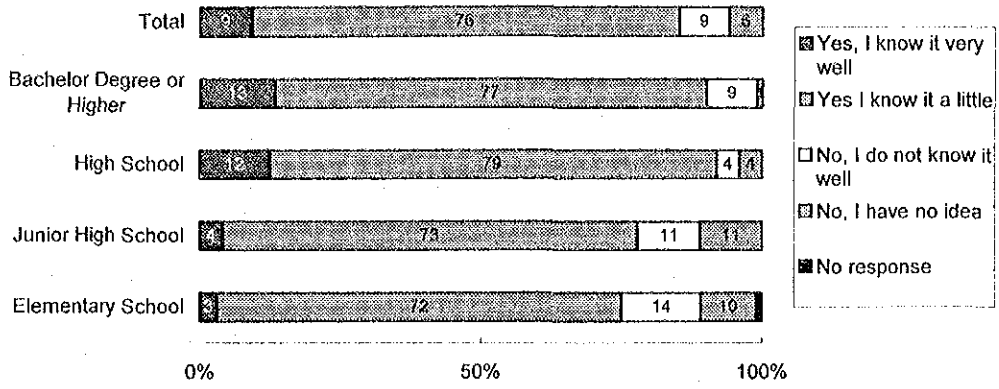
Figure 3-31: Awareness of Industrial Waste (Q.13)

In addition, the image of IW was very negative. This could be attributed to the active media reports on pollution problems caused by IW. The result of Q. 15, however, indicates that the level of knowledge on IW and IW management was not high, as shown in Figure 3-33.



Base: All who often/sometimes heard about industrial waste (334 samples)

Figure 3-32: Image About Industrial Waste (Q.14)



Base: All who often/sometimes heard about industrial waste (334 samples)

Figure 3-33: Knowledge About Industrial Waste (Q.15)

More than 70% of respondents think that existing IW treatment and disposal facilities are not operated properly and cause minor or serious environment problems. In particular, about half of respondents with Bachelor degree or higher think that the operation of existing IW treatment and disposal facilities cause serious environment problems as shown in Figure 3-34.

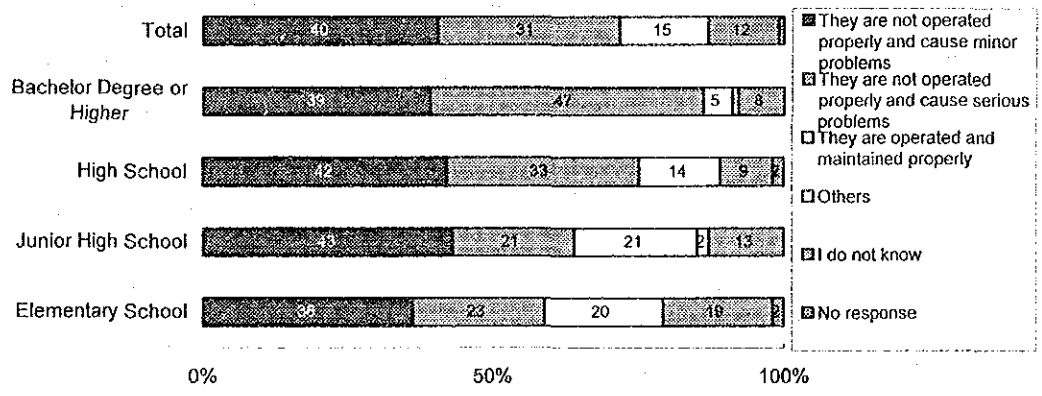
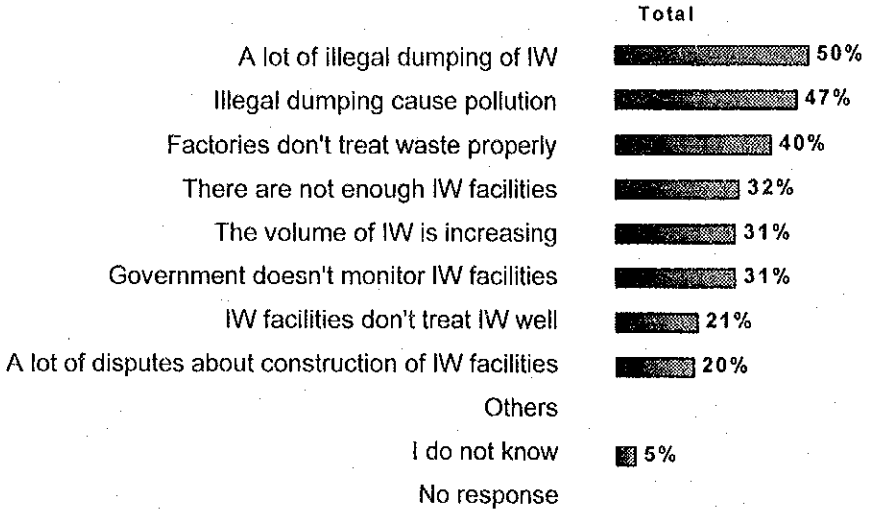


Figure 3-34: Operation of Industrial Waste Treatment And Disposal Facilities in Bangkok And Vicinity (Q.18)

Among problems related to IW that were obtained from news media such as TV news and newspaper, Illegal dumping and problems caused by illegal dumping are the most common problems. In addition, the higher educated group is more aware of problems related to IW in general, as shown in



Multiple Answers (to select all answers that respondents know)

Table 3-31.

Figure 3-35: Industrial Waste Problem Known from Media (Q.19)

Table 3-31: Industrial Waste Problem Known from Media

	Elementary School	Junior High School	High School	Bachelor or Higher
A lot of illegal dumping of IW	47%	45%	47%	62%
Illegal dumping cause pollution	35%	50%	50%	58%
Factories don't treat waste properly	36%	38%	43%	41%
There are not enough IW facilities	24%	29%	34%	41%
The volume of IW is increasing	23%	38%	33%	37%
Government doesn't monitor IW facilities	26%	30%	28%	43%
IW facilities don't treat IW well	19%	20%	22%	25%
A lot of disputes about construction of IW facilities	15%	11%	24%	28%
Others	0%	0%	1%	0%
I do not know	12%	0%	4%	0%
No response	1%	0%	0%	0%

c.2 Appropriate Management and countermeasures to solve problems caused by IW

Illegal dumping of IW is regarded as a cause of pollution, as shown in Figure 3-36. In particular, the younger generation and higher educated person felt that it caused serious problems.

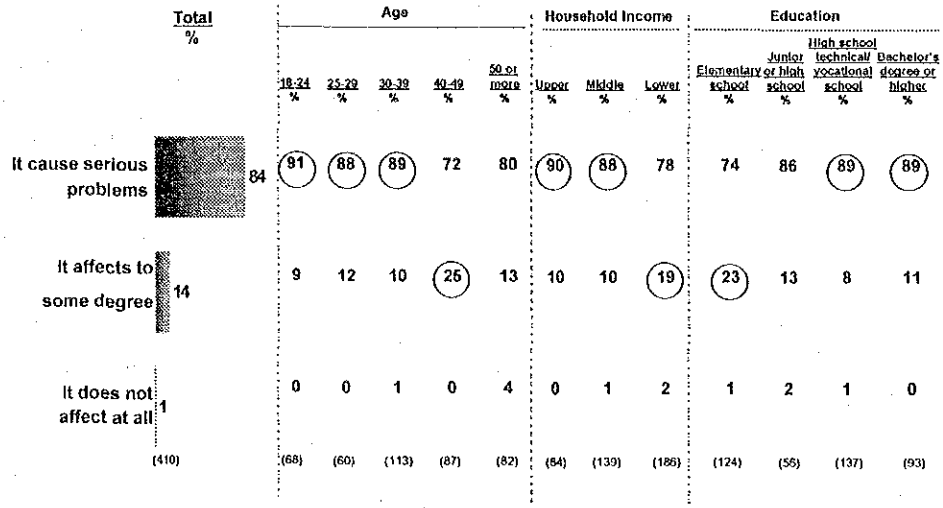


Figure 3-36: Effect of Illegal Dumping to Environment (Q.20)

Among those who admitted that illegal dumping of IW affected environment (402 samples), about 70% of respondents think that the government should tighten its control and increase penalty to prevent illegal dumping.

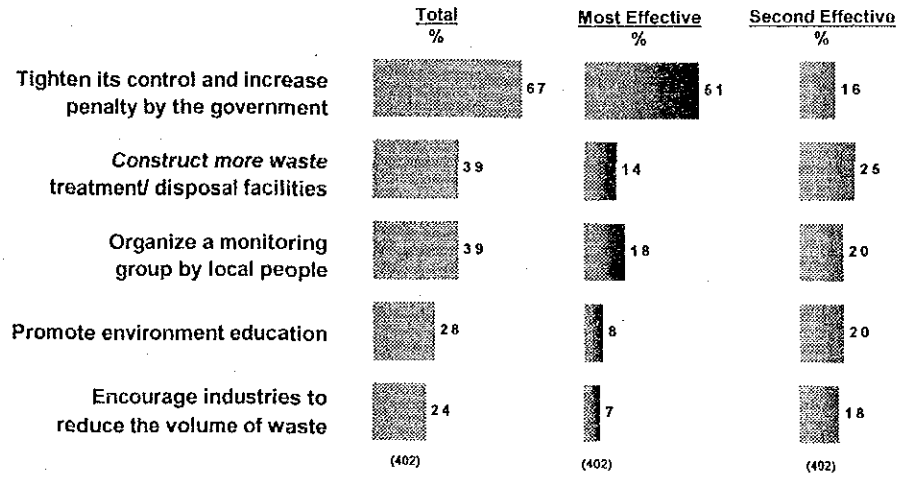


Figure 3-37: Solution to Illegal Dumping of Industrial Waste (Q.21)

More than 60% of respondents agree that it is urgent issues to construct new IW treatment/disposal facilities in Thailand. High-educated group tend to agree with construction plan of new facilities conditionally.

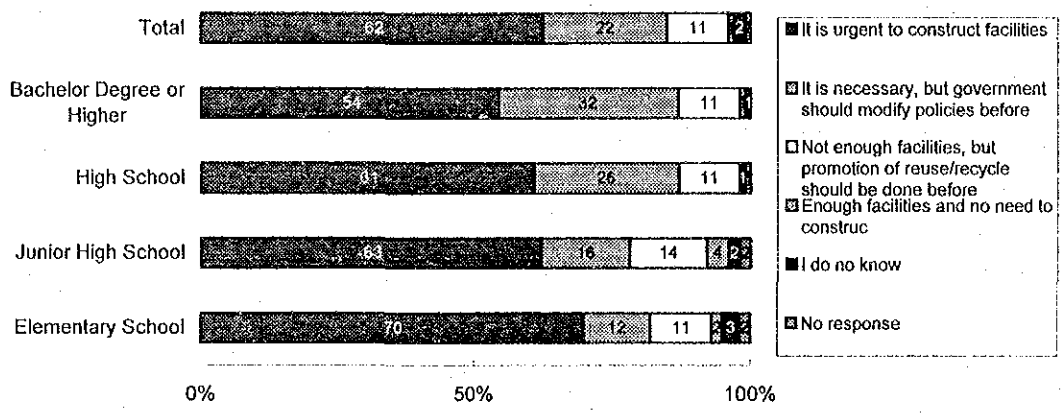
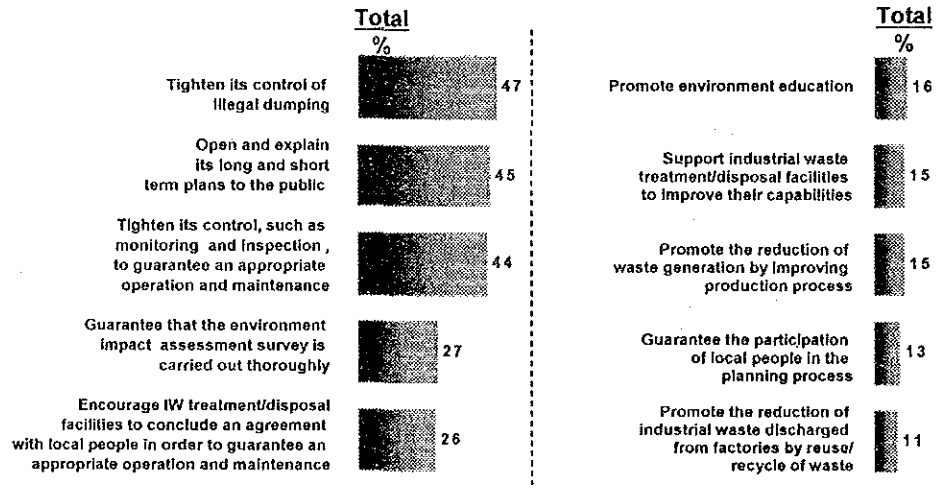


Figure 3-38: Opinion about Construction of New Industrial Waste Treatment/Disposal Facilities (Q.22)

Among those who agreed with the necessity of new facilities conditionally (89 samples), about half the group requires the government to tighten its control on illegal dumping (multiple answers up to 3). To reveal the plan is the second largest number of opinion.



Base: All who answer necessary to construct new facilities, but should modify current policies and measures before construct new facilities (89)

Figure 3-39: Policies Should Be Issued before Approval of New Facility Construction (Q.23)

A lot of cases in which local people are against the construction plan of IW or municipal waste treatment/disposal facilities are reported in the news media. There were not any dominant opinions as a reason for these disputes (multiple answers up to 3).

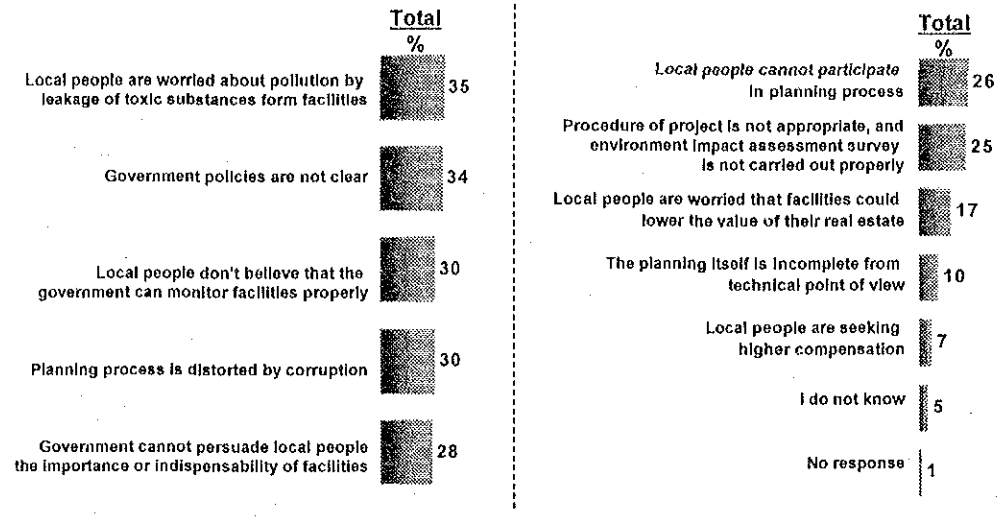


Figure 3-40: Reasons for Disputes over Construction Plan of Industrial Waste Treatment/Disposal Facility (Q.24)

c.3 Waste Minimization

Waste minimization by reuse or recycle of IW was commonly heard. In particular, the group with higher educational background have more often heard of it, as shown in Figure 3-41.

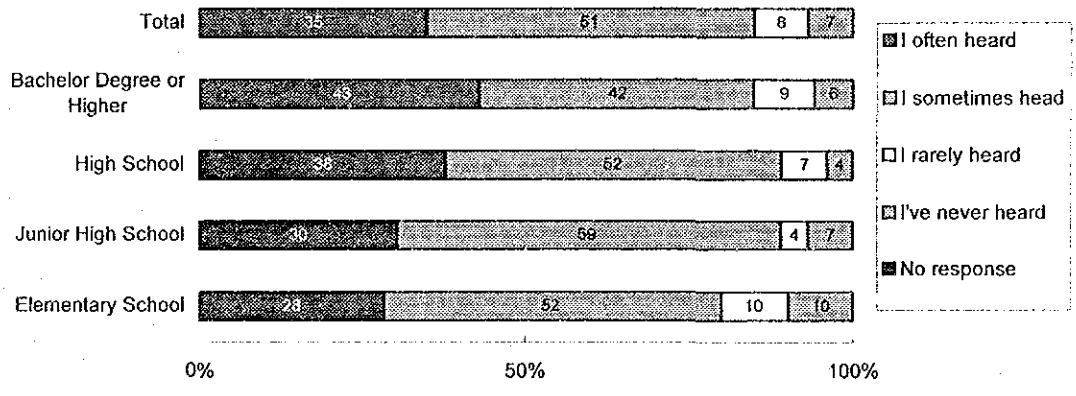


Figure 3-41: Awareness of Measures to Reduce The Volume of Industrial Waste from Factories (Q.25)

Among waste minimization measures, reuse of IW is the most well known measure. 70% of those who often/sometime heard about measures to reduce the volume of IW generated in factories (352 samples) knew reuse of IW.

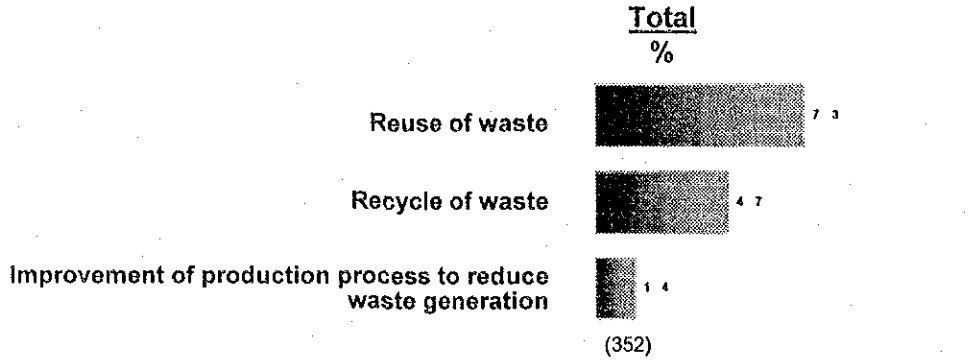


Figure 3-42: Measures Known (Q.26)

About 60% of respondents have heard the government program to promote reuse/recycle of IW. Most of them got to know the program through TV news, radio news or newspaper.

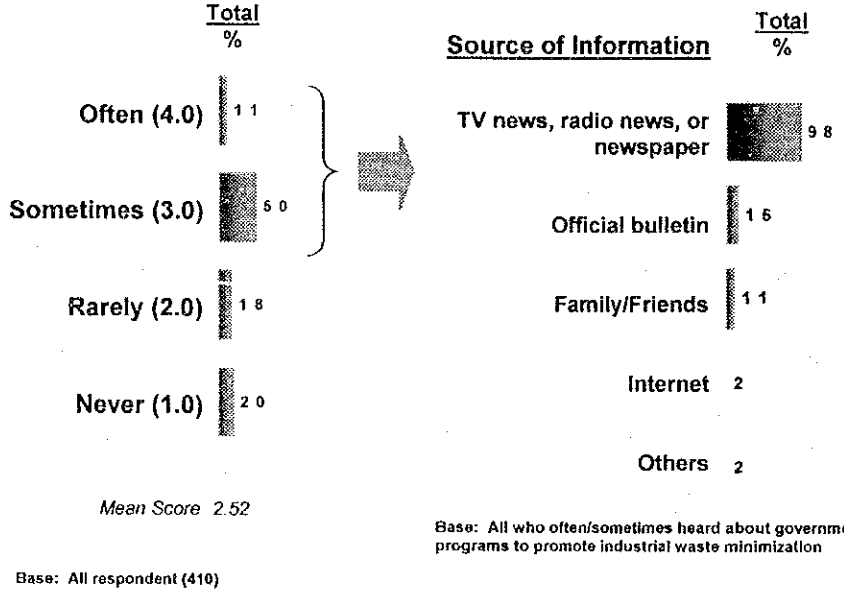


Figure 3-43 Awareness of Government Programs to Promote Industrial Waste Minimization (Q.27 and Q.28)

c.4 Cost of Industrial Waste Management and those who bear the cost

Even though, respondents expressed their concern about illegal dumping of IW, majority of them agree to some degree that industry pay enough attentions and bear the enough cost to treat /dispose of IW.

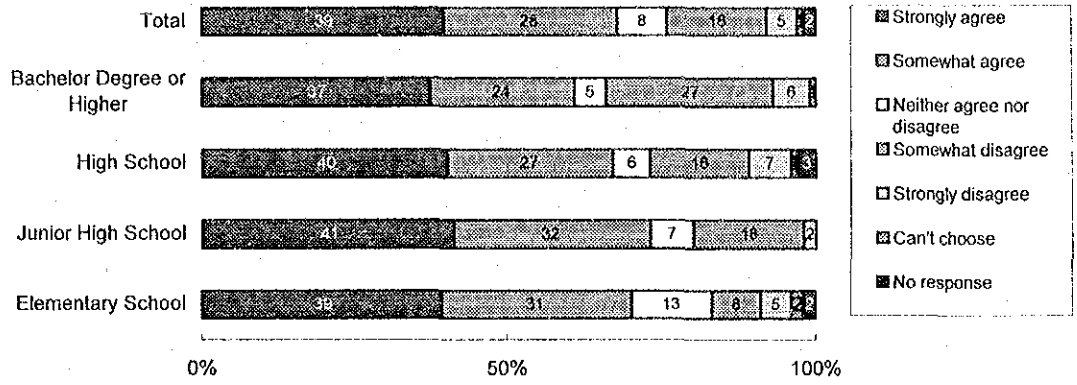


Figure 3-44: Agree-Disagree Rating on "Industry Pays Enough Attentions And Bear Enough Cost to Treat/Dispose of Industrial Waste" (Q.29)

Only half of respondents accepted that appropriated management of industrial wastes ended up with the increase in the product price. The willingness level is significantly high among higher educated group.

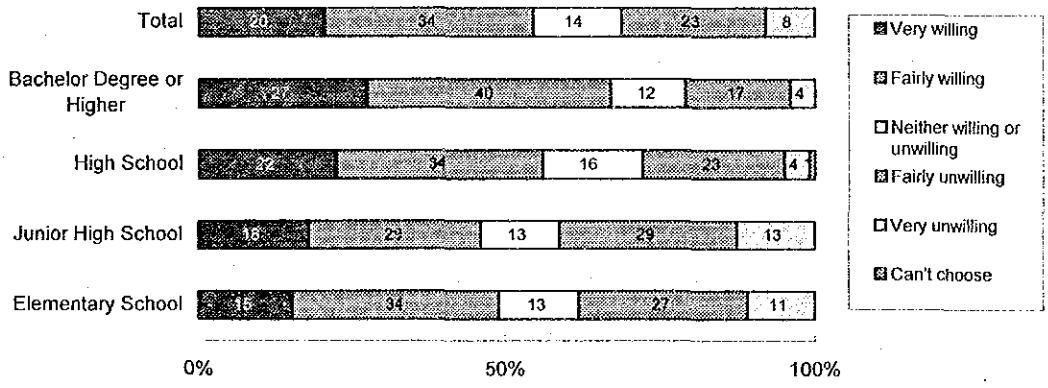


Figure 3-45: Willingness to Pay Higher if Waste Management Causes Higher Product Price (Q.30)

c.5 Establishment of Industrial Waste Treatment/Disposal Facilities

To the question about conditions which respondent want to set in order to accept the construction plan of IW or municipal waste treatment/disposal facilities in their district (multiple answers, select all that respondents agree with), participation in the

planning process and careful site-selection were chosen as the most important conditions.

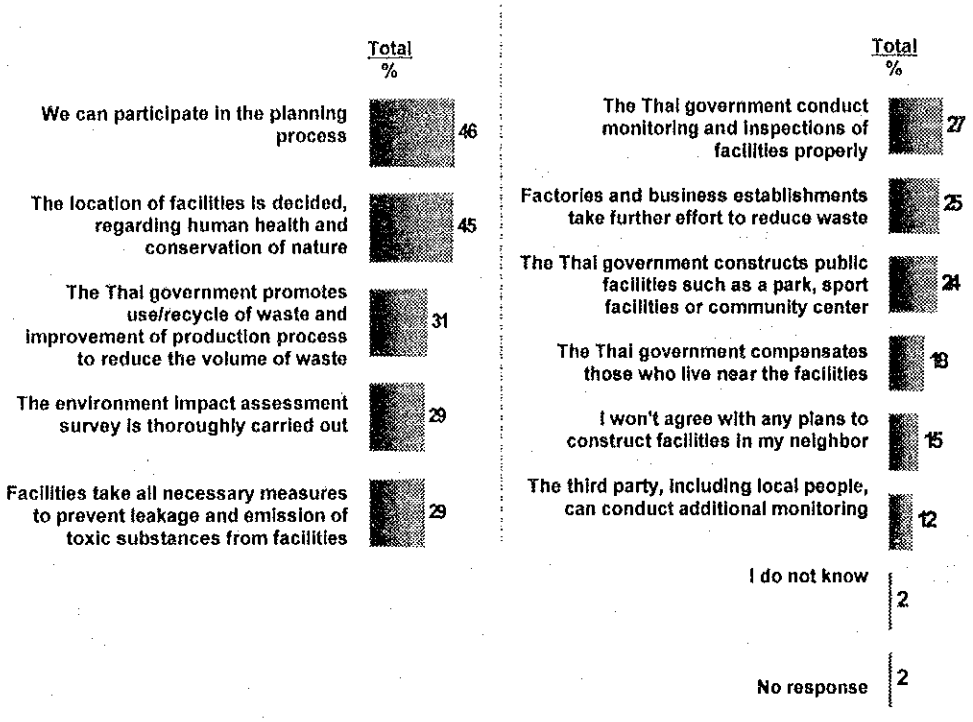


Figure 3-46: Conditions Set to Agree if The Government Plans to Construct Industrial Waste Treatment/Disposal Facilities (Q.31)

Constructing reuse/recycle center was regarded as a good policy (Figure 3-47). About 20% of respondents (74 samples) require the government to modify current policies and measures such as enforcement of monitoring and inspections of facilities and revelation of all necessary information and data to public, promote the construction of reuse/recycle center, as shown in Figure 3-48.

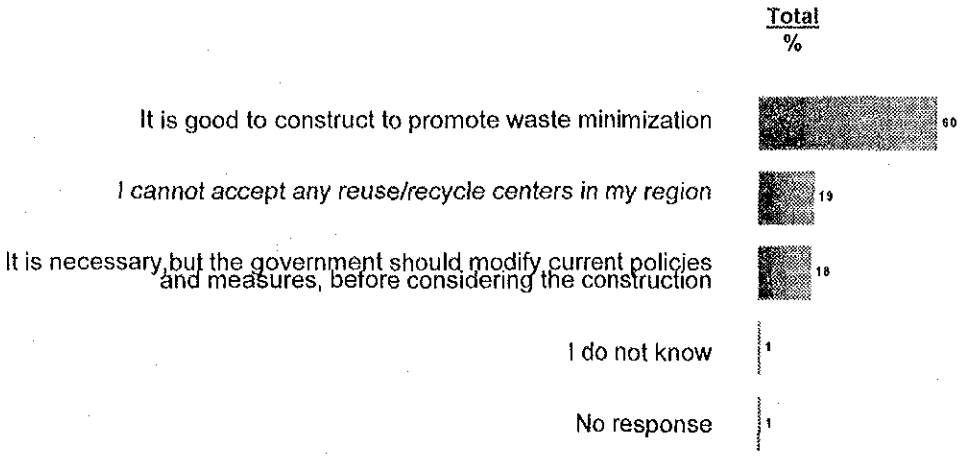


Figure 3-47: Opinion about Constructing Reuse/Recycle Center in Your District (Q.32)

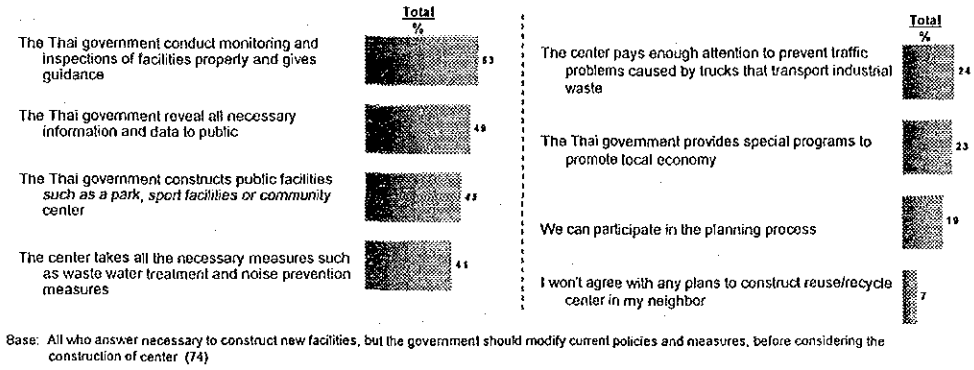


Figure 3-48: Conditions Set to Agree With The Construction Plan of Recycle Center (Q.33)

Chapter 4

Technical System on IWM

4 Technical System on IWM

4.1 Present IW Generation

4.1.1 Previous Studies

a. Non-Hazardous wastes

In Thailand, Non-HW was firstly defined in the MOI Notification No.1 B.E.2541 (1998) and waste generation surveys have been conducted since then.

a.1 Bangpoo Industrial Estate (Studied in September 1998)

Bangpoo Industrial Estate in Samut Prakarn province is the first industrial estate developed by IEAT. It is located 34 km southeast of Bangkok. IEAT is constructing an incineration plant of non-HW in this estate. In this project NEDO [1], a semi-governmental organization in Japan, provided a fluidized bed type incinerator with the capacity of 100 t/d. The feasibility study (F/S) report gives the amount and characteristics of wastes collected inside the estate. The estate's total area covers 5551 rai (888 hectares) divided into three development phases. At the time of F/S survey, 271 factories were existed, of which 263 factories were under operation.

The sampling survey of wastes was undertaken during 16-29 September,1998 at the temporal dump site.

The result is shown in Table 4-1 and Table 4-2. Average amount of collected non-HW is 61.18 ton/day. The examination of physical content of 24 samples of industrial wastes of Bangpoo Industrial Estate shows the high content of combustible wastes, raging from 67.38 to 97.02% by wet weight. The main components of waste are comprised of 22.71% as plastic and foam, 22.07% as textile, 16.21% as paper and 12.06% as steel and other metal. Bulk density is 0.185 kg/l in average. The moisture content is as low as 32%. There is little amount of kitchen garbage that decreases the calorific value of wastes, and the average lower calorific value is 3,380 kcal/kg.

Table 4-1: Estimated Collected Waste Volume in Bangpoo Industrial Estate (Sep.1998)

	Estimated Collected Waste Volume in Bangpoo Industrial Estate					
	Mon	Tue	Wed	Thu	Fri	Sat
BSA	70.0	70.0	70.0	74.0	70.0	70.0
PSA	136.0	176.0	88.0	136.0	96.0	80.0
CPL	67.8	112.8	59.1	54.6	72.4	31.4
PISSC & PO Bangpoo Region	25.0	25.0	25.0	25.0	25.0	25.0
PISSC & PO Preaksa Region	55.0	55.0	55.0	55.0	55.0	55.0
Total/day (m3)	**353.8**	**438.8**	**297.1**	**344.6**	**318.4**	**231.4**
Average/day (m3)	**330.68**					

[1] NEDO: New Energy and Industrial Technology Development Organization in Japan

Average Density (kg/l) for 24 samples	**0.185**
Average (ton/day)	**61.18**

Table 4-2: Characteristics of Waste in Bangpoo Industrial Estate (Sep.1998)

	Min.	Max.	Average
1) Physical Composition (% by wet weight)			
Paper	3.16	27.16	16.21
Textile	2.19	56.02	22.07
Plastic Foam	3.09	53.77	22.71
Wood, Leaves	0.00	17.51	2.49
Kitchen garbage	0.00	44.64	8.96
Bone and Shell	0.00	0.00	0.00
Leather, Rubber	0.00	38.02	6.21
Steel and Other Metal	1.28	32.62	12.06
Glass	0.00	10.87	1.66
Stone, Ceramic	0.00	5.26	0.58
Others	0.00	20.19	6.50
Combustible	67.38	97.02	84.77
Incombustible	2.98	32.62	15.23
Total			100.00
Density (kg./L)	0.12	0.22	0.19
2) Chemical Composition (% by wet weight)			
Moisture Content	8.72	53.61	31.99
Total Solids	46.39	91.28	68.01
Total Solids of combustible	37.57	89.04	63.41
Total Solid of incombustible	0.21	14.83	4.60
3) Combustible waste (% by wet weight)			
Ash	5.42	14.66	9.19
Volatile solid	29.53	82.43	54.23
Carbon including Org C	16.40	45.80	31.12
Org C	13.12	42.13	27.99
Hydrogen (H)	1.97	5.50	3.61
Nitrogen (N)	0.33	2.05	1.15
Phosphorus (P)	0.05	2.53	0.47
Potassium (K)	0.10	1.36	0.43
Sulphur (S)	0.03	0.49	0.14
Chlorine (Cl)	0.06	1.97	0.68
4) Heat Value in average (kcal/kg)			
DSCV		5,946.17	
HSCV		3,757.50	
LSCV		3,380.17	

a.2 Bangplee Industrial Estate (Studied in September 1998)

In Bangplee Industrial Estate in Samut Prakarn province, the similar study was conducted during 16-29 September, 1998. The results are shown in Table 4-3 and Table 4-4. Average of non-HW is 32.09 ton/day and is about half the amount of Bangpoo case. The 24 samples of industrial wastes of Bangplee Industrial Estate appeared to have high content of combustible wastes as in the case of Bangpoo. It is 96.05% in average by wet weight. The main components of wastes comprised textile (41%), plastic and foam (19 %), paper (20%), and leather and rubber (10%).

The rate of iron scrap is only 3 %. Generally, the recycling rate of iron scrap is high. The waste is sampled on the way to final disposal site from the factories. This means that the recyclable wastes were already removed from these sampled wastes. Waste density is 0.167 kg/l in average and the average lower calorific value is 3,972 kcal/kg.

Table 4-3: Estimated Collected Waste Volume in Bangplee Industrial Estate (September 1998)

	Estimated Collected Waste Volume in Bangplee Industrial Estate					
	Mon	Tue	Wed	Thu	Fri	Sat
BSA	136.0	136.0	136.0	136.0	136.0	136.0
CPL	–	4.9	–	–	8.1	–
PISSC & PO	25.0	25.0	25.0	25.0	25.0	25.0
Total/day (m3)	**190.0**	**194.9**	**190.0**	**190.0**	**198.1**	**190.0**
Average/day(m3)	**192.17**					
Average Density (kg/l) for 24 samples	**0.167**					
Average ton/day(t/d)	**32.09**					

Table 4-4: Characteristics of Waste in Bangplee Industrial Estate (Sep.1998)

	Min.	Max.	Average
1) Physical Composition (% by wet weight)			
Paper	6.26	68.01	19.69
Textile	0.00	88.29	40.88
Plastic Foam	2.37	73.00	19.24
Wood, Leaves	0.00	13.07	0.71
Kitchen garbage	0.00	6.71	0.62
Bone and Shell	0.00	0.00	0.00
Leather, Rubber	0.00	56.94	9.99
Steel and Other Metal	0.00	17.24	2.92
Glass	0.00	6.90	0.67
Stone, Ceramic	0.00	8.63	0.36
Others	0.00	30.65	4.92
Combustible	79.31	100.00	96.05
Incombustible	0.00	41.72	3.95
Total			100.00
Density (kg./L)	0.114	0.214	0.167

2) Chemical Composition (% by wet weight)			
Moisture Content	2.84	49.05	19.98
Total Solids	50.95	97.16	80.02
Total Solids of combustible	40.47	97.16	78.90
Total Solid of un-combustible	0.00	10.48	1.12
3) Combustible waste (% by wet weight)			
Ash	6.30	22.31	11.58
Volatile solid	34.17	86.54	67.33
Carbon including Org C	18.98	48.08	37.40
Org C	16.33	45.67	35.72
Hydrogen (H)	2.28	5.77	4.49
Nitrogen (N)	0.28	3.48	1.73
Phosphorus (P)	0.03	0.62	0.16
Potassium (K)	0.10	0.92	0.30
Sulphur (S)	0.03	0.21	0.10
Chlorine (Cl)	0.06	2.09	0.61
4) Heat Value in average (kcal/kg)			
DSCV	5,519.54		
HSCV	4,354.54		
LSCV	3,972.92		

c. Ladkrabang Industrial Estate (Studied in December 1998)

Japan Consulting Institute (JCI) had conducted the survey named "Feasibility Study on Ladkrabang Industrial Estate Industrial Waste Management Project in Thailand". The report was submitted in March 1999. In this survey, the factories survey was carried out for 106 factories in Ladkrabang Industrial Estate under IEAT. This industrial estate is located in Ladkrabang district, Bangkok and it is about 40 km away from central Bangkok.

Table 4-5 shows the summary of the survey conducted on 18 December 1998 in terms of amount and type of wastes. Unlike the municipal wastes, the composition of industrial wastes fluctuates very much depending on the types and process of industries. In the case of Ladkrabang Industrial Estate, many industries are mixed and it has many varieties of industrial wastes.

Part of waste is sold to the out of factories for the purpose of recycling, and the rate of selling and recycling of wastes can be regarded as the recycling rate. The right end column is the recycling rate The recycling rate of waste plastics, wastepaper, waste textile, iron scrap and waste stone are 52%, 66%, 50%, 99% and almost 100% respectively. It is inferred that the recycling of the industrial wastes is widely put into practice. But all the sludge that is classified in both Non-HWs and HWs goes to final dispose site.

Table 4-5: Investigation result of waste in Ladkrabang Industrial Estate

Type of Wastes			Sale or Recycle (A) (Kg/day)	Treatment & Final Disposal (Kg/day)	Total (B) (Kg/day)	Rate of Sale or Recycle (A)/(B) ×100 %
Solid Waste	Combustible Waste	Plastic	1,138.8	1,051.0	2,189.8	52.0
		Papers	1,974.1	1,027.3	3,001.4	65.8
		Woods	444.8	78.5	523.3	85.0
		Leathers	0.0	259.0	259.0	0
		Rubber	10.5	80.5	91.0	11.5
		Cloth	555.0	551.0	1,101.0	50.4
		Garbage	117.0	14,568.8	14,682.8	0.8
		Others	0.0	18.2 (Paint)	18.2	0
		Sub-Total	**4,235.2**	**17,361.3**	**21,865.5**	**19.4**
	Incombustible Waste	Ferrous Metal	5,844.7	32.8	5,877.5	99.4
		Metal	113.3	6,116.0	6,229.3	1.8
		Glass	1.7	2.8	4.5	37.8
		Sand	1,200.0	0.1	1,200.1	99.9
		Others	0.3	0.0	0.3	100.0
		Sub-Total	7,160.0	6,151.7	13,317.7	53.8
	Sub-Total		**11,395.2**	**23,783.0**	**35,178.2**	**32.4**
Liquid Waste	Waste oil		143.1	923.6	1,066.7	13.4
	Waste alkaline	Combustible	1,600.0	12,119.0	13,719.0	11.7
		Incombustible	0.0	2,000.0	2,000.0	0
	Waste acid	Combustible	1,000.0	16.9	1,016.9	98.3
		Incombustible	0.0	1,129.4	1,129.4	0
	Liquid waste Sub-total		2,731.4	16,188.9	18,923.0	14.4
Sludge	Factory Sludge		0.0	25,686.3	25,686.3	0
	Wastewater Treatment Sludge		0.0	6,185.0	6,185.0	0
	Sludge Total		0.0	31,871.3	31,871.3	0
Total	Combustible Wastes		6.978.3	62,562.1	69,540.4	11.1
	Incombustible Waste		7,160.0	9,281.1	16,441.1	43.5
	Grand Total		**14,138.1**	**71,843.2**	**85,981.5**	**16.4**

b. Hazardous waste

Since 1984, several organizations, institutes and local consultants conducted surveys regarding the generation of HW. The large values were predicted in the surveys conducted in the beginning of 1990s. For example, faculty of Engineering of Kasetart University predicted 12 million tons generation of HW in 2001. However the predicted amount of HW generation has been decreasing recently. DIW estimated that it is approximately 1.2 million tons in 2000 nationwide. The major surveys are introduced below.

b.1 Study by Thailand Development and Research Institute (TDRI, 1991)

In 1991, TDRI estimated the generation of HW in Thailand. The estimated annual generation value was about 1.1 million tons in 1986 and predicted that it would increase in about three times (about 3.4 million tons/year) in 1996.

Table 4-6: The generation of HW in Thailand nationwide (TDRI)

Type of Hazardous Wastes	Quantity (tons/year)		
	1986 Estimation	1991 Prediction	1996 Prediction
Heavy Metal Sludge & Solids	823,869	1,447,590	2,536,030
Oils	124,194	219,467	387,893
Acid Wastes	81,054	125,428	196,510
Infectious Wastes	46,674	76,078	123,219
Solvents	19,783	36,163	66,532
Alkaline Wastes	21,952	34,235	54,024
Inorganic Sludge & Solids	11,698	19,254	32,043
Photographic Wastes	8,820	16,348	30,398
Organic Sludge & Solids	3,737	6,674	11,951
Liquid Organic Residue	187	311	522
Aqueous Organic Residue	116	242	499
Off Spec Products	12	25	52
Total	1,142,096	1,981,815	3,439,673

Source: TDRI,1991

b.2 Study by Faculty of Engineering, Kasetsart University (1992)

Faculty of Engineering of Kasetsart University has conducted a risk assessment survey of HWs around the Bangkok Metropolitan Area and its vicinal 10 provinces in 1992. According to this survey, the generation of HWs from the surveyed area was 2.8 million tons/year. They predicted that it would increase to 12 million tons/year in 2001. From Kasetsart University survey data, JICA study team picked up the data of Bangkok Metropolitan Area and its vicinal 4 provinces that are the study area of the present study and summarized in Table 4-7.

Table 4-7: The Generation of HWs in Metropolitan Area and its vicinal 4 provinces (Kasetsart University)

Type of Hazardous Wastes	Quantity (1,000/year)	
	1992 Estimation	2001 Prediction
Oils	167.51	660.54
Liquid Organic Residues	0.08	0.35
Organic Sludge & Solids	63.70	274.08
Inorganic Sludge & Solids	26.82	101.54
Heavy Metal Sludge & Solids	2,190.38	9,232.96
Solvents	39.2	199.25
Acid Wastes	150.09	445.25
Alkaline Wastes	67.28	127.55
Off-Spec Products		
PCB	0.01	0.03
Aqueous Organic	0.30	1.81

Photo Wastes	1.34	8.15
Total	2,706.71.	11,051.51

Souce: Kasetsart University, "The Survey, Study and Design of Environmental Research and Development Center in Ratchaburi, 1992"

b.3 DIW (2001)

A staff of DIW reported that approximately 1.2 million tons of HW was generated in 2000 throughout the country. Table 4-8 shows its breakdown. About 90% of HWs were discharged in 14 provinces including Bangkok Metropolitan Area and its Vicinity and surrounding area.

Table 4-8: Amount of HWs in 2000 in Thailand (DIW, 2001)

Type of HW	Amount (tons/year)
Heavy Metal Sludge & Organic Solid	840,570
Acid or Alkali contaminated with heavy metal & non organic liquid	124,598
Oil sludge	186,848
Organic sludge & Waste	92,591
Total	1,244,607

Generation Zone	Amount (tons/year)
Bangkok & Vicinity	448,701
Central	470,999
East	227,260
Northeast	38,426
North	12,626
South	34,628
Total	1,244,607

Souce: DIW & JICA Seminar Presentation, July 24,2001

b.4 Other Studies

In cooperation with Envitech Consultant Co., Ltd, Environment Technologic Co., Ltd. has conducted to estimate the generation of HWs of Bangkok Metropolitan Area and the industry-concentrated six provinces. In 1996, 15,312 factories discharged HWs. The discharged value was about 2.6 million tons/year. Only about 400 thousand tons out of 2.6 million tons were treated in the treatment plants.

Consultant of Technology Co., Ltd. studied the preliminary design for Chonburi Environmental Research and Development Center. In this study, they conducted a industrial wastes generation survey in Samut Prakarn province and Eastern Seaboard Area. According to this study, the generation of HWs from Samut Prakarn province was about one hundred seventy thousand tons/year.

DIW conducted "Preparation of Register on Hazardous Waste Generation & GIS Application for the Province Samut Prakarn" with the support of GTZ of Germany. In this survey, CMS Engineering and Management Co., Ltd, a subcontractor, found that the monthly generation of HWs from Samut Prakarn province is 8.8 thousand tons. Table 4-9 shows the breakdown of HWs.

Table 4-9: HWs from industrial sector of Samut Prakarn province

Type of Hazardous Wastes	Quantity (tons/month)
Organic and Inorganic Acids	166
Alkalis	38
Heavy Metal Compounds	558
Liquid Inorganic Compounds	3
Solid Inorganic Compounds	350
Organic Compounds	160
Polymer Material	210
Fuel, Oil and Grease	1,066
Fine Chemicals and Biocides	4
Pickling Wastes	127
Filtered Material, Treatment Sludge	1,247
Other Toxic Substances i.e. Chemical Dust, Enamel Coat, Paint Pigment etc.	4,878
Total	8,807

Table 4-10 compares the results of the previous studies and JICA Study in terms of the amount of industrial wastes.

Table 4-10: The Comparison with previous studies and JICA Study

Non-hazardous Waste				
Organization	Area	Year	Amount	Status
NEDO	Banpoo Industrial Estate	Sep-99	62 tons/day	Estimation based on TS
NEDO	Banplee Industrial Estate	Sep-98	31 tons/day	Estimation based on TS
JCI	Ladkrabang Industrial Estate	Dec-98	85 tons/day	Estimation based on FS
JICA	BKK, SP, NT, PT, SS	2001	2,364,782 tons/year	Estimation based on FS

Hazardous Waste				
Organization	Area	Year	Amount	Status
Consultant of Technology	SP	1990	Appx. 170,000 tons/year	N/A
TDRI	Nationwide	1996	3,439,673 tons/year	Predicted in 1991
Environment Technologic & Envitech Consultant	BKK & Industrialized 6 provinces,	1996	2.6 Million tons/year	N/A
GTZ	SP	1999	Appx. 100,000 tons/year	Estimation based on FS
Kasetsart University	BKK, SP, NT,	2001	11,051,510 tons/year	Predicted in

	PT, SS			1992
DIW	Nationwide	2000	1,244,607 tons/year	Reported in 2001
JICA	BKK, SP, NT, PT, SS	2001	557,456 tons/year	Estimation based on FS

Note, BKK; Bangkok, SP; Samut Prakarn,NT; Nonthaburi, SS; Samut Sarkorn, PT: Pathum Thani, FS; Factory Survey, TS; Transportation Survey

4.1.2 Present IW Generation

a. Classification of IW and Industry

Prior to the factory survey DIW and the team set up the classification of IW and industry as described in the Section 3.1. The present IW generation is made based on this classification. It is summarized below.

- IW is divided into non-HW and HW in accordance with the MOI Notification No. 6 (1997) and No. 1 (1998).
- Non-HW is further divided into 14 categories based on the MOI Notification No. 1 (1998).
- HW is classified into 12 categories same as in the GTZ HW Study.
- Since target waste of the study is IW that generates at factories regulated by the Factory Act, the MOI categories and code of industry is applied to the study.
- In order to identify the current IWM of every category of factories, the team simplified the MOI 104 codes of factories to make 33 codes. The 33 codes of factory are applied to the study.

b. Estimation Method

For the estimation of current IW generation the Standard Unit Method (SUM), which requires the following indicators, is applied:

1. Generation rate of each category of IW of 33 each category of industries; and
2. Activity index represented by, for example, the number of employees or product shipment. To this study the former is applied because the team considered that it should be easier to get answers about the number of employees than product shipment.

IW generation is estimated with the equation A. It uses each IW generation rate of each industrial category per employee, which is calculated based on the data of factory survey as shown in the equation B.

Equation A: $IWG_{ij} = G_{ij} \times M_i$

j	Waste of category *j* among 26 waste categories (26 = 14 non-HW categories + 12 HW categories).
i	Industry of Code *i* among 33 categories.
IWG_{ij}	Generation amount of waste *j* from industry *i* in the study area (ton/year)
M_i	Number of employees (used as activity index) of industry *i* in the study area

G_{ij} Generation rate of waste ***j*** from industry ***i*** per employee (ton/employee/year)

IW generation rate, G, can be calculated using the total amount of IW both of each industrial category and the each type of IW, and the sum of employees (activity index) of each industry obtained from the factory survey, shown in the equation B.

Equation B: $G_{ij} = GAF_{ij} / M_i$

GAF_{ij} Total amount of waste ***j*** from sample factories of industry ***i*** (ton/year)

M_i Total number of employees (used as activity index) of sample factories of industry ***i*** (employee)

c. Number of Factories and Employees

Numbers of factories and employees used for the estimation of present IW generation are 33,092 factories and 1,584,782 employees as mentioned in the section 3.1.3. The table below presents number of factories and employees used for the estimation of each of 33 industrial codes.

Table 4-11: Number of Factories and Employees used for Estimation of Present IW Generation

Factory Study Code	Descriptions	Number of Factories	Percentage to Total (%)	Number of employees	Percentage to Total (%)
G01	Food (agricultural product, non-aquatic animals, aquatic animals etc.)	982	3.0	92,554	5.8
G02	Food (flour, sugar, tea, ice etc.)	1,083	3.3	30,685	1.9
G03	Drink, Beverage	110	0.3	17,448	1.1
G04	Textile, Thread, Fibre	1,110	3.4	143,267	9.1
G05	Textile product (Clothes, mats etc.)	959	2.9	58,807	3.7
G06	Wearing Apparel	2,115	6.4	189,939	12.0
G07	Hide, Fur, Footwear	879	2.7	64,105	4.0
G08	Woodwork (any or many items)	1,028	3.1	25,290	1.6
G09	Woodwork (bamboo, rattan, straw, cork etc.)	378	1.1	15,283	1.0
G10	Furniture	957	2.9	29,779	1.9
G11	Paper, Cardboard	689	2.1	26,679	1.7
G12	Printed matter	1,696	5.1	34,049	2.1
G13	Chemical matter, Petroleum	1,131	3.4	58,642	3.7
G14	Rubber	504	1.5	35,823	2.3
G15	Plastic product	2,957	8.9	98,506	6.2
G16	Glassware, Ceramics, non-Metallic Matter	738	2.2	41,168	2.6
G17	Steel basic industries, non-ferrous metal basic industries	682	2.1	29,249	1.8
G18	Metal product (tools, appliances, household furniture, building interior etc.)	472	1.4	13,969	0.9
G19	Metal product (construction, installation)	1,000	3.0	18,518	1.2
G20	Metal product (others)	5,051	15.4	94,039	5.9
G21	Machines (Engines, Turbines, Machinery)	761	2.3	14,406	0.9
G22	Machines (for producing metal or wood products)	335	1.0	6,584	0.4
G23	Machines (for paper, chemical, food, textile etc.)	291	0.9	5,204	0.3
G24	Machines (calculating machines, Accounting machines, Water pumps, air or gas compressors etc.)	642	1.9	56,926	3.6
G25	Electric product (Machines or Product under No.70, Radio set, Electric instruments or appliances etc.)	935	2.8	120,045	7.6

G26	Electric product (Electric Equipment)	381	1.2	24,898	1.6
G27	Transportation machines (Ship, Trains, Streetcars, Cars or Trailers)	1,103	3.3	54,702	3.5
G28	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles etc.)	300	0.9	26,821	1.7
G29	Precision machinery	664	2.0	58,164	3.7
G30	Others (Musical instruments, Sport, Toys etc.)	446	1.3	40,816	2.6
G31	Others (Electric power, Gas, Packaging, Cold storage etc.)	471	1.4	24,314	1.5
G32	Others (Engine-driven for vehicles or motorcycles etc	1,890	5.7	24,278	1.5
G33	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt etc.)	352	1.1	9,825	0.6
Total	---	33,092	100.0	1,584,782	100.0

d. Estimation of Present IW Generation

Based on the generation data of the 206 factories, generation rates (GRs) (ton/employee/year) of each study code of industry and each code of non-HW/HW are calculated, which are presented in Section 10.2.2. Generation amount is simply calculated by multiplying GR by number of employees. Annual generation amounts of non-HW and HW are estimated at about 2,365 thousand ton and 557 thousand ton respectively. The tables below present IW generation of each code of industries, non-HW generation of each non-HW category and HW generation of each HW category.

Table 4-12: IW Generation in accordance with Study Code of Industries

Factory Study Code	Descriptions	Non-HW (ton/year)	HW (ton/year)	Total (ton/year)
G01	Food (agricultural product, non-aquatic animals, aquatic animals etc.)	295,015	9	295,024
G02	Food (flour, sugar, tea, ice etc.)	11,881	1,218	13,099
G03	Drink, Beverage	47,208	30,079	77,287
G04	Textile, Thread, Fibre	64,299	1,562	65,861
G05	Textile product (Clothes, mats etc)	53,513	153	53,666
G06	Wearing Apparel	54,835	19	54,854
G07	Hide, Fur, Footwear	42,163	243	42,406
G08	Woodwork (any or many items)	143,705	2,264	145,969
G09	Woodwork (bamboo, rattan, straw, cork etc.)	61,848	48	61,896
G10	Furniture	159,222	5,820	165,042
G11	Paper, Cardboard	48,735	227	48,962
G12	Printed matter	36,232	9,156	45,388
G13	Chemical matter, Petroleum	5,107	45,395	50,502
G14	Rubber	44,213	1,357	45,570
G15	Plastic product	93,787	43,559	137,346
G16	Glassware, Ceramics, non-Metallic Matter	105,949	284	106,233
G17	Steel basic industries, non-ferrous metal basic industries	668,620	124,484	793,104
G18	Metal product (tools, appliances, household furniture, building interior etc)	60,446	1,024	61,470
G19	Metal product (construction, installation)	47,439	1,848	49,287
G20	Metal product (others)	74,770	78,984	153,754
G21	Machines (Engines, Turbines, Machinery)	35,982	2,248	38,230
G22	Machines (for producing metal or wood products)	2,346	1,298	3,644
G23	Machines (for paper, chemical, food, textile etc.)	2,985	283	3,268

G24	Machines (calculating machines, Accounting machines, Water pumps, air or gas compressors etc.)	6,086	5,954	12,040
G25	Electric product (Machines or Product under No.70, Radio set, Electric Instruments or appliances etc.)	72,951	147,919	220,870
G26	Electric product (Electric Equipment)	35,599	6,247	41,846
G27	Transportation machines (Ship, Trains, Streetcars, Cars or Trailers)	6,986	17,663	24,649
G28	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles etc.)	30,774	5,997	36,771
G29	Precision machinery	1,426	2,878	4,304
G30	Others (Musical instruments, Sport, Toys etc.)	13,929	98	14,027
G31	Others (Electric power, Gas, Packaging, Cold storage etc.)	35,605	15	35,620
G32	Others (Engine-driven for vehicles or motorcycles etc.	963	18,114	19,077
G33	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt etc.)	163	1,009	1,172
Total	---	2,364,782	557,456	2,922,238

Table 4-13: Non-HW and HW Generation according to the Waste Category

Waste Type	Non-HW Code for the Study	Descriptions	Total Generation Amount (ton/year)
Non-HW	C01-01	Parts of plants such as roots, barks and leave	58,096
	C01-02	Parts of animals such as bones, skins, hair and excreta	306,668
	C02	Parts of wood	382,775
	C03	Paper waste	91,307
	C04	Plastics or synthetic rubbers	163,704
	C05	Cloth, thread and fabric	112,911
	C06	Animal's fat and oil and vegetable oil	---
	C07	Natural rubbers	27,109
	C08	Metals and metal alloys (not in salt form)	720,592
	C09-01	Ceramics	34,421
	C09-02	Glasses	71,729
	C10	Stone, cement, sand or materials consisting of clay, sand or stone e.g. tile, brick gypsum and concrete	285,583
	C11	Mixed waste	45,917
	C12	Others	63,970
Total Non-HW			2,364,782
HW	W01	Acid	1,881
	W02	Alkalis	2,956
	W03	Heavy Metal Compounds	4,555
	W04	Liquid Inorganic Compounds	51,774
	W05	Solid Inorganic Compounds	585
	W06	Organic Compounds	14,579
	W07	Polymer Materials	18,331
	W08	Fuel, Oil and Grease	159,690
	W09	Fine Chemicals and Biocides	18
	W10	Pickling Waste	1,419
	W11	Filter Materials, Treatment Sludge	180,238
	W12	Other Toxic substance (besides W01-W11)	121,430
Total HW			557,456

e. Comparison of IW Generation with It in Japan

Definition of IW (industrial waste) differs each country. There are the following major differences between Thailand and Japan on the definition of IW:

- IW in Thailand is the waste generated from factories.
- IW in Japan is the waste generated from business activities.
- Business activities include construction, potable water and sewage, transportation and communication, wholesaling and retailing, agriculture, and mining in addition to manufacturing (factories).
- In Japan IW is classified into 19 categories of waste. The Ministry of the Environment (MOE) estimates IW generation amount based on the reports from 47 Prefectural governments on it according to the categories. The estimation of IW, however, includes hazardous industrial waste (specially controlled industrial waste) together with non-HIW. The estimation of HIW alone is not available.

Upon consideration of the above differences on the definition of IW, IW generation amount in Japan in 1999 is modified following the definition of IW in Thailand as much as possible and the results are summarized in the table below. Consequently, IW generation per capita in the study area is 0.341 tones/person/year while it in Japan is 1.11 tones/person/year. It means IW generation per capita in the study area is only about 30 % of it in Japan.

Item	Unit	Study Area			Japan in 1999*1	
		Non-HW	HW	Whole IW	IW except for it generated in the industries marked in *2	Whole IW
Generation	1,000 tones/year	2,365	557	2,922	141,488	399,799
Population	1,000 persons	8,574			126,926*3	
Generation per capita	ton/year	0.276	0.065	0.341	1.11	3.15

(Note) *1: IW Division, Waste Management and Recycling Department, MOE in Japan, January 2002.

*2: Construction, agriculture and public utilities such as electricity, gas and potable water/sewage.

*3: National Census in 2002, National Statistic Center in Japan

f. Estimation of HW Generation Based on the GTZ HW Study

The Classification of HW used in the study basically follows what was applied to the 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) to share and compare the data obtained by the previous study. Here the team deduces generation rates (GRs) of 12 categories of HW of the 33 industrial categories from the GTZ HW Study and calculates HW generation in the study area. The method of estimation is described as follows:

- The 104 MOI codes of factories applied to the GTZ HW Study are converted into the 33 study codes of factories.
- The team obtains generation amounts of 12 codes of HW of the 33 study codes in Samut Prakarn.

- Each HW generation rate (GR) is calculated by dividing each HW generation amount by total number of employees of corresponding factory code in Samut Prakarn. However, the GTZ HW Study does not provide the number of employees. Therefore, the number of employees is calculated by multiplying it of JICA study with the rate of the number of factories of GTZ and JICA study.
- If 33 codes of industries HW of all the 12 codes, theoretically there should be 396 (12 x 33) IW generation rates. According to the GTZ HW Study, however, any industrial sector generates only some sorts of HW, and the team obtained 105 HW generation rates.
- Each HW generation amount according to the 33 study codes in the study area is simply calculated by multiplying each GR by total number of employees of each 33-study factory codes in the study area.

Tables below present a comparison of HW generation of JICA study and GTZ study.

Table 4-14: Comparison of HW Generation Rates of JICA and GTZ Study

Unit: kg/employee/year

Study Code	Descriptions	Study	W01	W02	W03	W04	W05	W06	W07	W08	W09	W10	W11	W12	Total
G01	Food (agricultural product, non-aquatic animals, aquatic animals etc.)	JICA								0.1					0.1
		GTZ	-	-	-	-	-	-	-	-	-	-	-	-	-
G02	Food (flour, sugar, tea, ice etc.)	JICA								0.2			39.5		39.7
		GTZ	-	-	-	-	-	-	-	-	-	-	-	-	-
G03	Drink, Beverage	JICA		139.8						10.4			20.7	1,553.1	1,724.0
		GTZ	-	-	-	-	-	-	-	-	-	-	-	-	-
G04	Textile, Thread, Fibre	JICA								8.2			2.4	0.3	10.9
		GTZ								37.9			511.1	93.7	642.7
G05	Textile product (Clothes, mats etc.)	JICA							0.0	0.0			0.8	1.8	2.6
		GTZ						11.1	1.6	14.3			18.6	202.2	247.8
G06	Wearing Apparel	JICA								0.1					0.1
		GTZ	-	-	-	-	-	-	-	-	-	-	-	-	-
G07	Hide, Fur, Footwear	JICA						0.5		0.0				3.2	3.7
		GTZ			2.1		1.9			52.6			24.9	429.9	511.4
G08	Woodwork (any or many items)	JICA						4.9		0.1			80.1	4.4	89.5
		GTZ												2,734.2	2,734.2
G09	Woodwork (bamboo, rattan, straw, cork etc.)	JICA								2.4				0.7	3.1
		GTZ												347.2	347.2
G10	Furniture	JICA						11.0		1.8			35.7	146.9	195.4
		GTZ								20.5			4.5	207.8	232.8
G11	Paper, Cardboard	JICA						0.4						8.1	8.5
		GTZ								16.8			149.4	78.9	245.1
G12	Printed matter	JICA								80.8				188.4	268.9
		GTZ								43.1				107.1	150.2
G13	Chemical matter, Petroleum	JICA			29.3	62.2		21.9	27.7	36.6	0.3		286.8	309.3	774.1
		GTZ	8.7		0.2	0.2	2.4	18.6	10.3	27.3	0.4		47.5	390.2	505.8
G14	Rubber	JICA							0.3	37.0				0.6	37.9
		GTZ								86.3				43.1	129.4
G15	Plastic product	JICA						73.7	141.6	94.3				132.6	442.2
		GTZ						3.5	4.1	43.3				2.1	53.0
G16	Glassware, Ceramics, non-Metallic Matter	JICA								0.2				6.7	6.9
		GTZ								71.5				6.7	78.2
G17	Steel basic industries, non-ferrous metal basic industries	JICA								4,256.0					4,256.0
		GTZ	962.0		13.3		111.6			67.4		60.1	31.5	45.9	1,291.8
G18	Metal product (tools, appliances household furniture, building interior etc.)	JICA								4.5			68.8		73.3
		GTZ								10.3			82.7	232.4	325.4
G19	Metal product (construction, installation)	JICA								85.1			14.7		99.8
		GTZ								241.6				336.2	577.8
G20	Metal product (others)	JICA		5.5		458.2		13.6		38.2		9.1	8.8	306.5	839.9
		GTZ								19.3		15.6	101.5	87.6	224.4
G21	Machines (Engines, Turbines, Machinery)	JICA			46.0	5.0				72.5			29.2	3.3	156.0
		GTZ								14.5			10.0	37.0	61.5
G22	Machines (for producing metal or wood products)	JICA								60.5				136.7	197.2
		GTZ								11.6				345.5	357.1
G23	Machines (for paper, chemical, food textile etc.)	JICA						1.7		52.7					54.4
		GTZ								36.5				19.5	56.0
G24	Machines (calculating machines, accounting machines, Water	JICA			0.2	61.7		0.7	17.6	2.6			8.8	13.0	104.6

	pumps, air or gas compressors etc.)	GTZ								55.3			6.5	401.2	463.0
G25	Electric product (Machines or Product under No.70, Radio set, Electric instruments or appliances etc.)	JICA			1.7	12.1				0.6			1,121.6	96.2	1,232.2
		GTZ								9.4			61.7	59.9	131.0
G26	Electric product (Electric Equipment)	JICA	61.6		78.5					12.7		22.6		75.5	250.9
		GTZ								50.1			93.0	14.2	157.3
G27	Transportation machines (Ship, Trains, Streetcars, Cars or Trailers)	JICA					10.7	1.7		28.1			185.5	96.9	322.9
		GTZ						3.1		81		20.8	3.3	12.8	48.1
G28	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles etc.)	JICA	11.1		0.2			104.8	26.2	4.7			20.4	54.2	223.6
		GTZ						39.6		112.4		44.8	19.7	23.6	240.1
G29	Precision machinery	JICA						4.3	17.0	20.2			8.1	0.0	49.6
		GTZ						2.9		52.0		1.4	3.2	4.7	64.2
G30	Others (Musical instruments, Sport Toys etc.)	JICA											1.1	1.3	2.4
		GTZ						0.3		3.0		0.3	0.3	1.3	5.2
G31	Others (Electric power, Gas, Packaging, Cold storage etc.)	JICA								0.6					0.6
		GTZ		172.5					124.9	124.9				2,671.4	3,093.7
G32	Others (Engine-driven for vehicles or motorcycles etc.	JICA						43.6		324.0			373.8	4.7	746.1
		GTZ								129.5				470.3	599.8
G33	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt etc.)	JICA	5.0							1.0			46.6	50.1	102.7
		GTZ				10.7		70.9		7.9		1.1	7.9	26.5	124.6
All Category of Factories		JICA	1.6	7.0	2.9	19.6	0.6	4.8	5.0	56.4	0.0	0.8	125.3	121.7	345.7
		GTZ	45.3	1.4	0.8	0.1	5.5	3.9	2.0	41.0	0.0	7.4	127.3	186.6	421.3

Table 4-15: Comparison of HW Generation Estimated by JICA and GTZ Study for all the Study Codes of Industries

Factory Study Code	Descriptions	JICA Study			GTZ Study		
		Nos. of Factories Surveyed	Generation (ton/year)	Rate to Total	Nos. of Factories Surveyed	Generation (ton/year)	Rate to Total
G01	Food (agricultural product, non-aquatic animals, aquatic animals etc.)	243	9	0.0	---	---	---
G02	Food (flour, sugar, tea, ice etc.)	184	1,218	0.2	---	---	---
G03	Drink, Beverage	9	30,079	5.4	---	---	---
G04	Textile, Thread, Fibre	520	1,562	0.3	501	90,931	20.7
G05	Textile product (Clothes, mats etc.)	155	153	0.0	101	10,327	2.4
G06	Wearing Apparel	164	19	0.0	---	---	---
G07	Hide, Fur, Footwear	299	243	0.0	226	29,431	6.7
G08	Woodwork (any or many items)	163	2,264	0.4	148	62,780	14.3
G09	Woodwork (bamboo, rattan, straw, cork etc.)	92	48	0.0	70	4,183	1.0
G10	Furniture	133	5,820	1.0	109	5,923	1.3
G11	Paper, Cardboard	127	227	0.0	87	5,651	1.3
G12	Printed matter	89	9,156	1.6	55	4,151	0.9
G13	Chemical matter, Petroleum	382	45,395	8.2	310	41,424	9.4
G14	Rubber	94	1,357	0.2	83	5,677	1.3
G15	Plastic product	542	43,559	7.8	410	4,875	1.1
G16	Glassware, Ceramics, non-Metallic Matter	148	284	0.1	90	2,264	0.5
G17	Steel basic industries, non-ferrous metal basic industries	221	124,484	22.4	206	38,322	8.7
G18	Metal product (tools, appliances, household furniture, building interior etc.)	115	1,024	0.2	88	3,955	0.9
G19	Metal product (construction, installation)	203	1,848	0.3	182	10,522	2.4
G20	Metal product (others)	964	78,984	14.2	722	19,805	4.5
G21	Machines (Engines, Turbines, Machinery)	187	2,248	0.4	151	753	0.2
G22	Machines (for producing metal or wood products)	86	1,298	0.2	66	2,272	0.5
G23	Machines (for paper, chemical, food, textile etc.)	93	283	0.1	86	285	0.1
G24	Machines (calculating machines, Accounting machines, Water pumps, air or gas compressors etc.)	84	5,954	1.1	68	21,769	5.0
G25	Electric product (Machines or Product under No.70, Radio set, Electric instruments or appliances etc.)	200	147,919	26.6	108	13,432	3.1
G26	Electric product (Electric Equipment)	128	6,247	1.1	97	3,608	0.8

G27	Transportation machines (Ship, Trains, Streetcars, Cars or Trailers)	238	17,663	3.2	196	2,368	0.5
G28	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles etc.)	97	5,997	1.1	82	8,826	1.6
G29	Precision machinery	38	2,878	0.5	12	3,159	0.7
G30	Others (Musical instruments, Sport, Toys etc.)	93	98	0.0	17	53	0.0
G31	Others (Electric power, Gas, Packaging, Cold storage etc.)	96	15	0.0	37	32,425	7.4
G32	Others (Engine-driven for vehicles or motorcycles etc.	142	18,114	3.2	101	10,357	2.4
G33	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt etc.)	101	1,009	0.2	63	1,430	0.3
Total	---	6,430	557,456	100.0	4,472	438,958	100.0

Table 4-16: Comparison of HW Generation Estimated by JICA and GTZ Study for all the HW Categories

HW Code for the Study	Descriptions	JICA Study		GTZ Study	
		Generation	% in Total	Generation	% in Total
W01	Acid	1,881	0.3	29,250	6.7
W02	Alkalis	2,956	0.5	1,807	0.4
W03	Heavy Metal Compounds	4,555	0.8	535	0.1
W04	Liquid Inorganic Compounds	51,774	9.3	141	0.0
W05	Solid Inorganic Compounds	585	0.1	3,619	0.8
W06	Organic Compounds	14,579	2.6	4,531	1.0
W07	Polymer Materials	18,331	3.3	2,591	0.6
W08	Fuel, Oil and Grease	159,690	28.7	46,351	10.6
W09	Fine Chemicals and Biocides	18	0.0	29	0.0
W10	Pickling Waste	1,419	0.3	5,546	1.3
W11	Filter Materials, Treatment Sludge	180,238	32.3	102,777	23.4
W12	Other Toxic substance (besides W01-W11)	121,430	21.8	241,781	55.1
Total		557,456	100.0	438,958	100.0

Overall HW generation amount estimated by JICA and GTZ study seems to be quite similar. However, there are quite big differences observed in each HW generation rate of each categories of industry. This is because of the following aspects:

1. Comparing with GTZ study, JICA study covers wider area and factories but the number of samples (215 factories) is less than GTZ study.
2. The study area and year and target factories differ.

4.1.3 Present IW Flow

a. Present IW Flow

The team estimated current IW flow in the study area based on valid relics of 206 factories on IW generation and on-site/off-site IW disposal method, i.e. on-site storage, on-site treatment, on-site reuse/recycling, on-site final disposal, collection/transportation, off-site reuse/recycling, off-site treatment and final disposal. The table below shows current non-HW flow and HW flow in the study area.

Table 4-17: Non-HW Flow and HW Flow in the Study Area (2001)

IW / Items	Non-HW		HW	
	Amount (ton/year)	Rate to Total (%)	Amount (ton/year)	Rate to Total (%)
1. Generation	2,364,782	100.0	557,456	100.0
On-site Disposal*1	707,574	29.9	313,903	56.3
Off-site Disposal*2	1,657,208	70.1	243,553	43.7
2.Reuse/Recycling	1,853,964	78.4	101,337	18.2
On-site	321,414	13.6	22,455	4.0
Off-site	1,532,550	64.8	78,882	14.2
3. On-site Storage	42,081	1.8	3,842	0.7
4. On-site Treatment	20,405	0.9	182,994	32.8
(Reduction)*3	(8,493)	(0.4)	(123,935)	(22.2)
5. On-site Final Disposal	335,526	14.1	120,063	21.6
6. Off-site Treatment and Final Disposal	124,718	5.3	208,279	37.4
7. Collection by Waste Buyers*4	1,147,738	48.5	47,472	8.5

1. The term of disposal covers storage, discharge, collection, transportation, treatment and final disposal of waste. In concrete term on-site disposal covers IW long-term storage, reuse/recycling, treatment and final disposal at the generation sources, i.e. factories.
2. Off-site disposal covers IW collection/transportation, reuse/recycling, treatment and final disposal outside of the factories.
3. Reduction refers to the lost amount of waste through treatment such as dewatering, drying, incinerating, etc.
4. *Waste buyer in Thai is Por Kha Khong Gao.*

The following figures illustrate the above-mentioned non-HW Flow and HW Flow in 2001 respectively. In addition IW flows of 13 categories of non-HW (206 valid reply did not report C06: Animal's Fat and Oil and Vegetable Oil) and 12 categories of HW as well as non-HW/HW flows of 33 categories of industry are prepared and presented in Annex 4.1.

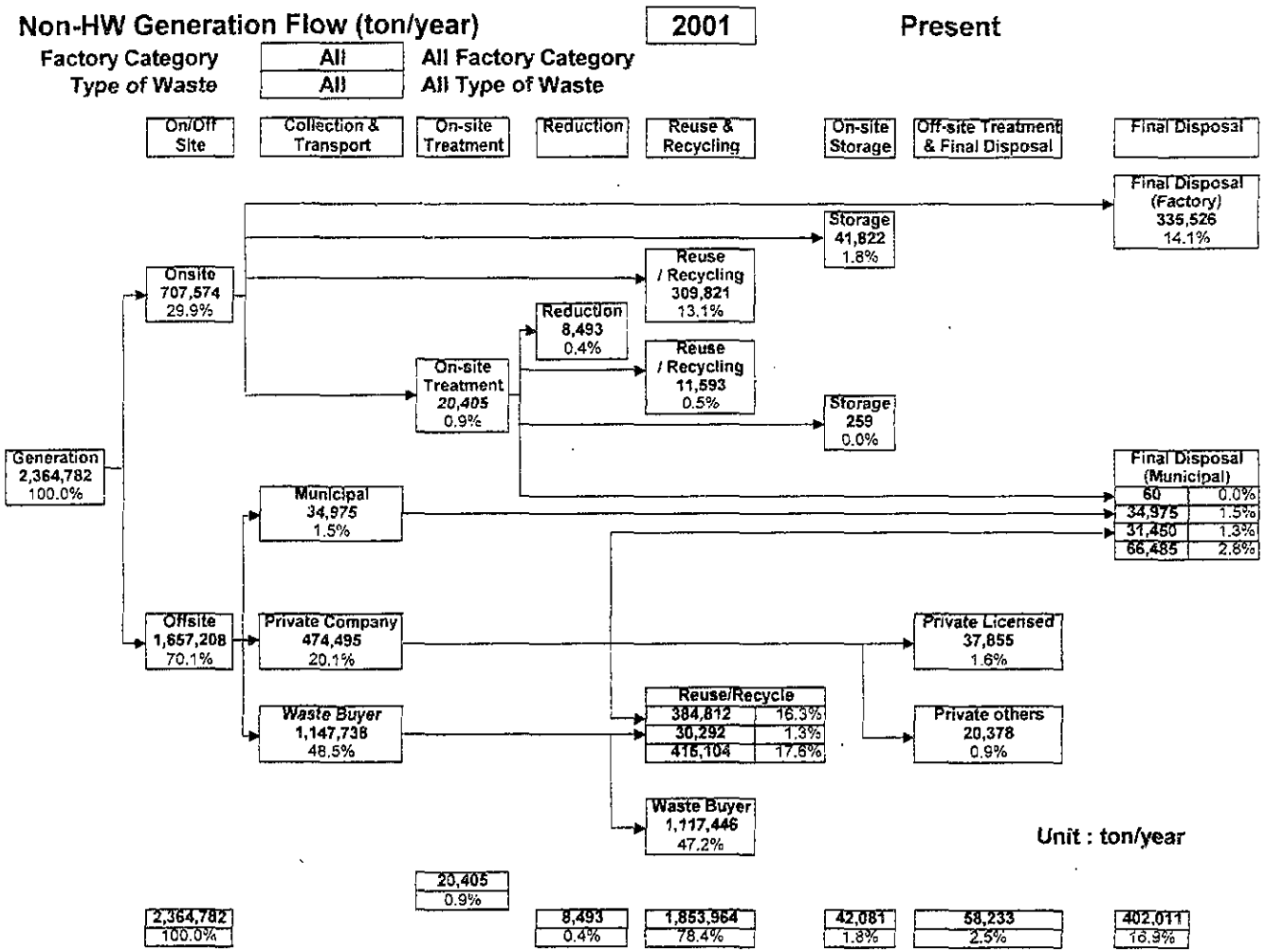


Figure 4-1: Non-HW Flow in the Study Area (2001)

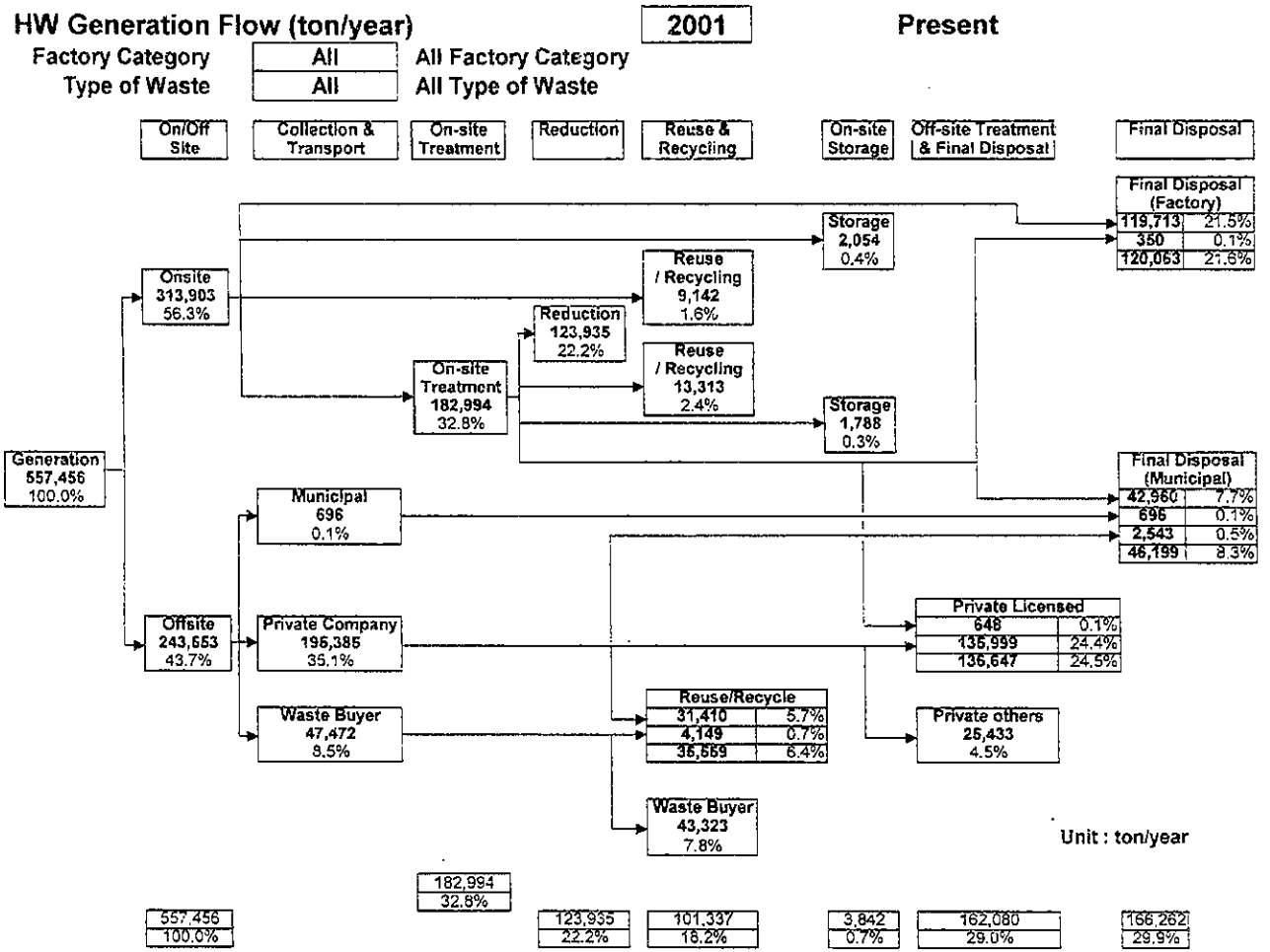


Figure 4-2: HW Flow in the Study Area (2001)

In order to understand current IWM it is important to know the following indicators of each category of IW and industry:

- Generation amount of each category of IW from each industrial sector, and its rate to total generation;
- Rate of on-site and off-site disposal; and
- Rate of reuse/recycling.

The team, therefore, presents the following 4 tables for presenting the above-mentioned indicators.

Table 4-18: Key Indicators of each Non-HW Category

MOI Notification No 1 (1998)	Non-HW Code for the Study	Descriptions	Total Generation Amount	% In total Generation	% of On-site Disposal	% of Off-site Disposal	% of Reuse/ Recycling
Group 1 - 1	C01-01	Parts of plants such as roots, barks and leave	58,096	2.5	0.0	100.0	100.0
Group 1 - 1	C01-02	Parts of animals such as bones, skins, hair and excreta	306,668	13.0	9.3	90.7	99.9
Group 1 - 2	C02	Parts of wood	382,775	16.2	22.6	77.4	98.3
Group 1 - 3	C03	Paper waste	91,307	3.9	1.2	98.8	97.8
Group 1 - 4	C04	Plastics or synthetic rubbers	163,704	6.9	6.1	93.9	86.9
Group 1 - 5	C05	Cloth, thread and fabric	112,911	4.8	21.7	78.3	90.8
Group 1 - 6	C06	Animal's fat and oil and vegetable oil	---	---	---	---	---
Group 1 - 7	C07	Natural rubbers	27,109	1.1	61.5	38.5	92.5
Group 1 - 8	C08	Metals and metal alloys (not in salt form)	720,592	30.4	26.5	73.5	81.5
Group 1 - 9	C09-01	Ceramics	34,421	1.5	100.0	0.0	0.0
Group 1 - 9	C09-02	Glasses	71,729	3.0	44.6	55.4	90.4
Group 1 - 10	C10	Stone, cement, sand or materials consisting of clay, sand or stone e.g. tile, brick gypsum and concrete	285,583	12.1	89.5	10.5	18.7
None	C11	Mixed waste	45,917	1.9	4.8	95.2	0.0
Group 2	C12	Others	63,970	2.7	39.8	60.2	76.5
Total	---	---	2,364,782	100.0	29.9	70.1	78.4

Table 4-19: Key Indicators of Non-HW from Each industrial Category

Study Code	Descriptions	Total Generation Amount	% In total Generation	% of On-site Disposal	% of Off-site Disposal	% of Reuse/ Recycling
G01	Food (agricultural product, non-aquatic animals, aquatic animals etc)	295,015	12.4	0.0	100.0	99.9
G02	Food (flour, sugar, tea, ice etc.)	11,881	0.5	0.0	100.0	14.5
G03	Drink, Beverage	47,208	2.0	0.0	100.0	96.6
G04	Textile, Thread, Fiber	64,299	2.7	20.2	79.8	94.3
G05	Textile product (Clothes, mats etc.)	53,513	2.3	17.7	82.3	99.6
G06	Wearing Apparel	54,835	2.3	0.0	100.0	79.6
G07	Hide, Fur, Footwear	42,163	1.8	67.5	32.5	77.0
G08	Woodwork (any or many items)	143,705	6.1	30.7	69.3	94.2
G09	Woodwork (bamboo, rattan, straw, cork etc.)	61,848	2.6	1.0	99.0	96.9
G10	Furniture	159,222	6.7	27.0	73.0	98.1
G11	Paper, Cardboard	48,735	2.1	10.3	89.7	96.8
G12	Printed matter	36,232	1.5	0.0	100.0	91.7
G13	Chemical matter, Petroleum	5,107	0.2	0.0	100.0	58.1
G14	Rubber	44,213	1.9	37.7	62.3	89.3

G15	Plastic product	93,787	4.0	0.1	99.9	99.6
G16	Glassware, Ceramics, non-Metallic Matter	105,949	4.5	64.8	35.2	52.4
G17	Steel basic industries, non-ferrous metal basic industries	668,620	28.2	61.9	38.1	49.9
G18	Metal product (tools, appliances, household furniture, building interior etc)	60,446	2.6	0.0	100.0	100.0
G19	Metal product (construction, installation)	47,439	2.0	0.0	100.0	97.7
G20	Metal product (others)	74,770	3.2	0.2	99.8	99.9
G21	Machines (Engines, Turbines, Machinery)	35,982	1.5	0.0	100.0	84.7
G22	Machines (for producing metal or wood products)	2,346	0.1	0.1	99.9	96.9
G23	Machines (for paper, chemical, food, textile etc.)	2,985	0.1	0.0	100.0	93.5
G24	Machines (calculating machines, Accounting machines, Water pumps, air or gas compressors etc.)	6,086	0.3	0.3	99.7	46.7
G25	Electric product (Machines or Product under No.70, Radio set, Electric instruments or appliances etc)	72,951	3.1	27.2	72.8	47.3
G26	Electric product (Electric Equipment)	35,599	1.5	5.3	94.7	98.2
G27	Transportation machines (Ship, Trains, Streetcars, Cars or Trailers)	6,986	0.3	0.0	100.0	95.0
G28	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles etc.)	30,774	1.3	37.7	62.3	98.3
G29	Precision machinery	1,426	0.1	19.1	80.9	73.0
G30	Others (Musical instruments, Sport, Toys etc.)	13,929	0.6	1.1	98.9	6.9
G31	Others (Electric power, Gas, Packaging, Cold storage etc.)	35,605	1.5	86.8	13.2	100.0
G32	Others (Engine-driven for vehicles or motorcycles etc.	963	0.0	0.0	100.0	100.0
G33	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt etc.)	163	0.0	0.0	100.0	100.0
Total	---	2,364,782	100.0	29.9	70.1	78.4

Table 4-20: Key Indicators of Each HW Category

HW Code for the Study	Descriptions	Total Generation Amount	% In total Generation	% of On-site Disposal	% of Off-site Disposal	% of Reuse/ Recycling
W01	Acid	1,881	0.3	0.2	99.8	0.0
W02	Alkalis	2,956	0.5	82.5	17.5	82.5
W03	Heavy Metal Compounds	4,555	0.8	0 0	100.0	45.7
W04	Liquid Inorganic Compounds	51,774	9.3	85.8	14.2	0.0
W05	Solid Inorganic Compounds	585	0.1	0.0	100.0	0.0
W06	Organic Compounds	14,579	2.6	8.6	91.4	32.2
W07	Polymer Materials	18,331	3.3	8.4	91 6	4.1
W08	Fuel, Oil and Grease	159,690	28.7	77.6	22.4	15.6
W09	Fine Chemicals and Biocides	18	0.0	0.0	100 0	0.0
W10	Pickling Waste	1,419	0.3	0.0	100.0	39.7
W11	Filter Materials, Treatment Sludge	180,238	32.3	68.2	31.8	1.4
W12	Other Toxic substance (besides W01-W11)	121,430	21.8	14.3	85.7	52.1
Total	---	557,456	100.0	56.3	43 7	18.2

Table 4-21: Key Indicators of HW from Each Industrial Category

Study Code	Descriptions	Total Generation Amount	% In total Generation	% of On-site Disposal	% of Off-site Disposal	% of Reuse/ Recycling
G01	Food (agricultural product, non-aquatic animals, aquatic animals etc.)	9	0.0	0.0	100.0	100.0
G02	Food (flour, sugar, tea, ice etc)	1,218	0.2	0.5	99.5	7.5
G03	Drink, Beverage	30,079	5.4	9 3	90.7	98 2

G04	Textile, Thread, Fiber	1,562	0.3	12.0	88.0	89.5
G05	Textile product (Clothes, mats etc.)	153	0.0	31.4	68.6	99.3
G06	Wearing Apparel	19	0.0	73.7	26.3	73.7
G07	Hide, Fur, Footwear	243	0.0	4.5	95.5	83.5
G08	Woodwork (any or many items)	2,264	0.4	89.5	10.5	95.2
G09	Woodwork (bamboo, rattan, straw, cork etc.)	48	0.0	0.0	100.0	100.0
G10	Furniture	5,820	1.0	2.0	98.0	74.3
G11	Paper, Cardboard	227	0.0	0.0	100.0	12.3
G12	Printed matter	9,156	1.6	0.0	100.0	100.0
G13	Chemical matter, Petroleum	45,395	8.1	37.5	62.5	33.5
G14	Rubber	1,357	0.2	0.0	100.0	96.9
G15	Plastic product	43,559	7.9	0.0	100.0	7.0
G16	Glassware, Ceramics, non-Metallic Matter	284	0.1	2.8	97.2	2.8
G17	Steel basic industries, non-ferrous metal basic industries	124,484	22.4	98.5	1 5	4.4
G18	Metal product (tools, appliances, household furniture, building interior etc.)	1,024	0.2	0.0	100.0	6.2
G19	Metal product (construction, installation)	1,848	0.3	0.0	100.0	85.3
G20	Metal product (others)	78,984	14.2	55.9	44.1	14.2
G21	Machines (Engines, Turbines, Machinery)	2,248	0.4	0.7	99.3	15.3
G22	Machines (for producing metal or wood products)	1,298	0 2	30.7	69.3	3.4
G23	Machines (for paper, chemical, food, textile etc.)	283	0.1	0.0	100.0	96.8
G24	Machines (calculating machines, Accounting machines, Water pumps, air or gas compressors etc.)	5,954	1.1	0.0	100.0	2.5
G25	Electric product (Machines or Product under No.70, Radio set, Electric Instruments or appliances etc.)	147,919	26.6	81.6	18.4	2.9
G26	Electric product (Electric Equipment)	6,247	1.1	0.0	100.0	39.0
G27	Transportation machines (Ship, Trains, Streetcars, Cars or Trailers)	17,663	3.2	10.5	89.5	4.0
G28	Transportation machines (Motorcycles, Tricycles, Bicycles, Aircraft, Wheeled vehicles etc.)	5,997	1.1	20.4	79.6	34.5
G29	Precision machinery	2,878	0.5	0.0	100.0	0.0
G30	*Others (Musical instruments, Sport, Toys etc.)*	*98*	*0.0*	*10.2*	*89.8*	*52.0*
G31	Others (Electric power, Gas, Packaging, Cold storage etc)	15	0.0	0 0	100.0	100.0
G32	Others (Engine-driven for vehicles or motorcycles etc.	18,114	3.2	1.5	98.5	32.5
G33	Others (Stone, Watches or Clocks, Central waste treatment plant, Generating steam, salt etc.)	1,009	0.2	40.5	59.5	1.2
Total	---	557,456	100.0	56.3	43.7	18 2

b. Limitations in the Use of the IW Flow

Though the team developed the IW flows, there are following limitations for the application of them. The team, therefore, recommends DIW to conduct additional factory surveys continuously in order to eliminate the limitations.

1. The flows are deduced from data obtained from the limited number of factories as shown in the table below.

Table 4-22: Rate of Factory Survey Data to Total of Study Area

	Factory Survey Data		Total		Rate to Total
	Number	Unit	Number	Unit	(%)
Number of Factories	206	Factory	33,092	Factory	0.62
Number of Employees	79,113	Employee	1,584,782	Employee	5.0
Non-HW Generation	118,904	ton/year	2,364,782	ton/year	5.0
HW Generation	27,349	ton/year	557,456	ton/year	4.9

2. As the estimation of IW generation requires the following basic data of the factories registered in the DIW and IEAT factory database, those factories that do not have the data are not counted in the study.
   - MOI factory code number; and
   - Number of employees.
3. Since the actual number of employees informed by the factories was 18 % more than that in the DIW factories registration database, the database seems not to be well updated. In addition the database does not have the factory registration data of industrial zones, industrial communities and industrial parks.
4. If 33 codes of industry generate each code of wastes (14 non-HW and 12 HW), theoretically there should be 858 (26 x 33) IW generation rates. However, from the factory survey the team obtained 288 IW generation rates.

4.2 IWM On-site

This section present IWM in factories based on the findings identified by the factory survey conducted at the 215 selected factories.

4.2.1 On-site Disposal

The term of disposal covers storage, discharge, collection, transportation, treatment and final disposal of waste. In a concrete term on-site disposal covers IW long-term storage, reuse/recycling, treatment and final disposal at the generation, i.e. factories, while off-site disposal covers IW collection/transportation, reuse/recycling, treatment and final disposal outside of the factories.

According to the IW flows made by the study the on-site disposal rate of HW (56.3%) is much higher than that of non-HW (29.9%). This is due to very high rate (on-site treatment: 32.8 + on-site final disposal: 21.6 = 54.4%) of on-site HW treatment/disposal compare with the rate (on-site treatment: 0.9 + on-site final disposal: 14.1 = 15.0%) of non-HW.

The highest rate of on-site HW disposal is W04: Liquid Inorganic Compounds (85.8%), followed by W12: Other Toxic Substance (85.7%) and W02: Alkalis (82.5%). On the other hand the highest rate of on-site non-HW disposal is C09-01: Ceramics (100%), followed by C10: Stone, Cement, Sand, etc. (89.5%) and C07: Natural Rubbers (61.5%).

4.2.2 Storage and Discharge

a. Separation of IW

According to the Factory Survey at 215 factories the separation of IW is not well conducted by the generators. The reasons are summarized below.

- As for the separation of HW from non-HW 17.2 % (13 + 24 = 37) of 215 factories discharge mixed wastes of HW and non-HW, and larger scale of factory more strictly conduct separate discharge.
- 24.6 % (53) of 215 factories do not strictly separate non-HW generated at the production process from non-HW from other sources in the factories (domestic/office waste). The reasons of no separation are mainly small generation, less need to separate and no ways for utilization.

b. Storage

33.5 % (72) of factories do not store IW inside according to the Factory Survey. It implies that the storage of IW is not well provided by the generators. The rate of factories that store their IW on-site increases in accordance with the number of employees.

66% (142) of factories replied IW is stored in their compound. 95.8 % (136) of 142 factories that store IW on-site separately store IW. However, purpose of on-site storage of the 142 factories is mainly temporal storage before collection (93.7%). The factories which temporarily store waste for the purposes of on-site reuse/recycling or on-site treatment/disposal are very limited and 2.1% and 2.8% respectively.

4.2.3 Treatment, Reuse and Recycling

Regarding on-site treatment, reuse and recycling the IW flows prepared by the study indicate the following aspects:

- On-site treatment rate of non-HW is very limited (0.9% of total generation) while that of HW is common (32.8% of total generation). Since on-site HW reduction rate by treatment is 22.2%, main objective of on-site treatment is considered as IW reduction.
- On the contrary on-site reuse/recycling rate of non-HW is much higher (13.6% of total generation) than that of HW (4.0% of total generation). However, on-site reuse/recycling rates of non-HW and HW are much smaller than those of off-site. Because off-site reuse/recycling rate of non-HW is 64.8% against 13.6% of on-site, and for HW 14.2% to 4.0%.
- The highest rate of reused/recycled HW is W02: Alkalis (82.5%: on-site 82.5% and off-site 0%), followed by W12: Other Toxic Substance (52.2%: on-site 10.4% and off-site 41.8%) and W04: Heavy Metal Compounds (45.7%: on-site 0% and off-site 45.7%). On the other hand the highest rate of reused/recycled non-HW is C01-01: Parts of plants such as roots, barks and leave (100%: on-site 0% and off-site 100%), followed by C01-02: Parts of animals such as bones, skins, hair and excreta (99.9%: on-site 9.3% and off-site 90.6%) and C02: Parts of wood (98.3%: on-site 21.2% and off-site 77.1%).

In addition to the above-mentioned aspects the following findings of the 215 Factory Survey indicate on-site treatment and reuse/recycle of IW is not very common compared to those of off-site:

- Only 14.9 % (32) of factories have on-site treatment of IW.
- Only 23.3 % (50) of factories conduct on-site reuse or recycling of IW.
- Only 10.2 % (22) of factories have on-site reuse/recycle plan of IW.
- 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.

4.2.4 Long-term Storage and Final Disposal

IW flows made by the study indicate on-site long-term storage is very limited but final disposal of IW is common:

- On-site storage of IW is very limited; i.e.0.7 % of total generation for HW and 1.8 % for non-HW.
- On-site final disposal of non-HW is 14.1% of total generation while 21.6% for HW. This indicates considerable amount of IW, especially HW, is disposed of at factory compound.

4.2.5 Industrial Cluster and Zero Emission

When waste as resource moves from factory A to factory B, and from factory B to factory C, etc. putting more than one factories together by the waste flow, the group of networked factories is called an industrial cluster in this report. In other words, an industrial clusters is formulated when two or more factories are linked by waste reuse/recycling activities.

Zero emission is a concept that aims to minimize waste that affects the environment by reducing waste generation and thickening the waste (resource) flow in the industrial cluster (Figure 4-3)。

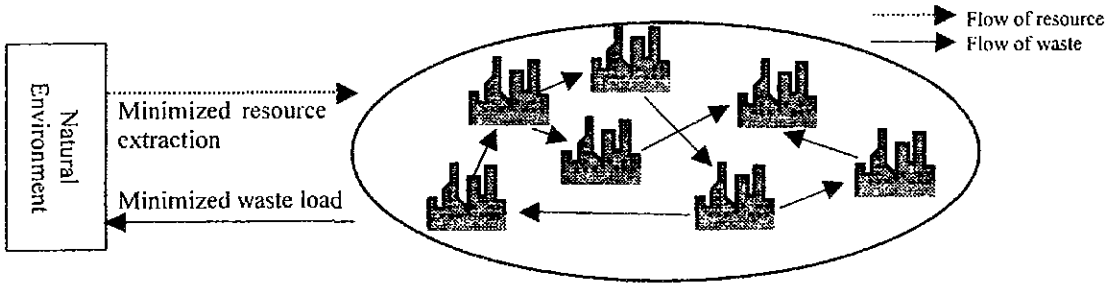


Figure 4-3: Illustration of Industrial Cluster and Zero Emission

The Zero Emission concept can be applied not only when an industrial cluster attempts to minimize waste load to the environment, but also when individual factories aim the minimization of waste to be finally disposed off by waste generation reduction and reuse/recycling, or when a society of a certain area as a whole

(city/town/village) intends to reduce the disposal amount of waste including municipal waste.

With such understandings of the terms, the current status of zero emission and the industrial cluster in Thailand is described below.

a. Zero Emission

a.1 Practices at Individual Factories

Activities toward zero emission done at individual factories can be considered as a combination of waste generation reduction and the promotion of on-site and off-site reuse/recycling, through which final disposal amount is to be minimized. With such understanding, the team summarizes zero emission practices as below.

- Promotion of generation reduction and recycling: The factory survey found that the majority of the surveyed factories do not have a plan to promote generation reduction or waste recycling.
- Recycling: Most of recyclable materials are traded with payment for off-site recycling.
- 17% of total generation of non-HW and 30% of total generation of HW are finally disposed of. The rate of on-site final disposal are particularly high, i.e. 14% and 22%, respectively.

Overall, the concept of zero emission does not seem to be widely diffused to individual factories.

a.2 Practices at Factories of Japanese Companies

The environmental committee of Bangkok Japanese Chamber of Commerce (JCCB) has conducted a questionnaire survey regarding their environmental issues, concern and activities to Japanese companies in Thailand from June to August of 2001. Among its 1,144 member companies, two hundred companies replied. The replying rate was 17.4%. According to the results, 83.5% of respondents answered that they regarded the environmental issues as primarily and/or comparatively important. 51% of respondents pointed out that industrial solid waste management was the first priority problem (Waste treatment, 26.0%; Energy conservation, 21.5%). Especially, they felt that a lack of treatment and disposal facilities for industrial solid waste and high treatment and disposal cost were the special concerns.

The following table summaries environmental activities of the respondents. 50% of the companies answered that they were conducting energy and resource conservation activities since these activities would have high cost reduction effects. Subsequently, waste reduction and zero emission followed. Because energy and resource conservation contributes to waste reduction and is closely related to zero emission, on the whole, the factories of Japanese companies in Thailand are highly motivated to achieve zero emission.

Table 4-23: Environmental Activities of Japanese companies belonging to JCCB

Industries	Number of factories	Environmental education	Reduce waste/ Zero emission	Development of recycle system	Environmental friendly products	Acquisition of ISO 14001	Communication with community	Energy & resource conservation
	Nos.	Percentage to 200 total companies						
All Companies	200	55.5	31.0	25.5	11.5	32.0	9.0	47.5
Manufacturing	148	60.1	35.1	24.3	11.5	38.5	7.4	50.7
Food	12	66.7	25.0	25.0	8.3	16.7	16.7	41.7
Fiber/Textile	10	80.0	30.0	10.0	20.0	20.0	20.0	50.0
Chemicals	24	62.5	33.3	25.0	20.8	45.8	4.2	54.2
Metal	12	58.3	16.7	25.0	8.3	41.7	8.3	50.0
Machinery	6	66.7	33.3	0	0	33.3	16.7	66.7
Electric/Electronics	39	48.7	46.2	28.2	5.1	35.9	7.7	61.5
Automobile	25	56.0	36.0	28.0	16.0	52.0	0	44.0
Others	20	ND*2	ND	ND	ND	ND	ND	ND
Non-Manufacturing*1	52	42.3	19.2	28.8	11.5	13.5	13.5	38.5

Note: *1. Including Trade (14 companies), Construction (12), Transportation & Telecommunication (11), Others (15), *2: No Data
Source: "Questionnaire Survey on Environmental Issues to Japanese Companies in Thailand (Summary)", Environmental Committee Bangkok Japanese Chamber of Commerce

a.3 DIW's Activity

DIW's approach to zero emission is rather practiced as part of its CT (cleaner technology) policy.

DIW has studied the Cleaner Technology jointly with the industrial sector, various agencies, universities, etc. with the collaboration of Danish Cooperation for Environment and Development (DANCED) since August 1998 and concluded the discussion as the Cleaner Technology Policy for Thai Industry. The "Cleaner Technology Policy for Thai Industry Second Edition" published in June 2001 includes the following activity plans and part of them has been already implemented.

- To establish CT committees of some of industrial sectors whose members are composed of the relevant ministries and departments (DIW, PCD, OEPP, Department of Industrial Promotion of MOI, etc.), Universities, and related industrial sector experts and industrial associations. The committees will formulate CT criteria, guidelines, incentives and other policy instructions. The committees of diary sector and rubber sector were established. The committee of frozen seafood sector will be formulated in the next fiscal year starting in October 2002.
- To establish a CT verification committee. The current activity includes assistance for IFCT (Industrial Finance Cooperation of Thailand) when it needs to determine whether a project which applies for IFCT loan aims at CT and