- To reuse waste at cement factories as alternative raw material.
- To promote on-site reuse/recycling of waste that is currently reused/recycled off-site, as far as it is economically viable.
- To properly control stocks of products and samples by blending them into products.
- To collect such waste as powder paint and mix it with products.

3. As for waste paint, generation reduction should come first. Once generated, it must be properly recycled or treated as follows.
   - To develop a system to collect waste paint from paint factories including small and medium sized factories by, for example, promoting waste collection by waste blenders, or having the raw material transporters collect waste paint on their way back.
   - To reuse waste paint as alternative raw material for cement production. The problem is that the amount of waste paint from individual factories is small and its quality varies from factory to factory. It is required to promote the waste blending industry, which blends waste and adjust its quality and quantity to the requirement of the cement factories.
   - To promote the use of the incinerator currently under construction for the thermal treatment of waste paint which cannot be accepted by the cement factories due to the high content of chlorine and/or heavy metals.
   - To stop landfilling waste paint which is not solidified enough.
4. As for waste solvent, the team recommends the following measures to maintain the present 100% reuse/recycling system.
   - To further promote off-site waste solvent recycling that is well developed at present. The team investigated the financial feasibility of the construction of a new factory that recycles a half (1,300 tons/year) of solvent generated in the whole study area. As a result, it was concluded to be feasible by the current selling price of recycled solvent at 24 bahts per kg if the cost for land and building construction, which shares significant part of estimated initial investment, is hold down enough (see Section 12.4.1 of the Main Report).
   - To promote paint factories that consumes large amount of solvent to install waste solvent distillation equipment after thorough examination of financial feasibility. The team investigated the financial feasibility of on-site waste solvent recycling at a paint factory. As a result, it was presumed that the financial viable level of on-site recycling of waste solvent would be around 100 liters per day of waste solvent recycled (see Section 12.4.2 of the Main Report).

4.3 Pilot Projects

Pilot projects (P/Ps) are the experimental implementation of some important components of the action plan (A/P) to be made in the study. Therefore, the

objectives of the P/Ps are to draw lessons, to examine the potential drawbacks and countermeasures, and to make the A/P more practical.

DIW and the team concluded that the following three items were to be carried out as the P/Ps:

- development of a waste exchange database (hereafter to be called PP1, including designing the waste exchange program).
- pilot waste exchange (hereafter to be called PP2).
- improvement of DIW factory database management (hereafter to be called PP3).

4.3.1 Waste Exchange Database (PP1)

a. Survey on Needs of Waste Exchange

In order to collect information of waste for supply or in demand, a questionnaire was sent to 5,760 factories which are listed in the DIW's factory database and have employees more than 50. The questionnaire is shown in the Annex 13.1. Consequently 1,014 factories replied.

b. Findings of the Survey

Findings of the survey are reported in Annex 13.2.

374 factories in total intend to supply 886 categories of wastes for waste exchange program of IW (Table 4-2). However, only 31 factories in total want to use 43 categories of wastes from waste exchange program (Table 4-3).

Table 4-2: List of Waste Available for Supply

Study Waste Code*	Number of Factories that can supply	Description
C01-01	6	Waste of Tree
C01-02	18	Waste from Animal
C02	53	Wood
C03	76	Paper
C04	76	Plastic, Polymer, Resin, etc.
C05	49	Textile
C06	8	Vegetable oil, Animal oil, Animal fat, etc.
C07	13	Natural rubber
C08	119	Metal, Metal alloy, Mixed metal, etc.
C09-01	4	Ceramic
C09-02	3	Glass
C10	27	Sand, Cement, Stone, Gypsum, etc.
C11	7	Mixed waste
C12	53	color wash powder, Treatment sludge, etc.
W01-01	17	Inorganic acid
W01-02	1	Organic acid
W02	10	Alkali
W03-01	2	Heavy metal compound
W03-02	19	Heavy metal compound, Heavy metal

W03-03	16	Heavy metal compound, Heavy metal, etc.
W04-01	3	Plating Waste
W04-02	6	Liquid Inorganic compound
W05	5	Solid Inorganic compound
W06-02	35	Organic compound, Solvent
W06-03	1	Organic compound
W07-01	7	Polymer material
W07-02	2	Polymer material
W07-03	4	Polymer material
W08-01	60	Oil, Grease
W08-02	15	Chlorinated solvent, Fuel, Methylene chloride
W08-03	21	Oil, Fuel, etc.
W09	1	Fine chemical and Biocide
W10	3	Pickling waste
W11-01	39	Treatment sludge, Filter material
W11-02	3	Pickling waste
W12-01	13	Other Toxic substance
W12-02	51	Waste from Specific Process, Other Toxic substance, etc.
W12-03	40	Other Toxic substance, Chemical container, etc.
Total	886	---

*See the code table in the opening pages of the report.

Table 4-3: Waste Demanded

Study Waste Code*	Number of Waste	Description
C01-02	3	Waste from Animal
C02	5	Wood
C04	2	Polymer
C05	3	Textile
C08	14	Metal, Metal Alloy
C10	2	Gypsum, Stone
W01-01	2	Inorganic acid
W01-02	3	Organic acid
W02	5	Alkali
W07-02	1	Polymer material
W08-01	2	Oil
W12-03	1	Chemical dust
Total	43	---

*See the code table in the opening pages of the report.

c. Waste Utilization Database

The information of waste that the respondent factories want to supply or receive were integrated into the database. The database has a link with the DIW's factory database and is accessible via internet. The system to allow factories to use this database for their waste reuse/recycling activities was named "Waste Utilization Data Center" by DIW.

d. Plan of the Operation of WUDC

With the proposal from the team about the operation of WUDC, its operational scheme was concluded as described below.

d.1 Fundamental Rules

Fundamental rules to be known to all the users have the following three components.

(i) Users

Factories which have the DIW factory registration number and filled in necessary information of the user registration form can fully enjoy the service of WUDC. Those who do not have the DIW factory registration number have a limited access to WUDC.

(ii) Legal consideration

Factories which intend to supply their waste to the others for reuse/recycling are subject to MOI Notifications No. 6 (B.E. 2570) in regard to non-hazardous waste and No. 1 (B.E. 2541) in regard to hazardous waste pursuant to the Factory Act B.E. 2535 and may need to obtain a waste transport permit from DIW. They may also need to follow the manifest system.

(iii) Disclaimer

WUDC is exclusively responsible for providing information on waste for supply and waste in demand provided from the registered users. The implementation of waste exchange is totally dependent on negotiation between the supplier and the user. Accidents, contract troubles, and any other conflicts should be solved by the parties concerned.

d.2 Methods to Access WUDC

There are two methods to access WUDC: on-line and off-line. On-line users access WUDC on the internet, and off-line users refer to the Newsletters and, if they are factories with DIW registration, post a user registration form, supply sheet, and/or demand sheet.

The on-line operation flow of WUDC is illustrated in Figure 4-2.

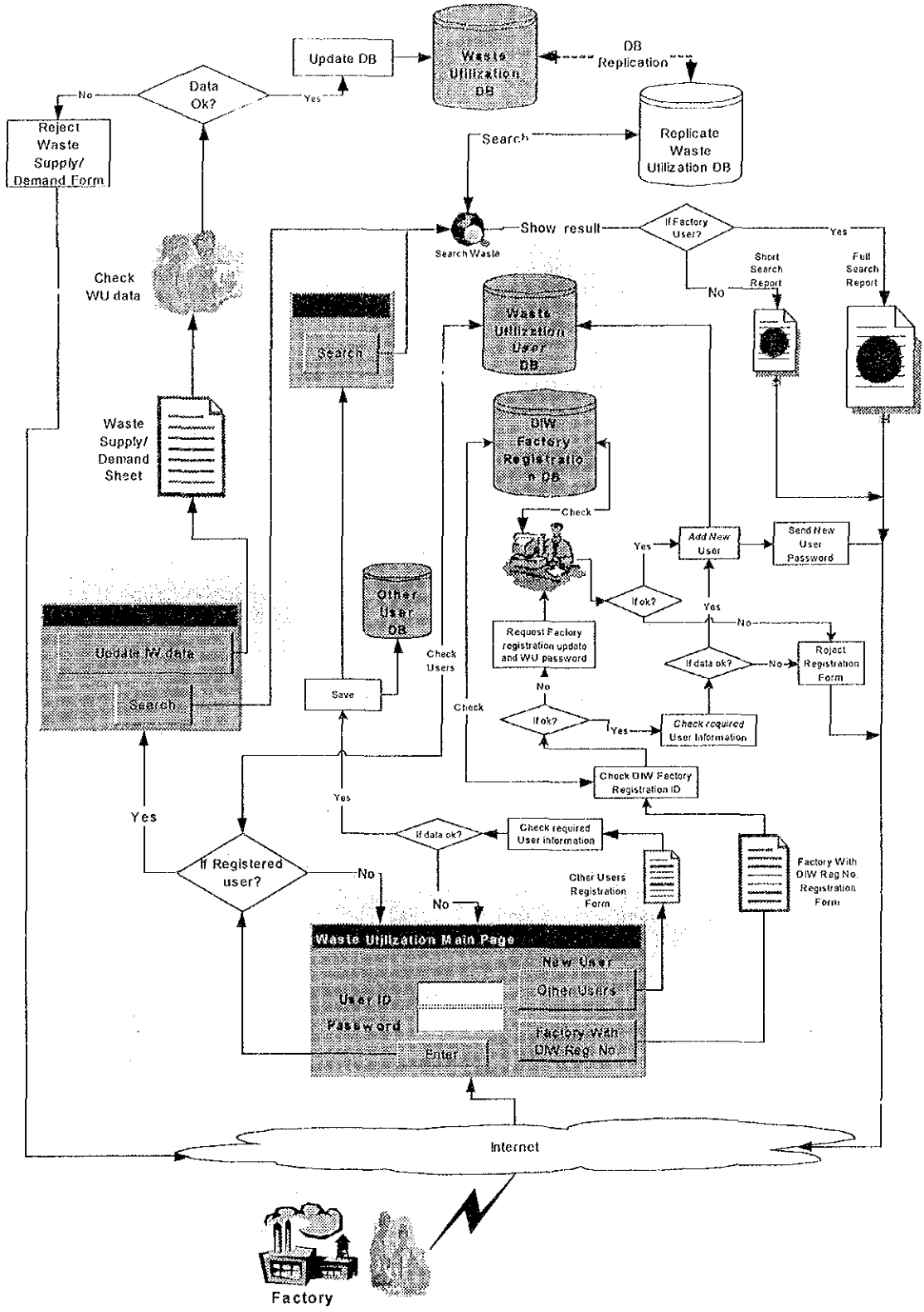
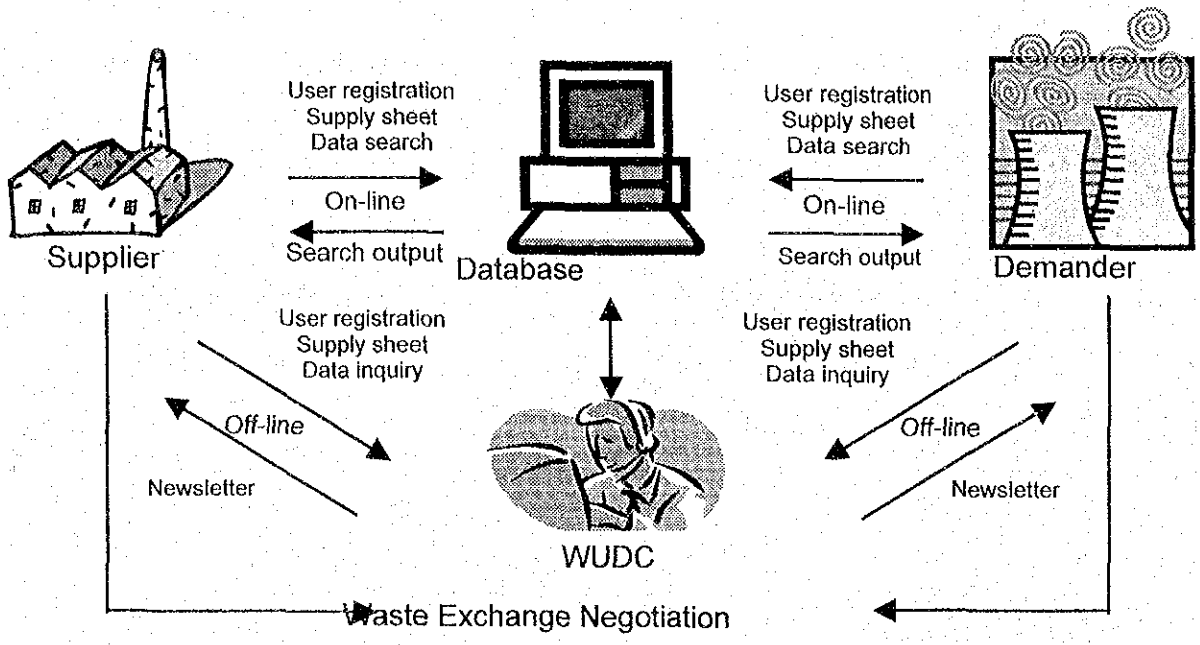


Figure 4-2: On-line Operation Flow of WUDC

d.3 Operational Scheme

The figure below illustrates the operational scheme for Users with DIW registration number.



Users without DIW registration number can only do the database search at the web site and obtain only a few items of the database.

d.4 WUDC Website

The WUDC website opened for the convenience of the users to register information and to find potential partners. The manual for the user to operate the website and the manual for the administrators to manage the website are in the Annexes 13.4 and 13.5.

d.5 WUDC Operation and Maintenance

Based on the recommendation of the team, DIW appointed four staff for the operation and maintenance of WUDC. They will carry out overall control of the system, data check of the information on waste for supply and waste in demand, public relations, website management, and others.

e. Evaluation of WUDC

The team had meetings repeatedly with DIW to define the structure of WUDC. The team designed WUDC with respecting the requests and opinions of DIW but the team recognizes the necessity to raise some issues for the improvement of WUDC. They are described below, together with advantages of WUDC.

- Excessive dependence on a computer or internet can exclude part of factories. As the volume of data in the database is one of the important elements to make WUDC useful, DIW should retain a system to allow factories to use WUDC by traditional communication means, with recommending them to have an internet access in parallel.

- When DIW finds an inappropriate waste supply/demand sheet, DIW does not put it into the database. There should be a way for the applicant to try again by receiving feedbacks on how to fill in the sheet.
- The website shows the name of factories. This is good to improve the reliability of information, but it is anticipated that some factories will not join WUDC due to reluctance to open their names.
- It is recommended to increase the number of WUDC users and demanders in particular. Factories, which have demand for waste, which have enough facility to reuse waste, but which do not have DIW registration number, should still be able to submit demand sheets. Also, waste exchange can be more successful if various sectors are involved. For this purpose, WUDC will need to have a linkage with other waste exchange programs which are expected to start at other organizations such as TEI.
- In many cases, waste exchange is not straightforward, and technical input is necessary. Even though waste exchange could bring economic benefit to recover initial cost, it seems to be difficult to expect technical input by either waste suppliers or waste demanders. One possibility is that the DIW gives technical advice to the users with a support of expertise of other organizations such as TEI. The other way will be to promote waste dealing business which provides technical services such as consulting, waste quality adjustment, partner finding, and others.
- The waste supplier needs a transport permit before supplying waste. For their convenience, the permit should be issued without unnecessary delay. On the other hand, the promotion of waste exchange may overlook disguised waste transport. DIW needs carefully examine prior the issue of a permit whether the receiver is capable as a waste receiver.

4.3.2 Pilot Waste Exchange (PP2)

a. Introducing Suppliers to Demanders

The team sorted out which factory can supply waste that is demanded by another by analyzing the database developed in PP1. Due to the excessive number of the suppliers, the team constructed a scoring role so that waste with higher possibility to be actually supplied would be ranked higher. The selected suppliers who got higher marks and whose willingness to carry out waste exchange was confirmed were then introduced to the corresponding demanders, whose intention to receive waste was also confirmed by the team before hand. The number of potential waste suppliers in total in the database and the number of selected potential waste suppliers introduced to the demanders are shown in Table 4-4.

Table 4-4: Number of Selected Suppliers to be Introduced

Information of Demander					Number of Potential Waste Suppliers in Total	Number of Selected Potential Waste Suppliers to be Introduced
Factory No. (Demander)	Study Code	MOI Code	Waste Code	Name of Waste		
F01	G01	006	C01-02	Bone, Skin, Meat	8	4
F02	G01	008	W02	Soda Slurry	6	2

F04	G04	022	W01-02	CH_3COOH	1	1
			W02	NaOH	6	4
F05	G04	022	W01-02	Organic Acid	1	1
F06	G04	022	W01-02	H_2SO4, HCl, Other Organic Acid	9	3
F07	G04	022	W08-01	Oil Waste	72	5
F08	G05	027	C04	PVC	5	2
F09	G06	028	C05	Elastic Cloth	34	8
F10	G06	028	C05	Polyester Fiber	1	1
F11	G07	032	C01-02	Bone	2	1
			C01-02	Viscera, Skin	11	4
F12	G07	033	C04	Synthetic Leather, PVC	6	3
F13	G08	034	C02	Pieces of Wood, Sawdust	43	6
F14	G08	034	C02	Pieces of Wood	38	6
			C02	Sawdust	13	4
F15	G09	036	C02	Plywood, MDF	2	2
			C05	Pieces of Cloth	35	4
F16	G09	036	C10	Soil	2	2
F17	G10	037	C02	Pieces of Wood	38	11
F18	G14	052	W01-01	Inorganic Acid	14	6
			W02	Alkali	10	3
F19	G14	052	W02	Caustic Soda	6	3
			W07-02	Latex Rubber	1	1
F20	G16	058	C10	Gypsum, Plaster	6	3
F21	G16	058	W08-01	Lubricating Oil	27	4
F23	G17	059	C08	Iron Scrap	51	4
F24	G17	059	C08	Low Mn Metal	51	4
			C08	Stainless Steel	5	2
			C08	Steel for Striking Fire	48	9
F25	G17	059	C08	Low Mn Metal	51	4
			C08	Metal	97	7
			C08	Stainless Steel	5	2
F26	G17	060	C08	Piece of Copper	14	3
			C08	Piece of Zine	6	3
F27	G17	060	C08	Aluminium	12	4
F28	G20	064	C08	Iron Scrap	51	6
F29	G20	064	W02	NaOH	6	3
F30	G21	065	C08	Aluminium Scrap	12	3
			C08	Iron Scrap	51	5
F31	G21	066	C08	Iron	51	5
Total Factories 29			Total Waste 41	---	908	158

Note (*): Some factories are counted twice or more since they can supply two or more kinds of waste.

b. Follow-up Work

It was intended that some of the demanders, after making contact with the introduced suppliers, would seek assistance and/or advise from the team, and pilot waste exchange would be carried out by such factories. However, no factories contacted the team by the predetermined deadline.

Therefore, the team determined to do a follow-up work in order to know the progress of waste exchange. The result is Table 4-5.

Table 4-5: Status of Demanders

Status		Number of Demanders	
		October 2001	December 2001
Ax	Negotiation failed.	0	3
A	The negotiation with supplier(s) is in progress.	8	6
B	The demander intends to start negotiation.	3	6
C	The demander does not yet decide whether to start.	11	4
D	The demander decided not to take actions because they are not satisfied with the information provided by the team.	3 (Other suppliers were then introduced.)	2
E	The demander decided not to take actions.	4	7
Z	The team could not trace.	0	1

c. Lessons Learned

- Factories should be well motivated to exchange waste in some way. The methods to motivate them will include the clear propagation of the governmental policy to prioritize waste exchange (or waste reuse/recycling) over waste disposal, and the publicity about how to realize waste exchange which brings benefit.
- The publicity of the program not only in the study area but also in much wider area or even nationwide, and the dissemination of technical knowledge on waste reuse/recycling are required to increase the number of users.
- In this pilot project, information was given in an asymmetry manner where initiative is left with the demanders, but in the online system of WUDC, information distribution becomes to be symmetry, and in some cases, suppliers will be more aggressive to execute waste exchange than demanders.
- The WUDC users should describe their waste available or their request for waste as in detail and precisely as possible.
- Due to the time constraint, waste information given by the team to the 29 demanders might not be kind enough for them. Because. the waste exchange database and its website are finally completed, such problems should be sorted out.
- The participation of mediating agents, who collect waste from several sources and deliver it as raw material, will be desirable in order to solve mismatches between the users and suppliers in terms of not only quantity but also quality.

d. Newsletter and Leaflet

For the PR purpose, DIW and the team issued two issues of newsletter and a leaflet. These are presented in the Annexes 13.6, 13.7 and 13.8. DIW will continue to issue the newsletter that will appear in DIW Magazine, which has been issued by DIW.

4.3.3 Improvement of DIW's Factory Database Management System (PP3)

a. Background and Objectives

The hindered data communication between the IT Center and the industrial provincial offices requires immediate improvement of the system and the team proposed in Section 3.1 that this should be an action plan.

Meanwhile, WUDC needs to obtain as many users as possible in order to be practically useful for the industries. Since the industrial provincial offices have close relations with factories located in their jurisdiction areas, it is preferable that the regional offices serve as contacts between WUDC and local factories.

With such understanding, the team and the C/P carried out pilot project 3 consisting of two component with objectives below.

- Smooth data transmission from one of the selected provincial regional office to the DIW headquarters (IT Center), and drawing lessons from this experience for the future data management system improvement between the other 74 regional offices and the DIW headquarters.
- Increase the publicity of WUDC and the number of WUDC users by WUDC dissemination activities at the provincial office.

After the discussion between the team and the C/P, it was decided that PP3 would take place at the Nonthaburi office.

b. Component 1 of PP3: Factory Database Improvement

b.1 Activities of PP3

To improve the factory DB, the team installed IT equipment to the IT Center and Nonthaburi office, and developed an interface program (IP).

b.2 Findings from the Application of the IP

In the attempt to apply the IP to the database update, the team found some fatal issues that severely hamper the update process. The next table shows which field of Nonthaburi DB corresponds with which field of DIW DB and what problems aroused when data were to be transferred.

Table 4-6: Problems Found in Data Transfer

Field Name in Nonthaburi DB	Field Name in DIW DB	Problems in Updating	Update
code	facreg	1. In Nonthaburi DB, data is expressed in such a format as ๆ 3-10(1)-1/44 นน, while in DIW DB, ๆ01001300144นน although these mean the same. 2. The number of factories in Nonthaburi DB is 1,525 and in DIW DB, 1,439. 1,382 factories are on the both DBs, but many of the others might be registered by different registration numbers due to typing errors, etc. Such factories need identification.	1. IP 2. MO
location	faddr	In the Nonthaburi DB the address is in one field and in	MO

	fmoo soi road	the DIW DB it is separate in 4 fields. It is not possible to update the data automatically.	
amp_no	prov amp	The province code number and the ampur[7] code number is in one field [amp_no] (e.g. amp_no=**1203**) in the Nonthaburi DB, and in the DIW DB they are separate in 2 [prov] and [amp] (**12** and **03**). The IP operates as follows: • Transfer 2 digits from left of [amp_no] to [prov] • Transfer 2 digits from right of [amp_no] to [amp]	IP
tambol	tumbol[8]	In the Nonthaburi DB data is the tumbol name and in the DIW DB a code for tumbol is used. Each tumbol has a numerical code. The interface program will transform the name of the tumbol in the DIW tumbol numerical code and then update this field.	IP
Man women	mansk manonsk womsk womnonsk	In the Nonthaburi DB the number of employees is classified in man and women, and in the DIW DB it is classified in man skilled and man nonskilled, woman skilled and nonskilled. It is not possible to update the data automatically.	MO
tcode	class	The Nonthaburi DB uses 5 digits and an additional Thailand language character for industrial type and the DIW DB uses 5 characters. The IP will update only 5 characters from left of [tcode].	IP
	last_user	This field will be updated with the name of the officer that updates the data.	IP
	last_update	This field will be updated with the date of update in DIW	IP
location	ADD_OWN MOO SOI ROAD	In the Nonthaburi DB the address is in one field and in the DIW DB it is separate in 4 fields. It is not possible to update the data automatically.	MO
office_wat office_amp office_tam	PROV AMP TUMBOL	In the Nonthaburi DB, data are in a text format while data in the DIW DB are code numbers. IP transforms the name of province, amphoe, and tambol to each code number.	IP IP IP
	LAST_USER	This field will be updated with the name of the officer that updates the data.	IP
	LAST_UPDATE	This field will be updated with the date of update in DIW	IP

MO=Manually by DIW officer, IP=automatically by the interface program

b.3 Next Steps for Improvement

In order to proceed the database update, DIW should do the followings in a stepwise manner shown in the table below.

[7] Ampur is a variation of the spelling of "amphoe" used in Chapter 2 which means district.
[8] Tumbol is a variation of the spelling of "tambol" used in Chapter 2 which means sub-district.

Table 4-7: Proposed Database Update Process

	2002	2003	2004	2005
Development of Universal Database Structure				
Review of PK				
Development of Universal Database Structure				
Application of the New Database Table Structure				
Stepwise Application of the New Database Table Structure				
Data Transfer				
Review and Modification of IP				
IP Installation after the New Database Table Structure Applied				
Data Transfer after IP Installed				

b.3.1 Development of Universal Database Structure

Before updating the data, the database structure of DIW DB and DBs of all the provincial industrial offices should be identical. DIW should survey the database structure of all the provincial industrial offices, clarify the difference, and develop an universal database structure that can be applied to all the database with the least trouble.

The most critical issue is the difference in the data format of PK (factory registration number). The current IP can convert the factory registration number, but in fact, the conversion of PK is not recommended for the security reason. Furthermore, the structure of the factory registration number is complex and it uses Thai letters that not all the PC can display, thus it is not a suitable PK. The team recommends DIW to develop a new PK, while the present PK is used complementary.

Since the DIW DB is linked with other many DBs of DIW, the team presumes that the new universal DB structure is developed based on the DIW DB structure. The team's recommendation on the new PK and the universal database structure are shown in the Main Report, Section 13.4.

b.3.2 Application of the New Database Table Structure

Once the universal database structure is developed, it should be applied to all the factory databases at DIW and the provincial industrial offices. It will be necessary to carry out intensive training programs for officers engaged in the database at all the offices and thoroughly prepare manuals and other documents.

b.3.3 Data Transfer

The IP may need some modification to be applicable to the universal database structure. The IP can be finally installed to the provincial industrial offices step by step and data can be transferred using the new PK.

c. Component 2 of PP3: WUDC Dissemination

c.1 Activities

The C/P and the team called for the participation to the WUDC dissemination meetings to 315 factories in Nonthaburi province, and 92 factories applied. The dissemination meetings were held trice a day for 5 consecutive days. The total attendants were 88 people.

c.2 Output of PP3

c.2.1 Increase in WUDC Data

During the dissemination meetings, 35 factories (42% of factories that attended) joined WUDC as new users, and 5 cases of waste demand information and 17 cases of waste supply information were added. Comparing with the result of PP1 that obtained 43 cases of waste demand information and 886 cases of waste supply information, the rate of waste demand information in PP3 was substantially high. The primary objective of the PP3, i.e. the increased number of WUCC users, was adequately achieved.

c.2.2 Enhancement of DIW's Capacity to Manage WUDC

The executer of the dissemination meetings was DIW: 8 DIW officers including those in charge of WUDC, other staff of Factory Environment Technology Bureau, and the staff of IT Center gave lectures and instructions of using the web site. They not only conveyed necessary information about waste management and waste exchange to the attendants, but also had a direct communication with people from factories on the issue of waste, which turned to be valuable experience to enhance the DIW7s capacity to manage WUDC.

c.2.3 Feedbacks from the Attendants and Response to Them

Simple questionnaires were given to the attendants who were asked to write their opinions freely. The major opinions, and the team's opinion about those and response of DIW were as follows.

Table 4-8: Major Opinions from Attendants

	Opinions from Attendants	Team's Opinion, DIW's Response
1.	We support the idea of WUDC and hope that WUDC becomes widely known to more factories to increase its information volume. This project is worth carrying out and should be planned at other provincial industrial offices.	The team considers that the performance of DIW was appreciated by the factories. The execution of the similar project at other provincial industrial offices is the team's proposal. DIW also recognizes the necessity to do so.

2.	Database should be always updated, and information should be given to factories.	All the new data are temporally stored in the temporal database first, and transferred to the real WUDC database after checked by the WUDC staff. WUDC. Such explanation might be lacking during the meetings. As described earlier, the IP to link the provincial industrial office and IT Center to convert factory data was developed. Using the IP, there will be no troubles due to the delay of updating the factory database of IT Center. The team and DIW issued the WUDC Newsletter twice in PP2. DIW plans to include an article about WUDC in the DIW Magazine, which has been regularly issued by DIW, to publicize newly registered waste information.
3.	(Opinions from five factories that attended) We are not used to use the internet and did not fully understand WUDC. There should be other options to join WUDC except for the internet.	WUDC allows factories to submit user registration forms, supply sheets, and demand sheets by writing. Such explanation might be lacking since the PP3 focused on the exercise of using the web site. It is clear that the necessity to pay attention to the off-line users as pointed out in section 4.3.1.e. DIW should be ready to receive the inquiries via telephone or fax and to input data on behalf of factories.
4.	There should be users that are not factories.	The team agrees In fact, DIW has received an application for user registration from organizations other than factories and well recognizes that waste recycling is not necessarily limited among factories.
5.	We hope that DIW provides services for waste management at factories not only waste exchange.	The team considers that WUDC is a good opportunity for DIW to make the relationship with factories closer. Learning the experience of WUDC, and developing its waste management system including the execution of regular industrial waste survey as proposed by the team elsewhere, DIW will understand more about the issues of waste management at factories. In doing so, DIW should examine what sort of services is in need.

c.2.4 Other Issues

The activities of the DIW staff in the PP3 were more than satisfactory. Unfortunately, however, the involvement of the officers of the Nonthaburi office was only limited. It is preferred that for the convenience of factories, the provincial industrial offices act as a contact window to receive questions about WUDC from factories and to probably allow factories without internet access to use computers. As commented by the attendants, it is recommended to carry out the similar project in other provincial industrial offices, but it is important for DIW to clearly show its full commitment in the promotion of WUDC to the provincial industrial offices and promote their involvement.

4.3.4 Overall Evaluation of the Pilot Projects and Tasks for the Future

Three pilot projects that were carried out can be considered as the test operation of two action plans proposed in Chapters 9 and 10: "Improvement of Data Control

System" and "Waste Exchange Plan". In regard to these two action plans, the overall valuation of the pilot projects is as follows.

a. Evaluation of Establishment of WUDC

a.1 Overall Evaluation

Waste exchange is in general accepted to the majority of people, but the materialization of waste exchange is in reality associated with various problems. However, now that the main focus of waste management is shifting from appropriate waste treatment and disposal to the minimization of waste generation, the promotion of waste exchange is a requirement of the modern society. Moreover, as the factory survey by the study team shows, trade routes of various waste have been developed in the study area, and waste trade will become more dynamic if information on where exists what kind of waste is available.

Accordingly, the team concludes that DIW should make the best use of WUDC as one of the action plans.

a.2 Tasks for the Future

a.2.1 Number of the Users

The number of the WUDC users must be as large as possible and DIW needs to make every effort to increase the user number. The dissemination of WUDC to the outside of the study area, development of cooperative works with FTI and other industrial groups for publicity, utilization of provincial industrial offices, aggressive request to the Code 106 factories to join WUDC, involvement of non-factory users or cooperation with other waste exchange promoting organizations, and public relations activities via DIW Magazines or other mass media are necessary.

a.2.2 Tracing Waste Exchange Negotiation

A question "whether waste exchange was realized" always remains. There is practically no way to trace the result of negotiation, but the application for transport permits and the record of modification/deletion of waste information by WUDC users can be hints for DIW to guess the result of negotiation.

The modification or deletion of waste information is left up to voluntary action of WUDC users. It will be recommended to show a message to urge the users to update their waste information whenever they log-in the site, or to add a new box to the supply sheet that shows how much percentage of waste has been exchanged.

a.2.3 Institution for O&M

DIW has appointed four staff to the O&M work of WUDC and the IT Center is ready to technically support the O&M of the database and web site. The institutional foundation has been established for the initial stage.

Strengthening the O&M institution will be necessary by such ways as the development of close relationship between DIW headquarters and provincial industrial offices, development of linkage with other organizations for effective waste reuse/recycling, paying sufficient attention to off-line users and keeping record of users' enquires in order to learn from experience and to make a progress in convenience and effectiveness.

a.2.4 Extended Functions on the Web Site

The functions on the web site can be widely extended by using information technology. The functions the WUDC currently has are basically enough, but may need to be improved for the convenience of the users.

a.2.5 Monitoring of Program Effect

The most appropriate indicator to measure the effect of WUDC is the number of successful cases of waste exchange, but it is difficult to know as explained earlier. Knowing the number of successful cases requires troublesome work such as sending questionnaires to all the users or carrying out an interview survey.

Alternative indicators will include the changes in the number of users or the number of kinds of waste registered, the number of website visitors, and the number of log-ins.

It is to be noted, however, that the evaluation of WUDC should be also done from the other aspects as below.

- Change in conscious of factories: factories will notice that they should pay attention to how much of what kind of waste they generate, that they are required to minimize waste discharge, and that DIW is the organization which provides supports to factories for appropriate waste management.
- Changes in conscious of DIW staff: the conscious of DIW staff will also change through the O&M work of WUDC which offers them with the opportunity to directly communicate with factories and puts them in a position to support factories for waste management.

b. Evaluation of Improvement of Data Control System

The factory registration database is not only used for the factory control by DIW in general, but also is the base to carry out some of the team's proposals for IWM such as periodical factory surveys and the introduction of a licensing system of industrial waste businesses. Even though PP3 could not achieve the initial purpose of database update, it clarified what should be done for this purpose.

The team recommends DIW to carry out the tasks described in Section 4.3.3.b.3, i.e. (i) development of the universal database structure, (ii) application of the new database structure and (iii) installation of IP and data transfer, and to improve the database steadily.

5 Conclusions and Recommendations

The team presents here conclusions and recommendations in regard to non-HW management, HW management and the common matters. It should be noted, however, that even though the team grouped conclusions and recommendations into three, some of those for non-HW management can be still applicable to HW management, and vice versa. Particularly, the use of cement factories that is recommended for HW management is valid not only for non-HW management but also municipal waste management.

5.1 Non-HW Management

5.1.1 Current Situation

As a result of the factory survey covering 215 factories, it was found that non-HW generation is 2.36 million ton/year in total, 1.5 tons per employee, or 0.274 ton per capita in the study area. The characteristics of the current non-HW management understood from the result of the factory survey is that the rate of reused/recycled non-HW to the total is as high as 78% (1.85 million tons) and the rate of off-site treatment/disposal is only 5.3% (0.125 million tons). The high reuse/recycling rate is obvious when compared with the rate in Japan, 42% in 1998. The reasons for this will be two: firstly the definition of industrial waste in Thailand is limited to "waste from factories" whereas in Japan industrial waste includes not only waste from factories but also sludge from public wastewater treatment works, construction debris, earth from a construction site and waste from agriculture, and secondly personnel cost in Thailand is relatively lower than the cost for materials.

Waste reduction by intermediate treatment is hardly be seen (the reduction rate in Japan is 74% in 1998) presumably because of low final disposal fee. The fee charged by BMA is 323-354 bahts/ton including transportation, and 200 bahts/ton only for disposal in Samut Prakarn. In short, factories do not need to reduce waste volume.

There are only three disposal sites with DIW's approval as of April 2002: one in Saraburi owned and operated by Better World Green, another in Chonburi by Eastern Seaboard Environmental Complex, and the other under construction in Sakeao by Professional Waste Technology (1999). All of these are outside of the study area. There are, however, landfills for municipal waste approved by the provinces or municipalities in every province, and they receive non-HW together with municipal waste. These landfills satisfies minimum requirement for non-HW final disposal, although some have problems such as insufficient soil cover.

5.1.2 Master Plan

The fundamental policies of the team for the formulation of the M/P are as below.

1. The minimization of waste generation at source should be promoted.
2. Generated waste should be reused or recycled as much as possible. The current reuse/recycling system should be improved and the reuse/recycling rate as high as 80% should be maintained even in the future when labor cost will increase.

3. Only after making efforts for waste minimization or waste reuse/recycling, waste finally discharged should be properly treated and disposed of without giving environmental negative impacts. In particular, on-site final disposal should be strictly controlled and shift to off-site final disposal, since on-site disposal tends to lack care for the environment.

With such policies, the team planned the waste flow in the target year 2010 as follows.

	2001		2010	
	Amount (ton/year)	Proportion (%)	Amount (ton/year)	Proportion (%)
Generation	2,364,782	—	2,601,993	—
Reuse/Recycling	1,853,964	78.4	2,067,445	79.5
On-site Final Disposal	335,526	14.1	173,833	6.7
Off-site Treatment/Final Disposal	124,718	5.3	352,091	13.5
On-site Reduction	8,493	0.4	8,624	0.3
On-site Storage	42,081	1.8	0	0

5.1.3 Recommendations

a. Improvement of Reuse/Recycling System and Maintenance of High Reuse/Recycling Rate

The most important issues of non-HW management are to improve the present reuse/recycling system and to maintain the high reuse/recycling rate. To achieve these, the team recommends DIW to take the following measures in cooperation with relevant governmental bodies such as MOSTE.

1. To investigate the real situation of the reuse/recycling system, understand such problems as the treatment and disposal of rejects from reuse/recycling processes, formulate an improvement plan, and to put the plan into effect.
2. To develop a system to control waste reuse/recycling enterprises including waste buyers (Por Kha Khong Kao), and for this purpose, to strongly promote the registration of waste separation and/or landfill facilities as Code 105 factory and waste reuse/recycling facilities as Code 106 factory.
3. After having the said facilities registered, to regulate their reuse/recycling activities and to develop technical and/or financial support systems for the promotion of appropriate reuse/recycling practices.

b. Construction of Treatment and/or Final Disposal Facilities

The amount of non-HW finally discharged for off-site treatment and/or final disposal after the effort of generation prevention and reuse/recycling is 125,000 tons in 2001. This is only 3.3% of the treatment/final disposal amount of municipal waste, which is 3.8 million ton/year. According to the future projection by the team, it increases 2.8 times in 2010, coming to no more than 352,000 tons.

The team calculated the tipping fee to be charged at a sanitary landfill which can receive the non-HW of 350,000 tons a year for six years. If the cost for land purchase is excluded, the tipping fee of 250 bahts/ton can give the FIRR of 14.3%, which

implies landfill construction is feasible taking account of the interest rate and inflation in Thailand. IEAT is forwarding the construction of an incineration plant for HW in Bangpoo Industrial Estate as of June 2002 and plans to charge 3,300 bahts/ton including 2,800 bahts/ton for incineration treatment and 500 bahts/ton for transportation. The team also has had information of some incineration plants whose treatment fee is also more than 2,000 bahts/ton. Therefore, intermediate treatment technology, especially waste incineration, is not financially viable at present.

Meanwhile, the importance to properly treat and dispose of waste without affecting the environment cannot be emphasized enough. Accordingly, the team recommends DIW to take the following measures in regard to the construction of treatment/disposal facilities.

1. To promote sanitary disposal as far as there are landfills available, since it is clear that intermediate treatment not for reuse/recycling but for volume reduction is hardly required in the present circumstances.
2. To encourage the private sector to construct landfills for non-HW, but at the same time, to continue disposing of waste as far as it is strictly controlled not to contain HW at municipal waste landfills for the time being taking account of the fact that there are only three disposal sites authorized by MOI in the whole country.
3. To strictly control and eliminate illegal treatment/disposal routes including illegal dump sites and non-registered treatment/final disposal facilities.

5.2 HW Management

5.2.1 Current Situation

As a result of the factory survey covering 215 factories, it was found that HW generation is 560,000 ton/year in total, 0.35 ton per employee, or 0.065 ton per capita in the study area. The characteristics of the current HW management understood from the result of the factory survey is that the rate of reused/recycled HW to the total is merely 18.2% (101,000 tons) and the rate of on-site treatment/final disposal is as high as 54.3% (303,000 tons). The high on-site treatment/final disposal rate is probably attributed to the facts that there are only a limited number of off-site treatment/final disposal facilities available in and around the study area, competitive pricing does not work, and consequently the fee for off-site treatment/final disposal is high.

To cope with such situation, DIW is increasing the number of authorized waste recycling/treatment/final disposal facilities. Nevertheless, as of August 2002 such facilities for HW are only three (one for Code 101 (intermediate treatment) and two for Code 106 (recycling)) in the study area, and 14 in the whole country including 11 for recycling, 2 for intermediate treatment and 3 for final disposal (some facilities provide more than two services). The 11 recycling facilities include 4 cement plants, 3 solvent recycling factories and 4 other facilities and waste recycled by them is still limited in terms of quantity and variety. Two intermediate treatment facilities include a wastewater treatment facility and a sludge stabilization facility: there is no thermal treatment facility.

Three final disposal facilities are not in the study area but in Rachaburi, Rayong and Sakaeo. The number is so small to serve for the demand in the whole country and it is desired to develop the facilities as close to the major HW generation areas as possible.

In conclusion, there is pressing demand for the treatment/final disposal facilities for HW, but their capacity is small and available only for limited types of waste. However, the development of the facilities for HW in a short-term seems to be significantly difficult as the strong opposition of the local people against construction is anticipated.

5.2.2 Action Plan

In formulating the Action Plan (A/P), the team adopted a principle of waste management hierarchy as follows aiming at the development of the proper HW management system: (i) to minimize HW generation as much as possible, (ii) to reuse/recycle HW generated as much as possible and (iii) to properly treat/dispose of HW, which could not reused/recycled.

With this principle, the team set targets for the waste flow in 2005 as shown below.

	2001		2005	
	Amount (ton/year)	Proportion (%)	Amount (ton/year)	Proportion (%)
Generation	557,486	—	580,909	—
Reuse/Recycling	101,337	18.2	163,141	28.2
On-site	22,455	4.0	22,838	4.0
Off-site	78,882	14.2	140,303	24.2
On-site Final Disposal	120,063	21.6	48,844	8.3
Off-site Treatment/Final Disposal	208,279	37.3	239,541	41.2
On-site Reduction	123,935	22.2	129,523	22.3
On-site Storage	3,842	0.7	0	0

The team considers that the increase in the annual off-site treatment/final disposal capacity by 30,000 ton of the A/P is certainly possible by the capacity expansion at the Samae Dum Center and the completion of the incineration plant at Bangpoo.

The increase in annual off-site reuse/recycling amount by 61,000 ton will be possible by the measures recommended below.

5.2.3 Recommendations

a. Promotion of the Use of cement factories

The most critical question that the current HW management system is confronted with is how to enhance the capacity of proper off-site reuse, recycling, treatment and/or final disposal which is severely inadequate at present. Especially, export-oriented industries under pressure from the high requirement of ISO14000 are eager for the urgent development of such facilities.

Under such situation, the use of cement factories as waste reuse/recycling facilities has the following advantages.

1. It promotes waste reuse/recycling by utilizing waste as raw material or fuel, and at the same time it makes up the deficit in final disposal capacity since residue is little.
2. It will not encounter public opposition as fiercely as the construction of new facilities because the existing cement factories are utilized.

HW that the cement factories in Thailand will receive will be waste oil and organic HW (sludge, etc.) among others from the result of the factory survey. Waste flows of these kinds of HW in 2005 was examined, and the amount of the two subject to the recycling at the cement factories was estimated at 56,000 tons/year. The possibility of the cement factories to receive this amount was examined as below.

1. In Japan the cement factories that produce 82 million tons of cement in a year receive 25.58 million tons of waste that is equal to 31% of the production.
2. Waste oil and organic HW share 1.3% and 6.8%, respectively, of waste received at the cement factories.
3. The total production capacity of four kilns of Kaeng Koi factory of Siam Cement, which has been approved by DIW as waste treatment plant, is 5.7 million tons/year. If the proportion given by the experience in Japan stated above is applied, the kilns can receive 22,971 tons/year (5,700,000 x 0.31 x 0.013) of waste oil and 120,156 tons/year (5,700,000 x 0.31 x 0.068) of organic HW. The total is 143,000 tons/year, well exceeding 56,000 tons/year.
4. The team executed a financial analysis by roughly estimating revenue and expenditure at a cement plant. The team assumed that revenue includes the savings from the substitution of virgin raw material and fuel with waste and the treatment fee charged on waste generators, while expenditure includes investment in plant modification for waste utilization, operation and maintenance cost of the modified section of the plant, and purchase of valuable waste such as waste oil. If the average treatment fee is set at 2,000 baths/ton and 3.4 tons out of 5.6 tons of waste is subject to the fee, FIRR is calculated at 21.1%. Therefore it is concluded that investment in plant modification is economically viable.

In this way, with the target to increase the annual off-site reuse/recycling amount by 62,000 tons, it is presumed that the reuse/recycling of 56,000 tons/year at the cement factories is technically and financially viable. Understanding the severe situation of current HW management, the team strongly recommends DIW to promote the use of cement factories.

b. Promotion of Waste Analysis/Blending/Adjusting Industry

Cement factories do not apply waste to production lines without a guarantee of quality and quantity that are satisfactory enough to substitute the raw material and fuel currently used. Waste from one factory may not meet the requirement of the cement industry, but if the qualitative and quantitative characters of waste generated at different factories is well understood and blended together to adjust quality and quantity, waste can be acceptable at cement factories. Waste blending and adjusting facilities and technology is essential to establish a recycling system driven by the

cement industry. The team recommends DIW to foster and lead the waste analyze, blending and adjusting industry in the following way to appropriately utilize cement factories as a treatment/reuse/recycling facility.

1. In order to stimulate the demand of the waste generators for the waste blending industry, DIW should strengthen the requirement to factories for proper IWM. As a result, the needs for the waste generators to supply waste that is currently difficult to recycle and has to be disposed of on-site or off-site will increase.
2. DIW should provide to the cement factories with information about the demand of the waste generators for waste recycling at the cement factories. Information will include information on what kinds of waste can be recycled at cement factories, and how such waste is currently treated and disposed of in Thailand. Also, DIW should promote and support the cement factories to prepare waste reception standards.
3. In order to promote the waste blending industry, DIW should publicize waste blending technologies used in Japan and other countries.
4. DIW should introduce a licensing system that does not only control the waste collection/transportation system, but also officially authorize the ability of the blenders so that their clients will trust them.

Assuming that all the HWs that are planned to be accepted for recycling in the cement factories in 2005 are pre-treated by HW blenders, the team made a preliminary financial appraisal of the HW blending project. Under the preconditions such as the blenders receive waste oil by charging only collection and transportation cost on the generators, and they receive solid waste by charging collection and transportation cost and treatment fee at 5,000 bahts/ton on the generators, the project was concluded financially feasible for the private sector (cf. the answers of HW disposal fee in the factory survey ranged from 700 to 16,700 bahts/ton, and weighed average was 6,940 bahts/ton).

c. Promotion of HW Reuse/Recycling not by Cement factories

There are many waste reuse/recycling methods other than waste application at cement factories, and DIW should also promote them. DIW needs to consider the following in promoting waste reuse/recycling business.

1. Top priority should be given to the improvement of existing facilities and reuse/recycling processes so that HW can be reused, recycled and/or treated.
2. The quality and quantity of waste that is acceptable should be clarified.
3. The necessity to install pollution prevention equipment must be examined and the fulfillment of the discharge standards should be ensured.
4. The profitability of the business is confirmed.

With such understandings, the team examined a method to recycle HW containing heavy metals which cement factories do not receive at non-ferrous smelting furnaces together with electric arc furnace dust. Assuming that the generators of electric arc furnace dust only bear the cost of collection and transportation and other HW treatment fee is set at 1,500 bath/ton in average in addition to collection and transportation cost, FIRR is calculated at 16.8%, which means this recycling method

is financially feasible considering the interest rate and inflation in Thailand. The analysis, however, was made on several assumptions and the team recommends DIW to further carry out the following.

1. Investigation of actual conditions of non-ferrous smelting factories which can serve as waste recycling/treatment facilities (in the whole country, if possible).
2. Selection of the smelting factories with higher possibility as waste recycling/treatment facilities.
3. Investigation of waste that can be accepted at the selected smelting factories (investigation of the source of zinc, i.e. electric furnaces, if zinc smelting factories are selected in Step 2).
4. Formulation of project implementation plan and evaluation of financial viability.

5.3 Common Matters

5.3.1 Elimination of Illegal or Inappropriate Treatment/Final Disposal Routes

Although statistic data or previous systematic studies are not available, there are a number of illegal or inappropriate industrial waste treatment/final disposal routes. The following is some of findings of the present study.

1. There is a large scale illegal waste dump near to Bangpoo Industrial Estate, that is the largest industrial estate in Samut Prakarn province, although the province has a municipal waste disposal site which was approved by the province and the municipality and receive non-HW at abound 200 bahts/ton. Similar situations can be found in other provinces or other industrial estates.
2. The factory survey tells that 21.6% of HW is disposed of on-site. Although the team did not investigate the real practices of on-site final disposal, environmental pollution such as groundwater contamination is anticipated since appropriate HW final disposal requires substantial facilities. The team has observed HW simply dumped into a simple hollow in earth without liners.
3. Sulfate electrolyte in waste batteries is illegally discarded somewhere in the course of collection for recycling. Moreover, illegal smelters produce 40% of primary lead by primitive technology without environmental countermeasures such as simple burning in drums.

According to the result of the Public Opinion Survey (POS), illegal dump is pointed out as the most concerned industrial waste problem and the majority (84%) answered that illegal dumps are seriously influencing the environment. From the result of POS, the team concludes that it is necessary to strengthen illegal dump control and to restore public confidence in order for the Thai government to execute the IWM plan.

The presence of the illegal or inappropriate treatment/final disposal routes not only hamper the emergence of appropriate treatment/final disposal routes but also can destroy the existing appropriate ones. In fact, as for waste battery recycling, the activities of illegal smelters have raised the price of waste batteries, which hamper the business of environmentally sound smelters.

At present in Japan, housing development is progressing in urban land plots from which old factories were moved out to the suburb. However, the biggest obstacle that it encounters is soil pollution caused by HW discharged to the factory premises in the past. Most HW found was disposed of before the 1970s when enough number of proper off-site treatment/final disposal facilities did not exist. It is significantly costly to deal with soil pollution and the financial problem often hinders the development plan. DIW should therefore urgently regulate on-site final disposal of HW.

Japan also leaned from its experience that the clean up of illegal dumps cost further more than initial proper waste treatment. The most effective way to stop illegal dumps is to strictly lay the responsibility for IWM on waste generators. DIW should stringently require factories to manage their waste in a proper manner, and let them understand that disposing of waste at a landfill as far as Sakaeo, 300 km away, is still financially advantageous than dumping waste now and cleaning up in future.

Therefore, the elimination of illegal or inappropriate industrial waste treatment/final disposal routes is a prerequisite to establish a proper IWM system and requires urgent actions. Since the supervision, control and exposure of illegal or inappropriate treatment/final disposal routes are the responsibility of several governmental bodies, DIW needs to cooperate them for the elimination. In order to prevent illegal dumps from taking place, DIW should take the following measures by working together with other governmental organizations.

1. To more strictly impose responsibility for illegal dumps (including the implementation of land cleanup and payment for the cost) on waste generator.
2. To clearly define the jurisdiction of relevant governmental organizations in regard to illegal dumps, so that they can cooperate effectively.
3. To make penal regulations against illegal dumps more severe and raise fines. To develop a law enforcement system to immediately expose offenders.
4. To urgently put the HW manifest system, this is proposed by PCD, into force and to thoroughly implement it. In future, to introduce a digital manifest system and to also cover non-HW.
5. To introduce a licensing system of waste collectors/transporters and waste buyers so that all the actors involved in the industrial waste management business can be under the administrative control.
6. To show the real condition of illegal dumps to the public and to conduct public relations activities to call for cooperation in the prevention of illegal dumps, so that the governmental bodies, waste generators and the citizens work together.
7. To strengthen the illegal dumps prevention system (patrols, joint works with the Police, cooperation with local population, etc.).
8. To ensure the capacity of industrial waste treatment and final disposal facilities which are technically appropriate and financially reasonable.

5.3.2 Thorough Waste Management at Source

Industrial waste management should start with the waste reduction at source. The team recommends DIW to take the following measures in order to enforce thorough waste management at factories based on waste reduction.

1. To direct factories to have a clear mechanism to place responsibility of waste management and a technical control system.
2. To establish training programs and a certificate system and legally enforce the appointment of the technical manager of IWM at every factory.
3. To strictly impose punishment upon inappropriate on-site waste treatment or final disposal through inspection or other occasions.
4. To further strengthen governmental technical and financial supports to promote waste minimization and reuse/recycling.
5. To stop the mixed discharge of non-HW and HW, and enforce separate discharge.

The basic idea of waste reduction at source will follow the four steps as below.

Step 1: Correct understanding of the real condition of waste generation

Step 2: Minimization of waste generation within factories

Step 3: Waste reuse/recycling within factories

Step 4: Waste minimization, waste reuse/recycling, and consequently waste reduction within a group of factories such as an industrial estate

MOI has been promoting Steps 1, 2 and 3 in cooperation with international aid agencies, but the execution of Step 4 is still limited. The team recommends DIW to learn from the example of Kokubo Industrial Park introduced in the Main Report and to promote waste minimization, reuse/recycling and waste reduction in an industry buildup area.

5.3.3 Use of WUDC

DIW and the team established Waste Utilization Data Center (WUDC) in the pilot project of the present study. WUDC is, however, not fully utilized. The adequate use of WUDC needs to solve such questions as below.

- How to disseminate WUDC
- How to materialize waste exchange

As of the end of February 2002, WUDC has a registration of 414 factories as a database user. This number is only 1% of the factories registered in the study area in total. WUDC should have further more users to be really useful. DIW will require to diffuse the existence of WUDC and to urge factories to be registered in cooperation with other relevant organizations. The establishment of new industrial codes, 105 for waste separation and final disposal facilities and 106 for waste reuse and recycling facilities, is a good opportunity to involve new users. Furthermore, it is recommended not to limit the database users with full access to factories alone but to involve sectors other than industry considering such facts as waste from food processing can be fed to livestock, and casting sand waste can be used as alternative raw material of construction materials. When such user expansion is difficult for DIW, it will be another way to make WUDC linked with the Material Exchange Center of TEI and other new databases to be emerged in future.

The experience of Pilot Project 2 tells that waste exchange between factories is not as simple as it would be expected. The enhancement of data volume through user expansion as stated above is one solution, and the other will be to make a breakthrough in the current conventional waste reuse/recycling system. As the factory survey revealed, the study area already has an extended waste reuse/recycling system and waste that factories want to supply through WUDC is waste difficult to be reused/recycled in the current system. It is needed to transform such waste into material that can be used by factories with new knowledge and technology in an economically viable way.

Most waste exchange programs in Japan have been organized by the government sector and some to them have a technical committee, which gives advice on the method of waste reuse/recycling. Such committees led by the government, however, tend not to pay enough attention to the economics, and take part in waste exchange only at the commencement without commitment. The team considers that the governmental side may make the basic advice and comments, but specific technical support required for individual cases should be made by the private enterprises which run their business with their expertise.

In Pilot Project 3, the DIW and the team tried to increase the number of WUDC users using one of the provincial industrial offices, and it was successful.

From such understanding, the team recommends DIW to take the following measures, with involving the provincial industrial offices, for the promotion of WUDC.

1. To strongly promote the registration of waste selection and landfill facilities as Code 105 and waste reuse and recycling facilities as Code 106.
2. To strongly promote the database user registration of those factories with Codes 105 and 106.
3. To hold seminars and/or workshops for the factories with Codes 105 and 106 to let them know waste exchange examples that could be realized in Thailand, including waste reuse/recycling at cement factories.

5.3.4 Unification of Industrial Waste Administration and Introduction of Manifest System

Waste management administration needs to involve many governmental organizations such as Ministry of Industry, Ministry of Public Sanitation, Ministry of Science, Technology and Environment, and local administration offices. However, there is no legislation or policy that demarcates and assigns responsibilities related to waste management to each organization in a consolidated manner. In future, the team proposes that MOI, MOPS, MOSTE and other administration organizations should work together to enact what is to be called Waste Management Act which covers not only industrial waste but also municipal waste, hospital waste and others.

Under the unified framework set by the act, registration with authorities and the acquisition of a license should be obligatory for all the industrial waste business enterprises including waste collection and transportation companies, waste buyers, waste reuse/recycling companies, intermediate treatment companies and final disposal companies to run their business. The license should be issued for each type of services provided and for each type of waste dealt with (or at least for non-HW or HW).

The process to build such an administration system with necessary legislation, however, requires substantial time and careful coordination among related organizations. Therefore the team recommends DIW to establish its unique license system described below as a tentative measure. Since the Factory Act can not be applied to collection and transport business, it is nothing but an expedient. DIW should urgently develop legislation and establish its authority over waste collection and transport companies.

1. Any company which is to collect and/or transport waste from a factory must be registered at DIW and acquire a license.
2. The transport permit is no longer necessary for a factory to discharge its waste outside. Instead, the factory must entrust waste collection and transport work to those registered companies. The factory should make a waste discharge record every time, and the record should be kept at the factory and ready to submit at the request of DIW.
3. The licensed collection/transport company should make a reception record when it receives waste from the factory and keeps the record ready to submit at the request of DIW.

The system above is proposed to be developed in the short term for the whole industrial waste management system either no-HW management or HW management.

Moreover, in order to trace the movement of HW and to make sure that HW undergoes proper disposal, the development of a manifest system is necessary in the mid- and long-term. On the legislation of HW manifest system of PCD/MOSTE, DIW should bear the responsibility to oversee factories that generate HW, cooperate with PCD for the management of the manifest system, and control HW management by applying the licensing system and the manifest system.

5.3.5 Database Update

DIW has Information Technology Center that keeps a database of factory registration and other data concerning factories. The team found, however, the management and data update of the database is not adequate. The establishment of the database is not enough and the database needs to continuously develop. The team recommends DIW to take the following measures for the proper maintenance and expansion of the database.

- To make a reporting rule thoroughly understood and executed so that data and information necessary for the database update can gather from bureaus within DIW, DIW regional offices, IEAT, and other relevant offices.
- To develop procedures to share the data in the databases such as waste classification by code numbers.
- To appoint the necessary number of personnel who control and update the databases.

The data communication between regional offices and the IT center has critical problems. The DIW factory database has data of 120,000 factories over the country. Inspection to those factories, comparison of the real condition to the registered data, data update, and registration of newly established factories are carried out by 600

DIW inspectors at 74 regional offices. Data to be entered to the database and data in the database to be renewed are sent from the inspectors to DIW headquarters in a paper form and the reports are simply piled up in the IT center. This should be urgently improved.

The improvement of data transmission between the provincial industrial offices and the IT Center was attempted in Pilot Project 3 (PP3) at the Nonthaburi office from May to June 2002. From the experience of PP3, the team recommends DIW to carry out the following.

1. It is necessary to unify the structure of the databases of the IT center and all the provincial industrial offices. Therefore, DIW should investigate the database structure of the provincial industrial offices, clarify the difference between that of the IT center and that of the provincial industrial offices, and develop a new universal database structure that can be most easily applied to all the databases.
2. DIW should apply the universal database structure to the IT center and all the provincial industrial offices. It should then followed by intensive trainings for the staff that operate the database and the preparation of manuals.
3. DIW may need to adjust the interface program that was developed in PP3 to the universal database structure, and install the program to the provincial industrial offices one by one. The data transfer can be then proceeded.

5.3.6 Accurate Understanding of IWM

The team surveyed 215 factories by interviews to understand the real situation of IWM from generation to final disposal. Replies from 206 factories out of 215 were valid and used for analysis. However, 206 factories are merely 0.62% of the total number of registered factories, i.e. 33092. It should be therefore well recognized that the picture of IWM revealed in the present study is based on the survey of only 0.62% of factories.

The improvement of IWM should start with the accurate understanding of real IWM. The team recommend DIW to take the following measures in order to raise the reliability of what the team figured out.

1. To regularly carry out the factory surveys as the team did in the present study (every five years in Japan).
2. To issue the ministerial notification which obligates factories to disclose the information of their waste management at the request of the authority in order to facilitate the factory surveys.
3. To check and analyze the newly obtained data and the existing data of 206 factories, and to renew the estimated amount of present and future waste generation and waste flows that the team elaborated.

Using the waste generation rate per employee that was obtained through the present study and the number of employees available from the DIW's database, the team estimated the amount of waste in the whole country as below.

	Number of Factories	Number of Employees	Non-HW Generation Amount	HW Generation Amount (tons/year)

			(tons/year)	
Whole Country	121,231	2,978,165	5,409,832	854,603
Study Area	33,092(27.3%)	1,584,782(53.3%)	2,364,782(43.7%)	557,456(65.2%)

Note: The figures in the parenthesis are the proportion to the whole country.

Similar estimation is possible by 33 industrial sectors and/or by 26 waste categories. The execution of the regular factory survey as in the present study will give a more reliable waste generation rate per employee, which in turn gives more reliable indicators necessary for the formulation of IWM plans.

5.3.7 Formulation of IWM Plans for Industrial Sectors

Following the S/W, the team did not investigate the IWM of particular industrial sectors. The plans developed in the present study are, therefore, not specific but comprehensive. It is, however, necessary to formulate IWM improvement plans by industrial sectors in order to put the M/P or A/P into effect. The formulation of IWM improvement plans for specific industrial sectors requires the detailed investigation of waste generated from that sector and experts with abundant knowledge about appropriate waste management (generation reduction, reuse/recycling, intermediate treatment and final disposal) gained from experiences.

The team studied IWM of the paint industry and proposed the improvement plan in Chapter 12 of the main report in order to demonstrate the formulation of an IWM improvement plan for a specific industry. Learning the method applied by the team, the DIW should work out the IWM improvement plans for particular industrial sectors with higher priority.