

**THE STUDY  
ON  
MASTER PLAN  
ON  
INDUSTRIAL WASTE MANAGEMENT  
IN  
THE BANGKOK METROPOLITAN AREA  
AND  
ITS VICINITY  
IN  
THE KINGDOM OF THAILAND**

**FINAL REPORT  
MAIN REPORT**

JICA LIBRARY



J1170330(3)

**NOVEMBER 2002**

**KOKUSAI KOGYO CO., LTD.  
EX CORPORATION**

MPI
JR
02-161

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)  
DEPARTMENT OF INDUSTRIAL WORKS  
MINISTRY OF INDUSTRY  
THE KINGDOM OF THAILAND

**THE STUDY  
ON  
MASTER PLAN  
ON  
INDUSTRIAL WASTE MANAGEMENT  
IN  
THE BANGKOK METROPOLITAN AREA  
AND  
ITS VICINITY  
IN  
THE KINGDOM OF THAILAND**

**FINAL REPORT  
MAIN REPORT**

**NOVEMBER 2002**

**KOKUSAI KOGYO CO., LTD.  
EX CORPORATION**



1170330(3)

## Preface

In response to a request from the Government of the Kingdom of Thailand, the Government of Japan decided to conduct and entrusted the Study on Master Plan on Industrial Waste Management in the Bangkok Metropolitan Area and its Vicinity to Japan International Cooperation Agency (JICA).

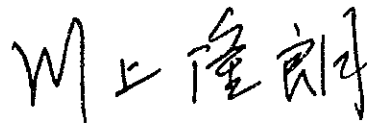
JICA sent a study team led by Mr. Shimura of Kokusai Kogyo Co., Ltd. and organized by Kokusai Kogyo Co., Ltd. and EX Corporation to Thailand six times from March 2001 to September 2002.

The study team held discussions with the officials concerned of the Government of the Kingdom of Thailand and conducted related field surveys. After returning to Japan, the study team carried out further studies and compiled the final results in this report.

I hope this report will contribute to the realization of the sound industrial waste management system and to the promotion of amity between the two countries.

I also express my sincere appreciation to the officials concerned of the Government of the Kingdom of Thailand for their close cooperation throughout the study.

November 2002

A handwritten signature in black ink, consisting of stylized Japanese characters and a large initial 'W'.

---

Takao KAWAKAMI

President

Japan International Cooperation Agency

November 2002

Mr. Takao KAWAKAMI  
President  
Japan International Cooperation Agency  
Tokyo, Japan


### **Letter of Transmittal**

We are pleased to submit you the report of the Study on Master Plan on Industrial Waste Management in the Bangkok Metropolitan Area and its Vicinity in the Kingdom of Thailand.

This study was conducted by the joint venture of Kokusai Kogyo Co., Ltd. and EX Corporation, under a contract to JICA, during the period from February 2001 to November 2002. The major contents of the report are the master plan for non-hazardous industrial waste management and the action plan for hazardous industrial waste management, both of which include the technically and economically feasible and sustainable improvement measures, as a result of the detailed analysis of field survey results.

We believe that the plans proposed in the report contribute to the formulation of sound industrial waste management system, which should be one of the fundamental requirements for the social and economic development of the Kingdom of Thailand. We sincerely hope that its Government gives the highest priority to the realization of the plans.

We would like to take this opportunity to express our truthful gratitude to the officials concerned of JICA, Ministry of Foreign Affairs and Ministry of Economy, Trade and Industry. We also wish to express our gratitude to the officials concerned of Ministry of Industry of Thailand, JICA Thailand Office and Embassy of Japan in Thailand for their cooperation and assistance throughout our field survey.



---

Susumu SHIMURA

Team Leader

The Study on Master Plan on Industrial Waste  
Management in the Bangkok Metropolitan Area  
and its Vicinity in the Kingdom of Thailand

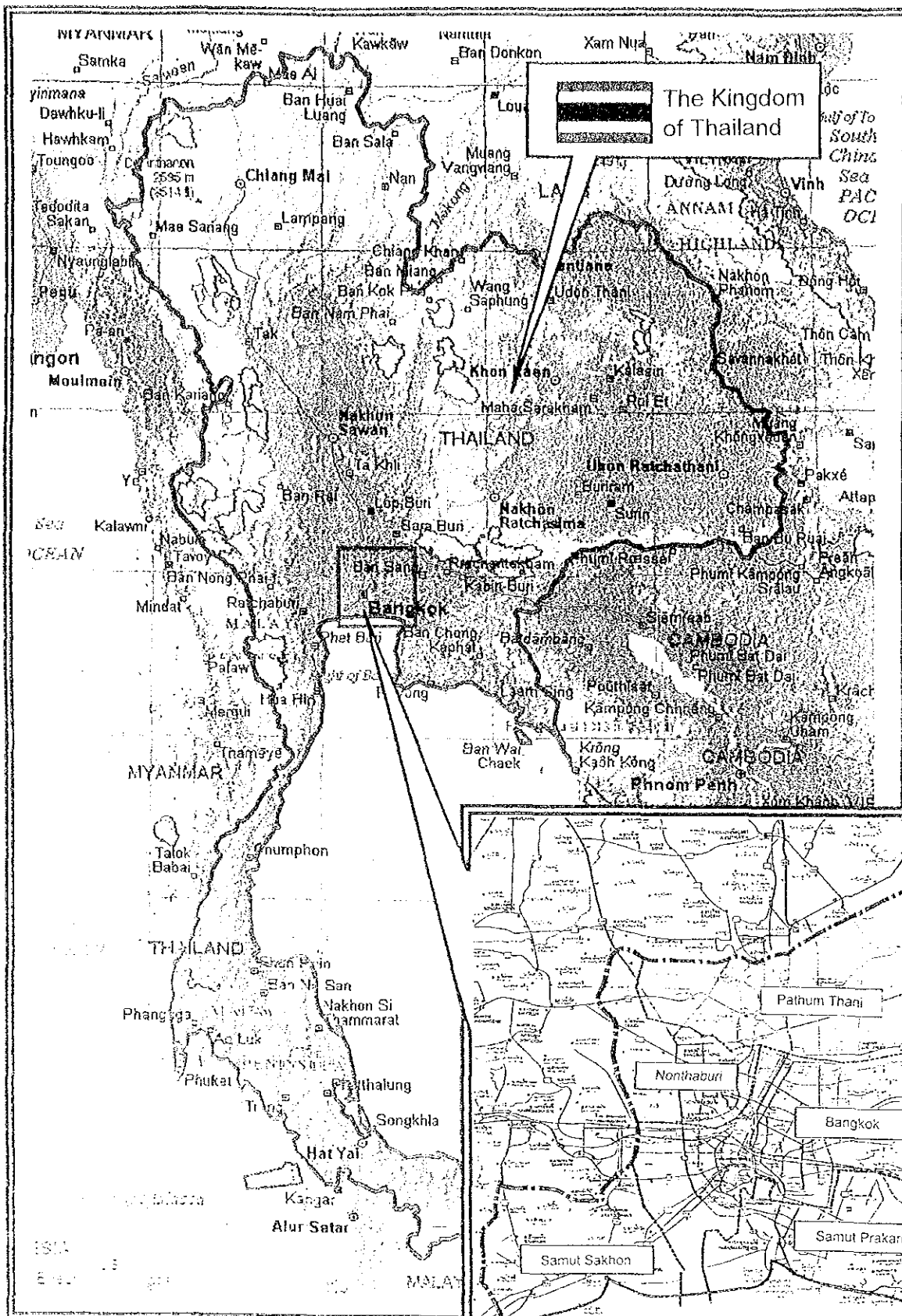
The Study on Master Plan on Industrial Waste Management  
In the Bangkok Metropolitan Area and its Vicinity  
In the Kingdom of Thailand

List of Volumes

Volume I	Summary
Volume II	Main Report
Volume III	Annex
Volume IV	Report of the Study on the Use of Waste Blenders in Japan with Particular Attention to Regulations

***This is the Main Report.***

Exchange Rate Used in the Report US\$ 1.0 = 43 Bahts, 1 Yen = 0.3 Bahts
--



Study Area



Interview at a Factory



Waste Management at a Factory (Storage of Waste for Recycling)



Waste Management at a Factory (Sludge)



Waste Management at a Factory (Separation of Waste Glass)



Waste Management at a Factory (Installation of Bins for Waste Separation)



Waste Management at a Factory (Mixed Non-HW Waste)

Plate 1: Factory Survey





Temporal Waste Storage of Waste Buyers (1)



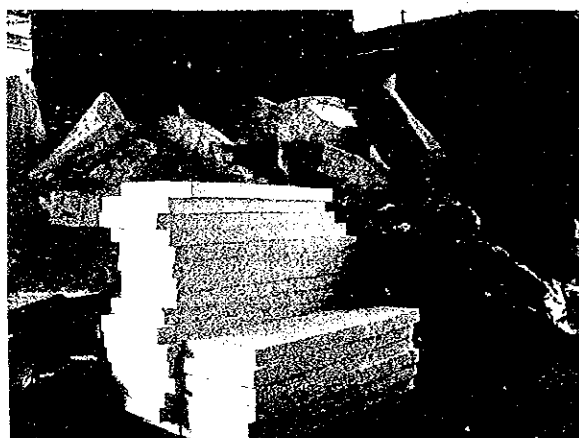
Temporal Waste Storage of Waste Buyers (2)



Waste Shop of Iron Scrap (1: Iron Scrap)



Waste Shop of Iron Scrap (2: Products to be  
Delivered to a Electric Furnace)



Plastic Recycling Factory (1: Material for  
Recycling)

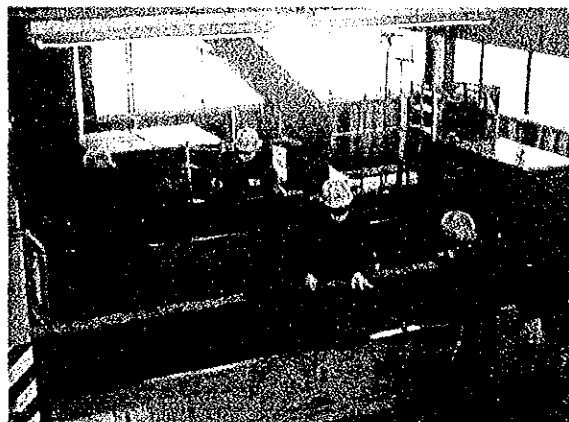


Plastic Recycling Factory (2: Recycled Products)

Plate 2: Survey on Waste Collection, Transport, Recycling, Treatment and Final  
Disposal Companies (1)



Recycling Factory: Storage of Unrecyclable Material



Recycling Factory: Separation of Glass Cullet



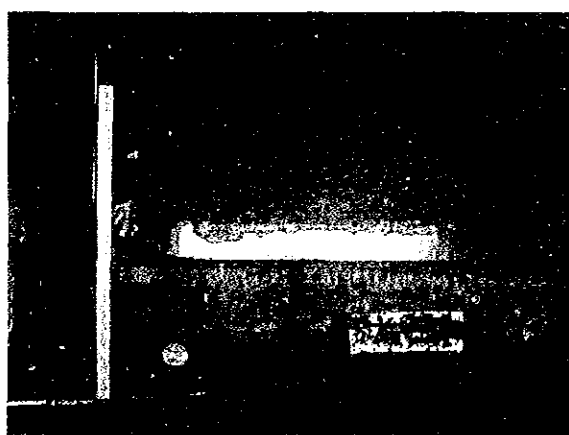
Recycling Factory: Separation of Metals from Electronic Parts



Recycling Factory: Variety of Recyclable Non-HW



Recycling Factory: Storage of Drums of Solvent for Recycling

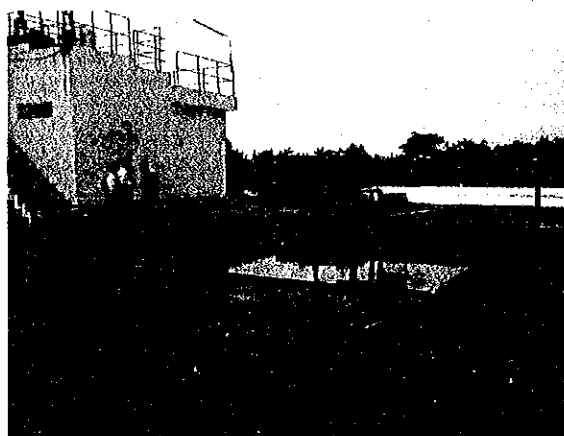


Recycling Factory: Furnace for Aluminum Scrap

Plate 3: Survey on Waste Collection, Transport, Recycling, Treatment and Final Disposal Companies (2)



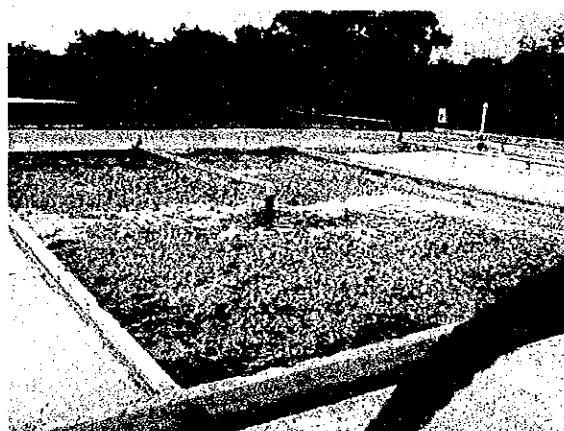
Waste Treatment Factory: Genco Samaedam Center (1: Wastewater Reception)



Waste Treatment Factory: Genco Samaedam Center (2: Wastewater Reception Tank)



Waste Treatment Factory: Genco Samaedam Center (3: Treatment of Wastewater from Dyeing)



Waste Treatment Factory: Genco Samaedam Center (4: Sludge Drying Bed)



Cement Factory (1: Off-spec Tires Fed to Cement Kiln)



Cement Factory (2: Waste Mixed with Raw Material)

Plate 4: Survey on Waste Collection, Transport, Recycling, Treatment and Final Disposal Companies (3)



Waste Treatment Plant: GENCO Map Ta Phut  
(Sludge Stabilization Facility)



Waste Final Disposal Site: GENCO Map Ta Phut  
(New Landfill Under Construction)



Private Non-Hazardous Waste Final Disposal Site  
(Landfill Cell)



Private Non-Hazardous Waste Final Disposal Site  
(Leachate Treatment Facility)



Private Hazardous Waste Final Disposal Site

Plate 5: Survey on Waste Collection, Transport, Recycling, Treatment and Final Disposal Companies (4)



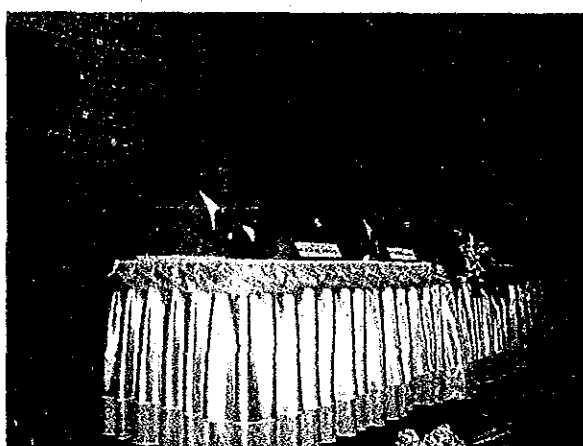
Instruction given to Interviewers of POS



Interview with Local Residents



Seminar (1)



Seminar (2)






Workshop (1)




Workshop (2)

Plate 6: Public Opinion Survey (POS)/Seminars/Workshops

  
  
  
**JAPAN**  
 Official Development Assistance  
 หมายเลขระบบ  
**000171**  
 วันที่ 5 ก.ค. 2545

## ศูนย์ข้อมูลการใช้ประโยชน์ของเสีย

  
**'tilization**

ชื่อผู้ใช้ : \_\_\_\_\_

รหัสผ่าน : \_\_\_\_\_


สถานะ : \_\_\_\_\_

ประเภท : \_\_\_\_\_

WUDC เป็น ศูนย์ข้อมูลการใช้ประโยชน์ของเสีย สำหรับการโดยสหประชาชาติในภูมิภาคเอเชียตะวันออกเฉียงใต้ โดยมีวัตถุประสงค์เพื่อให้บริการแก่หน่วยงานที่เกี่ยวข้องในการจัดการของเสียอย่างมีประสิทธิภาพและปลอดภัย

โปรดอ่านรายละเอียด

ศูนย์ข้อมูลการใช้ประโยชน์ของเสีย ก่อตั้งขึ้นจาก "โครงการศึกษาเพื่อจัดทำแผนแม่บท การจัดการของเสีย" ที่ดำเนินการโดยศูนย์ข้อมูลการใช้ประโยชน์ของเสีย ร่วมกับ "กรมส่งเสริมการค้าระหว่างประเทศ" โดยมีวัตถุประสงค์เพื่อให้บริการแก่หน่วยงานที่เกี่ยวข้องในการจัดการของเสียอย่างมีประสิทธิภาพและปลอดภัย


**Japan International Cooperation Agency**

หากท่านมีข้อสงสัยหรือต้องการข้อมูลเพิ่มเติม กรุณาติดต่อ สำนักงานโดยมีทีมงานคอยให้บริการ  
 โทร. 0-2302-4167 โทรสาร. 0-2302-4170  
 หมายเหตุ: <http://www.dew.go.th/wudc>

WUDC Website (Homepage)

## ค้นหาข้อมูลกากของเสีย

รหัสของเสีย :  (ดูรายละเอียด)

ชื่อกากของเสีย :

ประเภท :  (ต้องการกากของเสียจากโรงงาน)




จังหวัด :  (ทุกจังหวัด)

<< ค้นหา >>

<< เมนู >>

Waste Search Page

Plate 7: Pilot Project (Development of Waste Utilization Data Center Website)

  
  
  
**JAPAN**  
 Official Development Assistance

### รายละเอียดการขอส่งกากของเสีย

รหัสของเสีย : 000171 ชื่อกากของเสีย : กากของเสีย (กากของเสีย) ประเภท : กากของเสีย (กากของเสีย) จังหวัด : กรุงเทพมหานคร รายละเอียด : กากของเสีย (กากของเสีย) วัตถุประสงค์ : วัตถุประสงค์ (วัตถุประสงค์) วิธีการ : วิธีการ (วิธีการ) หมายเหตุ : หมายเหตุ (หมายเหตุ)	รหัสของเสีย : 000171 ชื่อกากของเสีย : กากของเสีย (กากของเสีย) ประเภท : กากของเสีย (กากของเสีย) จังหวัด : กรุงเทพมหานคร รายละเอียด : กากของเสีย (กากของเสีย) วัตถุประสงค์ : วัตถุประสงค์ (วัตถุประสงค์) วิธีการ : วิธีการ (วิธีการ) หมายเหตุ : หมายเหตุ (หมายเหตุ)
--	--

ชื่อ : \_\_\_\_\_

นามสกุล : \_\_\_\_\_

ตำแหน่ง : \_\_\_\_\_

หน่วยงาน : \_\_\_\_\_

โทรศัพท์ : \_\_\_\_\_

โทรสาร : \_\_\_\_\_

E-mail Address : \_\_\_\_\_

Test data3

Test data3

Test data3

Test data3

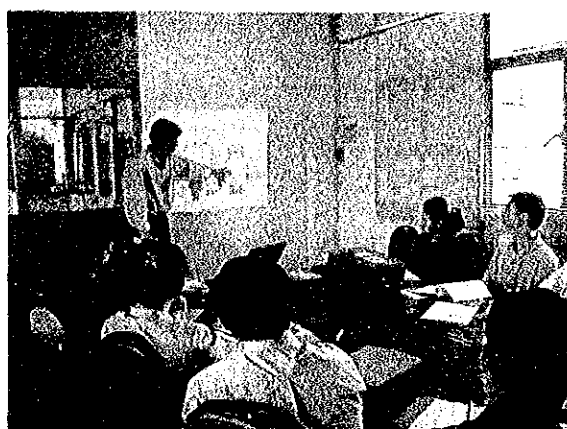
Test data3

Test data3

Search Result (Full Report)



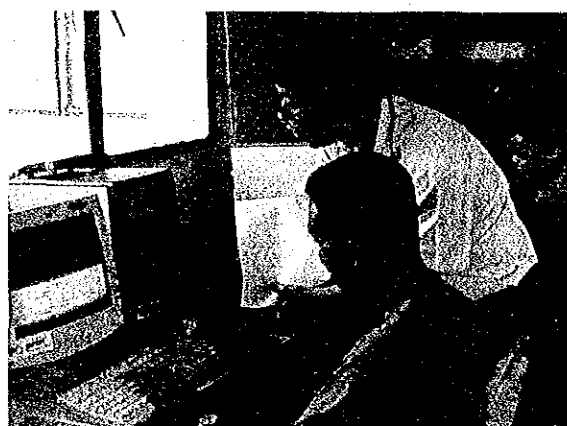
Lecture by DIW Staff (1)



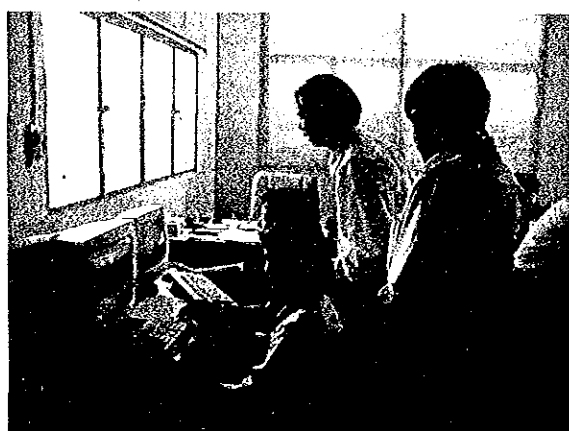
Lecture by DIW Staff (2)



Lecture by DIW Staff (3)



Internet Exercise (1)

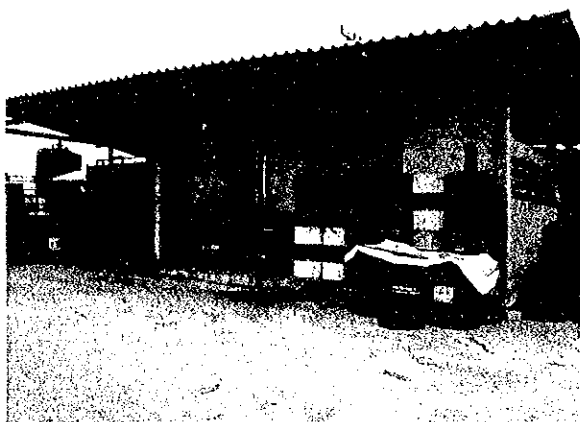


Internet Exercise (2)



Internet Exercise (3)

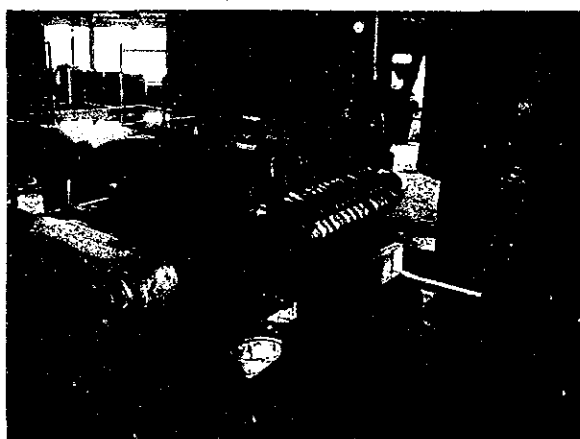
Plate 8: Pilot Project (WUDC Dissemination Seminar)



Waste Oil Recycling (1: Reception Facility)



Waste Oil Recycling (2: Recycling by Sulfuric Acid/Activated Clay Process)



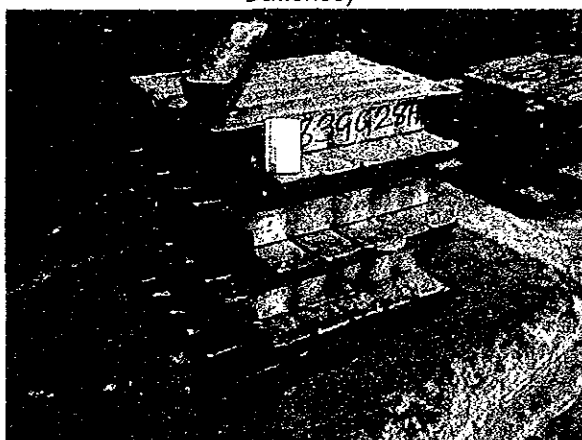
Waste Oil Recycling (3: Reformed Oil Production Process)



Waste Battery Recycling (1: Reception of Waste Batteries)



Waste Battery Recycling (2: Furnace)



Waste Battery Recycling (3: Recovered Lead)

Plate 9: Survey on Waste Oil and Waste Battery Recycling Industry



## CONTENTS

	Page:
Map of the Study Area	
Photos	
Conclusions and Recommendations	
Contents	
<b>1 Introduction</b>	<b>1-1</b>
1.1 Background	1-1
1.2 Scope of the Study	1-1
1.2.1 Objectives of the Study	1-1
1.2.2 Study Wastes	1-2
1.2.3 Study Area	1-2
1.3 Policies of the Study	1-2
1.4 Work Schedule	1-4
1.5 Study Organization and Persons Involved	1-8
1.6 Reports	1-10
1.7 Technology Transfer	1-10
<b>2 Profile of the Study Area</b>	<b>2-1</b>
2.1 Natural Conditions	2-1
2.1.1 Location and Territory	2-1
2.1.2 Topography	2-2
2.1.3 Climate	2-2
2.2 Social Conditions	2-3
2.2.1 Administration	2-3
2.2.2 Population	2-11
2.2.3 Public Utilities	2-17
2.3 Economic Conditions	2-19
2.3.1 National Economy	2-19
2.3.2 Regional Economy	2-25
2.3.3 Industries	2-26
<b>3 Fact Finding Surveys</b>	<b>3-1</b>
3.1 Factory Survey	3-1
3.1.1 Objectives and Waste Flow	3-1
3.1.2 Preparation of the Survey	3-3
3.1.3 Selection of Factory	3-8
3.1.4 Findings of the Survey	3-14
3.2 Survey on Non-HW Collection and Transportation Organizations	3-21
3.2.1 Objectives and Method	3-21
3.2.2 Contents of the Survey	3-22
3.2.3 Execution of the Survey	3-23
3.2.4 Findings	3-24
3.3 Survey on Waste Reuse/Recycling/Treatment Companies	3-28
3.3.1 Objectives and Method	3-28
3.3.2 Execution of the Survey	3-28
3.3.3 Findings	3-30

3.4	Survey on Associations .....	3-52
3.4.1	Objectives and Method .....	3-52
3.4.2	Contents of the Survey .....	3-52
3.4.3	Execution of the Survey .....	3-52
3.4.4	Findings .....	3-53
3.5	Study on MWM.....	3-54
3.5.1	Institutional System .....	3-54
3.5.2	Technical System.....	3-55
3.5.3	Current Issues .....	3-57
3.5.4	MOSTE's Policy on MWM.....	3-58
3.6	Public Opinion Survey .....	3-60
3.6.1	Objectives and Work Flow .....	3-60
3.6.2	Preparation of the survey .....	3-61
3.6.3	Execution of the Survey .....	3-65
3.6.4	Findings .....	3-66
<b>4</b>	<b>Technical System on IWM .....</b>	<b>4-1</b>
4.1	Present IW Generation .....	4-1
4.1.1	Previous Studies .....	4-1
4.1.2	Present IW Generation.....	4-9
4.1.3	Present IW Flow .....	4-16
4.2	IWM On-site.....	4-23
4.2.1	On-site Disposal .....	4-23
4.2.2	Storage and Discharge .....	4-24
4.2.3	Treatment, Reuse and Recycling.....	4-24
4.2.4	Long-term Storage and Final Disposal.....	4-25
4.2.5	Industrial Cluster and Zero Emission .....	4-25
4.3	Off-site IWM.....	4-28
4.3.1	Collection and Transportation .....	4-28
4.3.2	Reuse and Recycling .....	4-29
4.3.3	Treatment and Final Disposal.....	4-34
4.3.4	Illegal Dumping.....	4-50
4.3.5	IWM by Private Sector .....	4-53
<b>5</b>	<b>Institutional System on IWM.....</b>	<b>5-1</b>
5.1	Policy on Environmental Protection.....	5-1
5.1.1	National Economic and Social Development Plan.....	5-1
5.1.2	Policy on Environmental Protection and Waste Management .....	5-3
5.2	Industry and Industrial Waste.....	5-7
5.2.1	Classification of Factories .....	5-7
5.2.2	Registration of Factories.....	5-10
5.2.3	Classification of Industrial Waste.....	5-12
5.3	Organizations Relevant to IWM.....	5-15
5.3.1	DIW .....	5-15
5.3.2	PCD, MOSTE.....	5-19
5.3.3	IEAT .....	5-21
5.3.4	BMA and Other Local Administration.....	5-23
5.4	Legislation.....	5-26
5.4.1	Acts and Regulations concerning IWM.....	5-26

5.4.2	Control Institutes Concerning IWM .....	5-28
5.5	Administrative Procedures for IWM Enterprises .....	5-36
5.5.1	Factories engaged in IWM .....	5-36
5.5.2	Transporters and Waste Buyers .....	5-38
5.5.3	Incentive for IWM Activities .....	5-39
5.6	Public Participation .....	5-40
5.6.1	Public Awareness on IWM .....	5-40
5.6.2	FTI (Federation of Thai Industry) .....	5-41
5.6.3	Non-government Organization (NGO) and Local People .....	5-43
5.6.4	Other Organization Relating to the Public Participation .....	5-45
5.6.5	Public Participation in the Decision Making Process .....	5-46
6	Database Development .....	6-1
6.1	Current Database .....	6-1
6.1.1	Current Database (DB) of DIW .....	6-1
6.1.2	Current Database on IWM .....	6-7
6.2	Development Plan .....	6-10
6.2.1	Development Plan for New Database .....	6-10
6.2.2	Development of Non-HW Database .....	6-13
6.2.3	Development of Manifest System Database .....	6-18
7	Current Issues on IWM .....	7-1
7.1	IWM at Factories (Generation Sources) .....	7-1
7.1.1	Current Issues .....	7-1
7.1.2	Scheme for Improvement .....	7-1
7.2	Non-HW Management .....	7-1
7.2.1	Current Issues .....	7-1
7.2.2	Scheme for Improvement .....	7-3
7.3	HW Management .....	7-4
7.3.1	Current Issues .....	7-4
7.3.2	Scheme for Improvement .....	7-6
7.4	Institutional System .....	7-7
7.4.1	Current Issues .....	7-7
7.4.2	Scheme for Improvement .....	7-9
8	Estimation of Future IW Generation .....	8-1
8.1	Socio-Economic Framework of the Master Plan .....	8-1
8.1.1	Population .....	8-1
8.1.2	Economy .....	8-2
8.1.3	Number of Employees by Types of Industries .....	8-3
8.2	Projection of the Future Industrial Waste Generation .....	8-6
8.2.1	Scope of Projection .....	8-6
8.2.2	Methodology of Estimating the Future Industrial Waste Generation .....	8-7
8.2.3	Estimation Results of the Future Industrial Waste Generation .....	8-11
9	Non-HW Management Master Plan .....	9-1
9.1	Goal, Target and Strategy .....	9-1
9.1.1	Goal .....	9-1
9.1.2	Targets .....	9-1

9.2	Master Plan.....	9-5
9.2.1	Appropriate IWM at Source .....	9-10
9.2.2	Improvement of reuse/recycling system and Promotion of reuse/recycling industry.....	9-12
9.2.3	Development of Treatment/Final Disposal Facilities.....	9-13
9.2.4	Introduction of a Licensing System.....	9-15
9.2.5	Correct Understanding of State of IWM .....	9-16
9.2.6	Improvement of Data Control Systems .....	9-19
9.2.7	Integration of the Waste Management Administration .....	9-21
9.2.8	Public Participation.....	9-22
9.3	Measures for Promoting the Implementation of the Master Plan .....	9-25
9.3.1	Estimation of the Cost of Implementing the Master Plan .....	9-25
9.3.2	Measures to Promote Proper Non-IIW Treatment and Disposal in terms of their financial viability .....	9-28
9.4	Proposal Concerning Standards and Regulations.....	9-31
9.4.1	Classification of Industrial Waste.....	9-31
9.4.2	Licensing System to Control the Private IWM Business .....	9-32
9.4.3	Standards for non-HW treatment/disposal facilities.....	9-34
9.4.4	Site Selection Procedures and Standards.....	9-36
10	<b>HW Management Action Plan .....</b>	<b>10-1</b>
10.1	Selection of Action Plan.....	10-1
10.1.1	Scope of Work of The Study Concerning A/P .....	10-1
10.1.2	Selection of Action Plan .....	10-1
10.1.3	Target Year, Targets and Strategies of A/P .....	10-2
10.2	Waste Minimization Plan .....	10-2
10.2.1	The Concept of Waste Minimization.....	10-2
10.2.2	Action Plans of Waste Minimization at Source.....	10-5
10.3	Reuse/Recycling Promotion Plan.....	10-7
10.3.1	Targets and Strategies.....	10-7
10.3.2	Improvement Plan of Cement Factories .....	10-9
10.3.3	Plan of nurturing waste analysis, adjustment and blending industries (waste blender) .....	10-15
10.3.4	Plan of Zinc Recovery from Electric Arc Furnace Dust (An Example of HW Reuse/Recycling at Factories other than Cement Factories).....	10-19
10.4	Waste Exchange Plan .....	10-22
10.4.1	Dissemination of WUDC.....	10-23
10.4.2	Promotion of Waste Exchange .....	10-24
10.5	Financial Appraisal of Projects .....	10-24
10.5.1	Financial Appraisal of HW Recycling by Improved Cement Factory.....	10-25
10.5.2	Financial Appraisal of HW Blending Project for Recycling at Cement Factory.....	10-27
10.5.3	Financial Appraisal of Zinc Recovery Project .....	10-30
10.6	Implementation Framework .....	10-31
11	<b>Improvement Plan for Waste Oil and Waste Battery Recycling .....</b>	<b>11-1</b>
11.1	Objectives and Work Process.....	11-1
11.1.1	Background and Objectives.....	11-1

11.1.2	Work Process.....	11-1
11.2	Improvement Plan for Waste Oil Recycling .....	11-2
11.2.1	Field Investigation .....	11-2
11.2.2	Current Issues .....	11-4
11.2.3	Improvement measures for waste oil recycling.....	11-4
11.3	Improvement Plan for Waste Battery Recycling Industry .....	11-7
11.3.1	Field Investigation .....	11-7
11.3.2	Current Issues .....	11-10
11.3.3	Improvement plan for waste battery recycling .....	11-11
11.4	Conclusion and Recommendation.....	11-15
11.4.1	Waste Oil Recycling .....	11-15
11.4.2	Waste Battery Recycling .....	11-15
12	Formulation of IWM Plan for the Paint Industry.....	12-1
12.1	Introduction .....	12-1
12.1.1	Background and Objectives.....	12-1
12.1.2	Work Plan.....	12-1
12.2	Current Issues of IWM of Paint Industry .....	12-3
12.2.1	Survey Results .....	12-3
12.2.2	Current Issues of IWM of Paint Industry .....	12-5
12.3	Formulation of Improvement Plan for IWM of Paint Industry .....	12-9
12.3.1	Estimation of Future Waste Generation from Paint Industry .....	12-9
12.3.2	Goals of Improvement Plan and Future Waste Flow .....	12-9
12.3.3	Improvement Plan.....	12-10
12.4	Financial Appraisal of Solvent Recycling in the Paint Industry .....	12-17
12.4.1	Financial Viability of the Recycling Business Focusing on Waste Solvent Generated from Paint Industries.....	12-17
12.4.2	Financial Viability of On-Site Recycling and Reuse of Waste Solvent by the Paint Manufacturing Factories .....	12-20
12.5	Conclusions and Recommendations.....	12-22
12.5.1	Conclusions .....	12-22
12.5.2	Recommendations .....	12-22
13	Pilot Projects.....	13-1
13.1	Objectives and Work Flow.....	13-1
13.1.1	Objectives .....	13-1
13.1.2	Selection of the P/Ps .....	13-1
13.1.3	Waste Exchange in Thailand .....	13-1
13.1.4	Description of PP1 and PP2.....	13-2
13.2	Waste Exchange Database (PP1).....	13-3
13.2.1	Survey on Needs of Waste Exchange.....	13-3
13.2.2	Findings of the Survey.....	13-5
13.2.3	Waste Utilization Database .....	13-7
13.2.4	Plan of the Operation of WUDC .....	13-15
13.2.5	WUDC Website.....	13-19
13.2.6	WUDC Operation and Maintenance.....	13-19
13.2.7	Evaluation of WUDC .....	13-21
13.3	Pilot Waste Exchange (PP2).....	13-23
13.3.1	Candidates of Target Wastes and Target Factories .....	13-23

13.3.2	Waste Exchange Attempts.....	13-24
13.3.3	Newsletter and Leaflet.....	13-29
13.4	Improvement of DIW's Factory Database Management System (PP3).....	13-30
13.4.1	Background and Objectives.....	13-30
13.4.2	Content of PP3.....	13-31
13.4.3	Selection of Provincial Office .....	13-31
13.4.4	Component 1 of PP3: Factory Database Improvement .....	13-32
13.4.5	Component 2 of PP3: WUDC Dissemination .....	13-49
13.5	Overall Evaluation of the Pilot Projects and Tasks for the Future.....	13-51
13.5.1	Establishment of WUDC.....	13-52
13.5.2	Improvement of Data Control System.....	13-54

## List of Tables

	Page:
Table 1-1: Team Members .....	1-9
Table 1-2: Number of Report Copies Submitted .....	1-10
Table 1-3: Technology Transfer Opportunities.....	1-10
Table 2-1: Area of the Five Provinces in the Study Area .....	2-1
Table 2-2: Climate in B.E. 2541 (1998) of the Five Provinces.....	2-3
Table 2-3: Administrative Unit and Population of Bangkok at the End of 1999.....	2-7
Table 2-4: Administrative Unit and Population of Nonthaburi at the end of 1999.....	2-9
Table 2-5: Administrative Unit and Population of Pathum Thani at the end of 1999 ...	2-9
Table 2-6: Administrative Unit and Population of Samut Prakarn at the end of 1999	2-10
Table 2-7: Administrative Unit and Population of Samut Sakhon at the end of 1999.	2-11
Table 2-8: Population in the Study Area.....	2-11
Table 2-9: Electricity Supply in the Study Area .....	2-17
Table 2-10: Water Supply in the Study Area .....	2-18
Table 2-11: Wastewater Treatment Plant (WWTP) in the Study Area.....	2-19
Table 2-12: Number of Factories Registered in Accordance with the Factory Act, 1992	2-27
Table 2-13: Gross Provincial Product by Sub-Sector of Industry at Current Market Prices (1998) .....	2-29
Table 2-14: Investment Incentives in Zone 1 .....	2-30
Table 2-15: Composition of the Manufacturing Industry in the Industrial Estates/Parks in Bangkok and its Vicinity.....	2-31
Table 3-1: Classification of Non-HW Applied to the Factory Survey.....	3-4
Table 3-2: Idea of Subdivision of GTZ HW Code.....	3-5
Table 3-3: Classification of HW Applied to the Factory Survey .....	3-6
Table 3-4: Main Contents of the Factory Survey .....	3-7
Table 3-5: Study Code and MOI Code of Factories.....	3-9
Table 3-6: Number of Factories Registered in DIW Database .....	3-10
Table 3-7: Number of Factories Registered in IEAT Database .....	3-10
Table 3-8: Registration Data on Industrial Zones, Communities and Parks not under the Control of IEAT in the Study Area .....	3-11
Table 3-9: Number of Factories Counted in the Study .....	3-12
Table 3-10: Number of Factories Surveyed .....	3-13
Table 3-11: Number of Factories Replied to Question on Waste Generation.....	3-15
Table 3-12: Collection Service Providers .....	3-16
Table 3-13: Number of Districts and Municipalities in the Study Area .....	3-22
Table 3-14: Assumed Share and Estimated Quantity of Industrial Waste Collected Daily for Each Block of the Districts in Bangkok .....	3-25
Table 3-15: Estimated Quantity of Factory Waste Collected Daily by the Districts and Municipalities.....	3-25
Table 3-16: Estimated Quantity of Factory Waste Collected Annually by the Districts and Municipalities .....	3-26
Table 3-17: Waste Collection of Private Companies .....	3-27
Table 3-18: Number of Factories with DIW Authorization as Waste Business Enterprises .....	3-29
Table 3-19: Quantity of Iron and Iron Scrap (1991-1996).....	3-31
Table 3-20: Factories with DIW Authorization as Waste Business Enterprises (HW)	3-46
Table 3-21: Factories with DIW Authorization as Waste Business Enterprises (Non-HW) .....	3-50
Table 3-22: Associations to be Surveyed.....	3-53

Table 3-23: Number of collection vehicles by type, drivers and workers .....	3-55
Table 3-24: Quantity of Waste collected by the districts and municipalities.....	3-55
Table 3-25: Quantity of Waste carried into each transfer station.....	3-55
Table 3-26: Average Waste Collection Fee by Size of Factories.....	3-56
Table 3-27: Distribution of Respondents (Sex and Age) .....	3-66
Table 3-28: Distribution of Respondents (2).....	3-68
Table 3-29: Distribution of Respondents (3).....	3-68
Table 3-30: List of Possessions.....	3-68
Table 3-31: Industrial Waste Problem Known from Media.....	3-78
Table 4-1: Estimated Collected Waste Volume in Bangpoo Industrial Estate (Sep.1998)4-1	
Table 4-2: Characteristics of Waste in Bangpoo Industrial Estate (Sep.1998).....	4-2
Table 4-3: Estimated Collected Waste Volume in Bangplee Industrial Estate (September 1998).....	4-3
Table 4-4: Characteristics of Waste in Bangplee Industrial Estate (Sep.1998) .....	4-3
Table 4-5: Investigation result of waste in Ladkrabang Industrial Estate .....	4-5
Table 4-6: The generation of HW in Thailand nationwide (TDRI) .....	4-6
Table 4-7: The Generation of HWs in Metropolitan Area and its vicinal 4 provinces (Kasetsart University) .....	4-6
Table 4-8: Amount of HWs in 2000 in Thailand (DIW, 2001).....	4-7
Table 4-9: HWs from industrial sector of Samut Prakarn province.....	4-8
Table 4-10: The Comparison with previous studies and JICA Study .....	4-8
Table 4-11: Number of Factories and Employees used for Estimation of Present IW Generation .....	4-10
Table 4-12: IW Generation in accordance with Study Code of Industries .....	4-11
Table 4-13: Non-HW and HW Generation according to the Waste Category .....	4-12
Table 4-14: Comparison of HW Generation Rates of JICA and GTZ Study .....	4-14
Table 4-15: Comparison of HW Generation Estimated by JICA and GTZ Study for all the Study Codes of Industries.....	4-15
Table 4-16: Comparison of HW Generation Estimated by JICA and GTZ Study for all the HW Categories .....	4-16
Table 4-17: Non-HW Flow and HW Flow in the Study Area (2001).....	4-17
Table 4-18: Key Indicators of each Non-IIW Category.....	4-20
Table 4-19: Key Indicators of Non-HW from Each industrial Category .....	4-20
Table 4-20: Key Indicators of Each HW Category .....	4-21
Table 4-21: Key Indicators of HW from Each Industrial Category .....	4-21
Table 4-22: Rate of Factory Survey Data to Total of Study Area.....	4-23
Table 4-23: Environmental Activities of Japanese companies belonging to JCCB.....	4-27
Table 4-24: Reuse and recycling rate of Non-HW by type.....	4-30
Table 4-25: The reuse and recycling rate of HW by type .....	4-31
Table 4-26: Amount of Reuse and Recycle of HW by type.....	4-31
Table 4-27: Comparisons between JICA study and the PCD study in terms of recycled waste quantities .....	4-33
Table 4-28: Waste Treatment at Samae Dam Center.....	4-34
Table 4-29: Current IWM Facilities (1): In the Study Area and Outside Industrial Estate under IEAT.....	4-36
Table 4-30: Current IWM Facilities (2): In Industrial Estates under IEAT of the study area .....	4-39
Table 4-31: Future Plan of IWM Facilities: In the Study Area including Industrial Estates under IEAT .....	4-44
Table 4-32: Estimates of Regional CGHW by Waste Source (1996).....	4-45
Table 4-33: Illegal Dumping of Chemical Waste From April 2000 to March 2001 ....	4-50



Table 5-1: Main Policies in the Enhancement and Conservation of National Environmental Quality Policy and Plan B.E. 2540-2559 (1997-2016).....	5-5
Table 5-2: Environmental management goals and guidelines in the Enhancement and Conservation of National Environmental Policy and Plan B.E. 2540-2559 (1997-2016).....	5-5
Table 5-3: Goals of Environmental Quality Management Plan B.E. 2542-2549 related to Waste Management .....	5-6
Table 5-4: Summarized details of each law and regulation related to industrial waste management. ....	5-26
Table 5-5: Required Items to be described in the Request for Transport Permit.....	5-33
Table 5-6: Required Items in the Waste Manifest System.....	5-33
Table 5-7: Factory Categorization concerning the IWM .....	5-37
Table 6-1: Factory Registration Database Fields .....	6-1
Table 6-2: Field of Industrial Category .....	6-4
Table 6-3: Manifest Data from Samae Dam Center (Number of Factories, Number of Manifest Sheets and Waste Amount) .....	6-23
Table 7-1: Off-site HW Treatment/Final Disposal Facilities.....	7-5
Table 8-1: Population in the Study Area .....	8-1
Table 8-2: Population growth rate in the Study Area (1995-2000).....	8-1
Table 8-3: Population Projection in the Study Area (2000-2010) .....	8-2
Table 8-4: Projection of GDP Growth in Thailand (1999-2002).....	8-2
Table 8-5: Projected GDP Growth in Thailand (2002-2010).....	8-2
Table 8-6: The projected future number of employees by types of Industries in accordance with the TSIC Code .....	8-5
Table 8-7: 33 categories of factories and their correspondence with TSIC .....	8-6
Table 8-8: Non-HW Generation rate (per employee) .....	8-8
Table 8-9: HW generation rate per employee .....	8-9
Table 8-10: Number of employees in 2001 and its increase .....	8-10
Table 8-11: Non-HW generation by type of industry in 2010 .....	8-11
Table 8-12: Non-HW generation by type of waste in 2010 .....	8-12
Table 8-13: HW generation by type of industry in 2005 .....	8-12
Table 8-14: HW generation by type of waste in 2001, 2005 and 2010.....	8-13
Table 9-1: Targets of Non-HW Management .....	9-2
Table 9-2: Summary of the Non-HW M/P .....	9-6
Table 9-3: Preconditions for Cost Estimation of Landfill Facility Development .....	9-25
Table 9-4: Outline of Landfill Facility Plan and Estimated Construction Cost in OEPP Report .....	9-26
Table 9-5: Unit Operation Cost of Landfill Facility .....	9-27
Table 9-6: Treatment and landfill fees of non-HW at the existing treatment facilities and landfills.....	9-29
Table 9-7: Preconditions of the Project for Preliminary Financial Appraisal.....	9-29
Table 9-8: Results of Estimating the Financial Feasibility indicators .....	9-30
Table 9-9: Operational Standard of IW disposal facilities.....	9-35
Table 9-10: Site Selection of MOSTE for Solid Waste Management Facilities.....	9-36
Table 9-11: Site Selection Criteria for HW Landfill.....	9-37
Table 9-12: Summary sheet for excluding criteria.....	9-42
Table 9-13: Summary sheet for reducing criteria.....	9-43
Table 9-14: Summary of the scores on environmental criteria .....	9-46
Table 9-15: Summary of the scores on planning criteria .....	9-47
Table 9-16: Summary of the scores on nature and landscape criteria.....	9-49
Table 9-17: Summary of the scores on political and juridical criteria .....	9-50

Table 9-18: Summary of the scores on Financial and Economic criteria .....	9-51
Table 9-19: Final score for each location.....	9-52
Table 10-1: Targets of HW A/P .....	10-7
Table 10-2: Type, use and volume of wastes received by cement factories in Japan in 1999.....	10-10
Table 10-3: Processes at which Waste Is Received .....	10-11
Table 10-4: Acceptance inspection standard of Industrial waste in Japan.....	10-12
Table 10-5: Improvement items at the cement production process .....	10-14
Table 10-6: Facilities and Equipment for HW Blending Industry .....	10-17
Table 10-7: An Example of analysis of EAF dust in Japan .....	10-20
Table 10-8: Estimation of zinc recovery potential from EAF Dust in Thailand.....	10-21
Table 10-9: Estimated Amount of HW to be recycled or reused in cement industry (2005) .....	10-25
Table 10-10: Cost of Facility Improvement in Cement Factories for HW Recycling.....	10-26
Table 10-11: Preconditions of the Project.....	10-26
Table 10-12: Results of Financial Feasibility Indicators by Cases.....	10-27
Table 10-13: Estimated Amount of HW Treated by HW Blender.....	10-28
Table 10-14: HW Treatment Capacity of the Blender.....	10-28
Table 10-15: Cost of HW Blending Facilities (per unit).....	10-28
Table 10-16: Preconditions of the HW Blending Project .....	10-29
Table 10-17: Results of Financial Feasibility Indicators by Cases .....	10-29
Table 10-18: Estimated Cost of Zinc Recovery Project.....	10-30
Table 10-19: Preconditions of the Project.....	10-30
Table 10-20: Results of Financial Feasibility Indicators by Cases .....	10-31
Table 10-21: Implementation Framework of HW A/P .....	10-32
Table 11-1: List of Waste Oil Recycling Factories.....	11-2
Table 11-2: Specification of Reformed Fuel Oil.....	11-6
Table 11-3: List of Waste Battery Recycling Factories .....	11-7
Table 11-4: Comparison of MF (Pb-Ca type) Battery and Normal (Pb-Sb type) Battery.....	11-9
Table 12-1: 11 Factories Surveyed.....	12-2
Table 12-2: Waste from 11 Factories Surveyed.....	12-4
Table 12-3: Waste Amount from Paint Factories in the Study Area .....	12-4
Table 12-4: Future Waste Generation from Paint Industry .....	12-9
Table 12-5: Initial Investment Cost of the Project .....	12-18
Table 12-6: O/M Cost of the Proposed Solvent Recycling Facility.....	12-19
Table 12-7: Preconditions of the Project.....	12-19
Table 12-8: Results of Financial Feasibility Indicators by Cases .....	12-20
Table 12-9: Preconditions of On-Site Recycling of Waste Solvent.....	12-21
Table 12-10: Results of Financial Feasibility Indicators of On-site Waste Solvent Recycling.....	12-21
Table 12-11: Measures to Reduce Waste from Paint Industry.....	12-23
Table 13-1: Result of Posted Questionnaires .....	13-4
Table 13-2: Study Code and MOI code of Respondent Factories.....	13-4
Table 13-3: List of Waste Available for Supply .....	13-6
Table 13-4: Waste Demanded .....	13-7
Table 13-5: Pilot Projects and Operational Scheme of WUDC .....	13-16
Table 13-6: Requirement of Manpower for WUDC O&M.....	13-20
Table 13-7: Candidates of Target Wastes .....	13-23
Table 13-8: Planned Procedure and Progress of PP2.....	13-25
Table 13-9: Criteria for Scoring Waste Suppliers.....	13-25
Table 13-10: Number of Selected Suppliers to be Introduced .....	13-26

Table 13-11: Status of Demanders .....	13-27
Table 13-12: Content of the Newsletters Issue 1 and Issue 2 .....	13-30
Table 13-13: Result of the Comparison of Factory Registration Number between the Two Databases .....	13-41
Table 13-14: Problems Found in Some Fields .....	13-42
Table 13-15: Proposed Database Update Process .....	13-43
Table 13-16: Major Opinions from Attendants .....	13-50

## List of Figures

	Page:
Figure 1-1: Study Area.....	1-3
Figure 1-2: Work Schedule (1).....	1-5
Figure 1-3: Work Schedule (2).....	1-6
Figure 2-1: Five Provinces in the Study Area.....	2-1
Figure 2-2: Structure of National Public Administration in Thailand .....	2-4
Figure 2-3: Map of Bangkok.....	2-12
Figure 2-4: Map of Nonthaburi .....	2-13
Figure 2-5: Map of Pathum Thani.....	2-14
Figure 2-6: Map of Samut Prakarn.....	2-15
Figure 2-7: Map of Samut Sakhon .....	2-16
Figure 2-8: Trend of Actual Economic Growth Rate in Thailand (1970-1999) .....	2-20
Figure 2-9: Changes in Structure of GDP in Thailand (1960-1999).....	2-22
Figure 2-10: Changes in Percentage of Employed Persons by Sector (1990-2000) ....	2-22
Figure 2-11: Trend of Per Capita GDP in Thailand .....	2-23
Figure 2-12: Comparison of Per Capita GDP among ASEAN Countries.....	2-24
Figure 2-13: Disparity in Average Monthly Income among Regions in Thailand .....	2-24
Figure 2-14: Distribution of GRP by Provinces of Bangkok and its Vicinity .....	2-25
Figure 2-15: Comparison of per capita GRP among the regions of Bangkok and its Vicinity.....	2-26
Figure 2-16: Comparison of the Scale of Manufacturing Industry Between Bangkok and its Vicinity .....	2-27
Figure 2-17: Structure of Manufacturing Industry in Bangkok and its Vicinity.....	2-28
Figure 3-1: non-HW Flow.....	3-2
Figure 3-2: Flow Chart of Factory Survey .....	3-3
Figure 3-3: Non-HW Flow of 206 Factories Surveyed.....	3-18
Figure 3-4: HW Flow of 206 Factories Surveyed .....	3-18
Figure 3-5: Material Flow of Iron Products in 1994 .....	3-32
Figure 3-6: Material Flow of Aluminum Products in 1994 .....	3-34
Figure 3-7: Material Flow of Paper products in 1994 .....	3-35
Figure 3-8: Life Cycle of Glass.....	3-36
Figure 3-9: Material Flow of Glass Products in 1994 .....	3-38
Figure 3-10: Material Flow of Plastic Products in 1995~1996 .....	3-40
Figure 3-11: Material Flow of Tire in 1994 .....	3-43
Figure 3-12: Location of Factories with DIW Authorization as Waste Business Enterprises .....	3-45
Figure 3-13: Work Flow of POS .....	3-62
Figure 3-14: Districts where PSUs are located .....	3-65
Figure 3-15: Distributions of Samples (Sex, Age and Income).....	3-67
Figure 3-16: Distribution of Population from ACNielsen Media Index 2001 .....	3-67
Figure 3-17: Problems in Thai Society (Q.1).....	3-69
Figure 3-18: Interest in Environment Issues (Q.2-1) .....	3-69
Figure 3-19: Sources of Information of Environment Issues (Q.2-2) .....	3-70
Figure 3-20: Seriousness of Environment Problems (Q.3) .....	3-70
Figure 3-21: Effect from Environment Degradation (Q.4) .....	3-71
Figure 3-22: Environment Conservation VS Economic Development (Q.5) .....	3-71
Figure 3-23: Opinion on Environment Conservation Tax (Q.6).....	3-72
Figure 3-24: Habit of Saving Water and Energy (Q.7-1).....	3-72
Figure 3-25: Reasons for Saving Water and Energy (Q.7-2).....	3-73

Figure 3-26: Source of Pollution (Q.8) .....	3-73
Figure 3-27: Reliability Rating of Organizations (Q.9) .....	3-74
Figure 3-28: Whether Environment Regulations are Observed (Q.10) .....	3-74
Figure 3-29: Most Effective Measures to Make Regulations Observed (Q.11).....	3-75
Figure 3-30: Things to Be Done by the Government to Improve Environment (Q.12)3-75	
Figure 3-31: Awareness of Industrial Waste (Q.13) .....	3-76
Figure 3-32: Image About Industrial Waste (Q.14) .....	3-76
Figure 3-33: Knowledge About Industrial Waste (Q.15).....	3-77
Figure 3-34: Operation of Industrial Waste Treatment And Disposal Facilities in Bangkok And Vicinity (Q.18).....	3-77
Figure 3-35: Industrial Waste Problem Known from Media (Q.19).....	3-78
Figure 3-36: Effect of Illegal Dumping to Environment (Q.20) .....	3-79
Figure 3-37: Solution to Illegal Dumping of Industrial Waste (Q.21).....	3-79
Figure 3-38: Opinion about Construction of New Industrial Waste Treatment/Disposal Facilities (Q.22).....	3-80
Figure 3-39: Policies Should Be Issued before Approval of New Facility Construction (Q.23) .....	3-80
Figure 3-40: Reasons for Disputes over Construction Plan of Industrial Waste Treatment/Disposal Facility (Q.24).....	3-81
Figure 3-41: Awareness of Measures to Reduce The Volume of Industrial Waste from Factories (Q.25).....	3-81
Figure 3-42: Measures Known (Q.26) .....	3-82
Figure 3-43 Awareness of Government Programs to Promote Industrial Waste Minimization (Q.27 and Q.28).....	3-82
Figure 3-44: Agree-Disagree Rating on “Industry Pays Enough Attentions And Bear Enough Cost to Treat/Dispose of Industrial Waste” (Q.29).....	3-83
Figure 3-45: Willingness to Pay Higher if Waste Management Causes Higher Product Price (Q.30).....	3-83
Figure 3-46: Conditions Set to Agree if The Government Plans to Construct Industrial Waste Treatment/Disposal Facilities (Q.31) .....	3-84
Figure 3-47: Opinion about Constructing Reuse/Recycle Center in Your District (Q.32)3-85	
Figure 3-48: Conditions Set to Agree With The Construction Plan of Recycle Center (Q.33) .....	3-85
Figure 4-1: Non-HW Flow in the Study Area (2001) .....	4-18
Figure 4-2: HW Flow in the Study Area (2001) .....	4-19
Figure 4-3: Illustration of Industrial Cluster and Zero Emission .....	4-25
Figure 4-4: Industrial Waste Management System of Bangpoo Industrial Estate .....	4-40
Figure 4-5: Industrial Waste Management System of Bangplee Industrial Estate.....	4-41
Figure 4-6: Industrial Waste Management Inside the Industrial Estates.....	4-42
Figure 4-7: The concept flow of CGHW management .....	4-47
Figure 5-1: Main purpose and goals of NESDP concerning the Environment .....	5-2
Figure 5-2: Hierarchy from the national environment policy to the action plans .....	5-4
Figure 5-3: Flow Chart of Factory Permission Application to DIW .....	5-11
Figure 5-4: Procedures for Land Use and Operation in Industrial Estates.....	5-12
Figure 5-5: Organization chart of DIW .....	5-16
Figure 5-6: Structure of Provincial Industrial Office (in case of Nonthaburi) .....	5-19
Figure 5-7: Structure of Pollution Control Department .....	5-20
Figure 5-8: Organization chart of IEAT.....	5-22
Figure 5-9: The organization chart of Department of Public Cleansing of BMA.....	5-24
Figure 5-10: The organization chart of Municipality .....	5-25

Figure 5-11: Relation of Act, Regulations and Notification or Announcement concerning hazardous waste management .....	5-26
Figure 5-12: Procedure of Inspection of Group 1 Factories.....	5-31
Figure 5-13: Procedure of Inspection of Group 2 Factories.....	5-32
Figure 5-14: Procedure of Inspection of Group 3 Factories.....	5-32
Figure 5-15: Chart of Hazardous Waste Transport Coordinating Center .....	5-35
Figure 5-16: Manifest System Proposed by PCD .....	5-36
Figure 5-17: Actors involved in IWM.....	5-37
Figure 5-18: Flow of Public Participation in EIA.....	5-53
Figure 6-1: Existing Network System in DIW.....	6-3
Figure 6-2: Current DB of DIW .....	6-4
Figure 6-3: Main Web Page related to Industrial Information.....	6-5
Figure 6-4: Web page related to industrial information.....	6-5
Figure 6-5: GIS Map with Location of factories in Bangkok .....	6-7
Figure 6-6: Description of HW DB.....	6-8
Figure 6-7: GIS Data Center HWDB scheme .....	6-9
Figure 6-8: New DB Management Scheme .....	6-11
Figure 6-9: Schedule for DB application development.....	6-12
Figure 6-10: User interface .....	6-12
Figure 6-11: Non-HW DB Scheme.....	6-13
Figure 6-12: Manifest System Scheme .....	6-19
Figure 6-13: Detail of Manifest data from Samac Dam.....	6-20
Figure 8-1: Forecast of the Future Growth Trend of Production and No. of Employees in Manufacturing Sector .....	8-3
Figure 9-1: Non-IIW Flow (2005) .....	9-3
Figure 9-2: Non-HW Flow (2010) .....	9-4
Figure 9-3: Structure of the Non-HW M/P .....	9-5
Figure 9-4: Improvement of DB management systems .....	9-21
Figure 9-5: Basic flow of treatment/disposal of wastes .....	9-34
Figure 9-6: Site Selection Process for a new landfill .....	9-40
Figure 10-1: HW flow in 2005 .....	10-8
Figure 10-2: Waste utilization in the cement production process.....	10-11
Figure 10-3: Concept of cement plant improvement .....	10-14
Figure 10-4: Current Recycling System.....	10-16
Figure 10-5: Future Recycling System.....	10-17
Figure 10-6: Conceptual Image of Waste Oil Mixing Facility .....	10-18
Figure 10-7: Conceptual Image of Solid Waste Crushing Facility .....	10-18
Figure 10-8: Flow of Scraper Irons Recycling in Thailand .....	10-20
Figure 10-9: Flow of Heavy Metal Recovery from EAF Dust and other HWs .....	10-22
Figure 11-1: Sulfuric Acid/Activated Clay Process .....	11-3
Figure 11-2: Waste Oil Recycling in Japan .....	11-5
Figure 11-3: Comparison of Quantity of Waste Battery .....	11-8
Figure 11-4: Comparison of Quantity of Waste Battery Recycling.....	11-9
Figure 11-5: Tendency of Waste Battery Recycling in Japan.....	11-12
Figure 12-1: Location of 11 Factories Surveyed.....	12-3
Figure 12-2: Flow of Waste from Paint Industry of the Study Area (2002) .....	12-6
Figure 12-3: Comparison of the Rate of Total Waste Generation Amount and Reuse/Recycling Amount.....	12-7
Figure 12-4: Flow of Waste from the Paint Factories in the Study Area in 2010.....	12-10
Figure 12-5: Production Process of Paint (except for Powder Paint) .....	12-11
Figure 12-6: Sources and Countermeasures of Waste Generated from the Paint Industry.....	12-12

Figure 13-1: Waste Utilization Database Scheme.....	13-8
Figure 13-2: User Registration Form .....	13-9
Figure 13-3: Supply Sheet.....	13-10
Figure 13-4: Demand Sheet.....	13-11
Figure 13-5: On-line Operation Flow of WUDC .....	13-18
Figure 13-6: Entities Involved in the DB Update P/P .....	13-33
Figure 13-7: Components of Equipment Installed .....	13-34
Figure 13-8: Relations of Fields to be Updated .....	13-40

Contents of Annex		Page
<b>Annex 3    Annex to Chapter 3 of the Main Report</b>		
Annex 3.1	Survey Sheet for Factory Survey .....	3-1
Annex 3.2	Results of the Factory Survey .....	3-20
Annex 3.3	Waste Flow 206 Factories Surveyed.....	3-55
3.3.1	Now-HW .....	3-55
3.3.2	HW.....	3-80
Annex 3.4	Result of the Survey on Waste Reuse/Recycling/Treatment Companies .....	3-104
Annex 3.5	Treatment/Final Disposal Facilities for Hazardous Waste and/or Non-Hazardous Waste.....	3-108
Annex 3.6	Survey Sheet for Public Opinion Survey on Environment and Industrial Waste Management In Bangkok and its Surrounding Area....	3-129
<b>Annex 4    Annex to Chapter 4 of the Main Report</b>		
Annex 4.1	Present Waste Flow in Study Area .....	4-1
4.1.1	Non-HW Flow .....	4-1
4.1.2	HW Flow .....	4-29
<b>Annex 5    Annex to Chapter 5 of the Main Report</b>		
Annex 5.1	Classification of Industry .....	5-1
Annex 5.2	MOI Notifications Concerning IWM.....	5-25
Annex 5.2.1	The Notification of the Ministry of Industry No.6 [B.E. 2540 (1997)] Issued Pursuant to the Factory Act B.E. 2535 (1992)....	5-25
Annex 5.2.2	The Notification of the Ministry of Industry No.1 [B.E. 2541 (1998)] Issued Pursuant to the Factory Act B.E. 2535 (1992)....	5-27
Annex 5.2.3	List of Characteristics and Properties of Wastes or Unusable Materials Attached to the Notification of the Ministry of industry No.6 [B.E. 2540 (1997)].....	5-29
Annex 5.2.4	Criteria and Methods of Detoxification, Disposal, Discarding or Landfilling of Wastes and Unusable Materials Attached to the Notification of the Ministry of Industry No. 6 [B.E. 2540(1997)]	5-61
Annex 5.2.5	Criteria and Methods of Detoxification, Disposal, Discharging or Landfilling Attached to the Notification of the Ministry of Industry No.1 [B.E. 2541(1998)] .....	5-65
Annex 5.3	Forms to be Submitted to MOI .....	5-66
Annex 5.3.1	Request Form for Transport Permit .....	5-66
Annex 5.3.2	Notice of Details of Wastes or Unusable Materials Attached to the Ministry of Industry No.6 [B.E. 2540 (1997)] (Ro Ngo 6)	5-70
<b>Annex 6    Annex to Chapter 6 of the Main Report</b>		
Annex 6.1	Non-HW DB User's Manual .....	6-1
Annex 6.2	Manifest DB User's Manual .....	6-13
<b>Annex 12    Annex to Chapter 12 of the Main Report</b>		



Annex 12.1	Survey Sheet of IWM Plan for the Paint Industry .....	12-1
Annex 12.2	Waste Flow of 11 Paint factories Surveyed .....	12-11
Annex 12.3	Waste Flow of Paint Factories in the Study Area .....	12-17

## **Annex 13 Annex to Chapter 13 of the Main Report**

Annex 13.1	Survey of Needs on Waste Exchange in Industrial Waste Management .....	13-1
Annex 13.2	Findings of the Survey .....	13-13
Annex 13.3	Details of Candidates of Target Waste .....	13-22
Annex 13.4	WUDC User Manual.....	13-44
Annex 13.5	WUDC Manual for Administrators .....	13-56
Annex 13.6	Leaflet .....	13-69
Annex 13.7	WUDC Newsletter Issue 1 .....	13-76
Annex 13.8	WUDC Newsletter Issue 2.....	13-88
Annex 13.9	Manual for Installing and Using the Interface Program for Factory DB Update at the Nonthaburi Provincial Industrial Office .....	13-100
Annex 13.10	Manual of the Data Comparison System Between the Provincial Industrial Office (PIO) and DIW.....	13-111

## **Annex 15 Minutes of Meetings**

## LIST OF ABBREVIATIONS

A/P	Action plan
BMA	Bangkok metropolitan administration
C/P	Counterpart
DB	Database
DF/R	Draft final report
DIW	Department of industrial works
FIRR	Financial internal rate of return
F/R	Final report
FTI	The Federation of Thai industries
GIS	Geographic information systems
HW	Hazardous waste
IC/R	Inception report
IEAT	Industrial estate authority of Thailand
ISIC	International standard industrial classification
IT/R	Interim report
IW	Industrial waste
IWM	Industrial waste management
JICA	Japan international cooperation agency
LC	Local consultant
M/M	Minutes of meetings
M/P	Master plan
MOI	Ministry of industry
MOPS	Ministry of public sanitation
MOSTE	Ministry of science, technology and environment
MW	Municipal waste
NSEDP	National Social and Economic Development Plan
NGO	Non-Governmental organization
NPV	Net present value
MWM	Municipal waste management
Non-HW	Non-hazardous waste
OEPP	Office of Environmental Policy and Planning
O&M	Operation and maintenance
P/P	Pilot project
P/R	Progress report
PCD	Pollution control department
POS	Public opinion survey
S/W	Scope of work
TEI	Thai Environment Institute
TSIC	Thailand standard industrial classification
WUDC	Waste Utilization Data Center

Code for Industrial Sectors

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

Central waste treatment plant is MOI code 101.

MOI code 105 "waste sorting and landfilling" and code 106 "waste reuse/recycling" were newly added in December 2001.

### Non-Hazardous Industrial Waste

Type of Non-Hazardous Waste	Non-Hazardous Waste Code
Parts of plants such as roots, barks and leave	C01-01
Parts of animals such as bones, skins, hair and excreta	C01-02
Parts of wood	C02
Paper wastes	C03
Plastics or synthetic rubbers	C04
Cloth, thread and fabric	C05
Animal's fat and oil and vegetable oil	C06
Natural rubbers	C07
Metals and metal alloys (not in salt form)	C08
Ceramics	C09-01
Glasses	C09-02
Stone, cement, sand or materials consisting of clay, sand or stone e.g. tile, brick gypsum and concrete	C10
Mixed waste	C11
Others	C12

### Hazardous Industrial Waste

HW Code for the Study	Description	Detail Description
W01-01	Inorganic acid	Sulfuric acid (H <sub>2</sub> SO <sub>4</sub> ), Hydrochloric acid (HCl), Nitric acid (HNO <sub>3</sub> ), Phosphoric acid (H <sub>3</sub> PO <sub>4</sub> ), Other inorganic acids
W01-02	Organic acid	Acetic acid (CH <sub>3</sub> COOH), Formic acid (HCOOH), Other organic acids
W02	Alkalis	Caustic soda (NaOH), Ammonia (NH <sub>3</sub> ), Sodium carbonate (Na <sub>2</sub> CO <sub>3</sub> ), Other alkaline materials
W03-01	Heavy Metal	Salts
W03-02	Compounds	Toxic salts (Hg, As, Cd, Pb, Cr)
W03-03		Heavy metal other than the above
W04-01	Liquid Inorganic	Plating wastes, Cyanides
W04-02	Compounds	Liquid inorganic compounds other than the above
W05	Solid Inorganic Compounds	Asbestos, Slag, Silt
W06-01	Organic Compounds	Reactive chemical wastes (Oxidizing agents, Reducing agents, etc)
W06-02		Solvents
W06-03		Organic compounds other than the above
W07-01	Polymer Materials	Epoxy resin, Chelate resin, Polyurethan resin
W07-02		Latex rubber
W07-03		Polymer materials other than the above
W08-01	Fuel, Oil and Grease	Lubricating oil (Engine oil, Grease, etc)
W08-02		Chlorinated solvents (Trichloroethylene, Methyl chloride, etc)
W08-03		Oil waste other than the above
W09	Fine Chemicals and Biocides	Pesticide, Medicine
W10	Pickling Waste	---
W11-01	Filter Materials,	Inorganic sludge
W11-02	Treatment Sludge	Organic sludge
W12-01	Other Toxic substance	Non-HW mixed or contaminated with HW according to MOI Notification No. 6 (Year 1997) pursuant to the Factory Act.
W12-02	(besides	Waste from specific industrial processes
W12-03	W01-W11)	Chemical dust, Chemical container etc.