THE PREPARATORY SURVEY
ON
SOLID WASTE TREATMENT BUSINESS
IN SOUTHERN VIETNAM
(PPP INFRASTRUCTURE PROJECT)

FINAL REPORT
(MUNICIPAL SOLID WASTE TREATMENT PROJECT)
(INDUSTRIAL WASTE TREATMENT PROJECT)

AUGUST, 2015

JAPAN INTERNATIONAL COOPERATION AGENCY (JICA)

KOBELCO ECO-SOLUTIONS CO.,LTD.

TSUNEISHI KAMTECS CORPORATION

YACHIYO ENGINEERING CO., LTD.

WORLD LINK JAPAN,INC.

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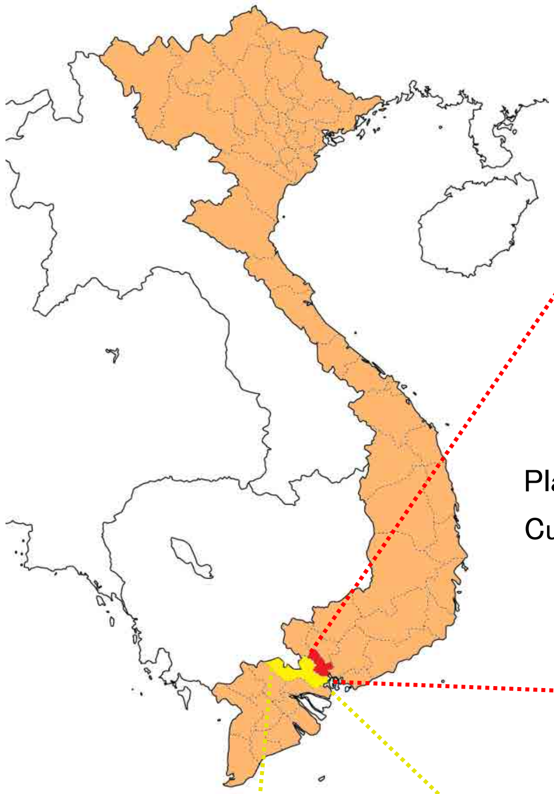
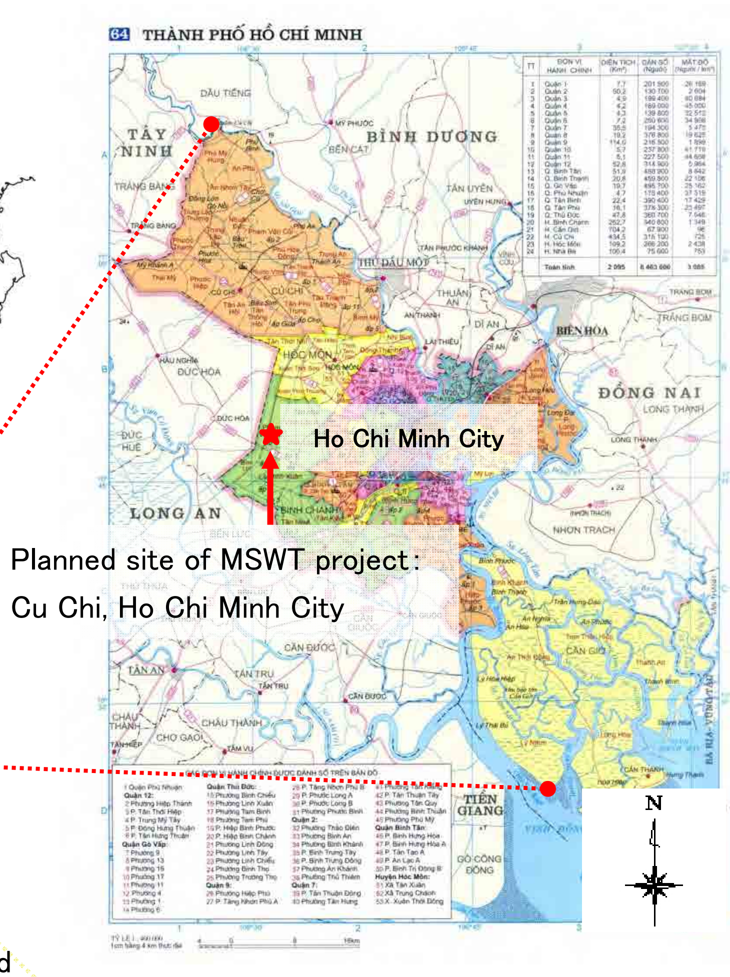
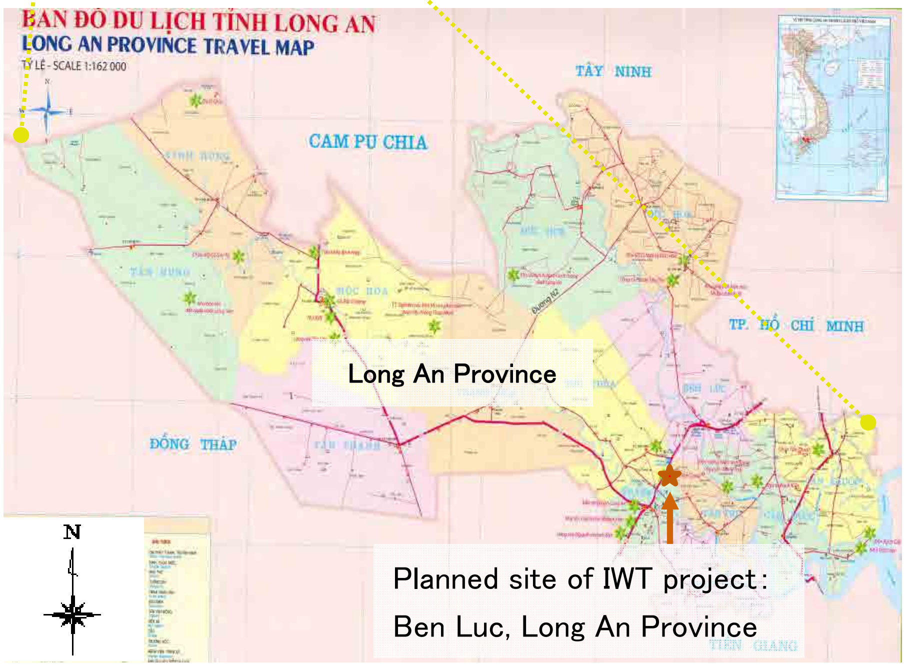


Location of Long An Province and Ho Chi Minh City in Vietnam



Map of Ho Chi Minh City



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Abbreviation

Abbreviation	Description in English
BOT	Build Operate Transfer
CITENCO	Ho Chi Minh City Urban Environment Service Company Limited
DOC	Department of Construction
DOIT	Department of Industry and Trade
DONRE	Department of Natural Resources and Environment
DPI	Department of Planning and Investment
EIA	Environmental Impact Assessment
EPC	Engineering・Procurement・Construction
EVN	Electricity Authority of Vietnam
GEC	Global Environment Centre Foundation
IRR	Internal Rate of Return
JBIC	Japan Bank for International Cooperation
JCM	Joint Crediting Mechanism
JETRO	Japan External Trade Organization
JICA	Japan International Cooperation Agency
MOC	Ministry of Construction
MOF	Ministry of Finance
MOIT	Ministry of Industry and Trade
MONRE	Ministry of Natural Resources and Environment
MPI	Ministry of Planning and Investment
ODA	Official Development Assistance
NEDO	New Energy and Industrial Technology Development Organization
PPP	Public–Private Partnership
SPC	Special Purpose Company

PART 1

CHAPTER 1 BASIC POLICY FOR THE STUDY

1.1 BACKGROUND OF THE STUDY

The amount of solid waste generated in Vietnam in 2009 was 28 million tons. It is announced that approximately 70% of waste was collected and 85% was disposed. Therefore, including uncollected 30% of solid waste, approximately 40% amount of solid waste left without appropriate treatment or illegally dumped. Moreover, it is uncertain whether collected 70% amount of solid waste was disposed after sufficient environmental countermeasure. Such solid waste disposal problem is in serious condition related with issue of lack of landfill site. Therefore, in 2009, Government of Vietnam developed the national policy (Decision No.2149, 2009/QD-TTg) for solid waste management for treatment and reduction of municipal solid waste (MSW) and industrial waste which is set 2025 as the target year.

In Ho Chi Minh City, the biggest city in South Vietnam, the issue of MSW treatment is deteriorating. Ho Chi Minh City has 7.8 million people, 1.8 million households, over 10,000 hotels and restaurants, and 800 above factories. MSW generated from Ho Chi Minh City is already over 7,000tons/day. According to master plan of Ho Chi Minh city, generation amount of MSW is increasing in accordance with population growth and economic development, and it is expected generation amount of MSW will be doubled in 2020. Therefore, sanitary treatment for MSW is required as substitute of land disposal.

In this situation, Ho Chi Minh City developed Master Plan (M/P) for solid waste management (SWM) to promote incineration treatment and composting, targeting to achieve 10% for incineration treatment, 40% for composting, 40% for direct landfill and 10% for recycling.

In Ho Chi Minh City, industrial waste is generated 2,361tons/day (non-hazardous industrial waste: 2,000tons/day, hazardous industrial waste: 350tons/day, medical waste: 11tons/day) in 2010, and is treated by 13 waste treatment facilities licensed by Ho Chi Minh City and a lot of other unauthorized private .

Long An Province, which is one of the provinces composed the Southern Key Economic Zone, is facilitating industrialization recently and number of industrial park is increasing. Industrial waste generated from Long An Province is 1,141tons/day (non-hazardous industrial waste: 937tons/day, hazardous industrial waste: 204tons/day) in 2010.

Binh Duong Province is located in the north of Ho Chi Minh City, lots of Japanese company invests actively in this province. Industrial waste generated from Binh Duong Province is 1,052tons/day (non-hazardous industrial waste: 883tons/day, hazardous industrial waste: 169tons/day) in 2010. Dong Nai Province is one of the provinces, which is rapidly facilitating industrialization and an amount of industrial waste generation is the second-highest in the southern area. Industrial waste generated from Dong Nai Province is 1,331tons/day (non-hazardous industrial waste: 1,206tons/day, hazardous industrial waste: 125tons/day) in 2012. Ba Ria-Vung Tau Province is faced at the South China Sea, and one of the famous seaport area in Vietnam.

Hazardous industrial waste generation, 208.4 tons/day is the second-highest in the southern area (industrial waste: 934.7tons/day, non-hazardous industrial waste: 726.3tons/day).

In this situation of increasing industrial waste dramatically, in the Southern Key Economic Zone including Ho Chi Minh City and Long An Province, sanitary treatment for industrial waste is required as substitute of land disposal.

1.2 BASIC POLICY FOR THE SURVEY

1.2.1 OBJECTIVE OF THE SURVEY

The municipal solid waste treatment project aims to properly treat MSW generated from Ho Chi Minh City and to supply electricity by using heat source which is generated by waste incineration.

The outline of this project is shown below.

Table1-1 Outline of Municipal Solid Waste Treatment Project

Items	Descriptions
Contents	/ Waste treatment / Electricity supply by waste to energy
Target waste	/ Municipal solid waste (Ho Chi Minh City)
Target area	Ho Chi Minh City
Candidate site	Northwest Solid Waste Treatment Complex
Outline of facilities	[Incineration facility] / Treatment capacity: 600tons/day, Stoker type (300tons/day, 2 line) / Output: 11,350kW
Facilities	Waste feed facility, Incinerator, Ventilation facility, Boiler facility, Flue gas treatment facility, Stack

Source: JICA study team

The industrial solid waste treatment project aims to properly treat industrial waste (hazardous and non-hazardous) and medical waste generated from Long An province, Ho Chi Minh City and surrounding provinces and to supply electricity by using heat source which is generated by waste incineration.

The outline of this project is shown below.

Table1-2 Outline of Industrial Solid Waste Treatment Project

Items	Descriptions
Contents	/ Waste treatment / Electricity supply by waste to energy
Target waste	/ Industrial waste (hazardous and non- hazardous) /Medical waste

Items	Descriptions
Target area	Long An province, Ho Chi Minh City, Dong Nai Province, Binh Duong Province, Ba Ria-Vung Tau Province
Candidate site	Long An province Thuan Dao Industrial Complex
Outline of facilities	[Incineration facility] / Treatment capacity: 150tons/day / Output: 4MW [Ash fired plant] / Target treatment: ash (bottom ash, fly ash) / Treatment capacity: Max 50tons/day [Landfill] /Capacity 10 years
Facilities	Waste feed facility, Incinerator, Ventilation facility, Boiler facility, Flue gas treatment facility, Stack

Source: JICA study team

The objectives of the survey are following below;

- To consider the feasibility of this project as private investment business and propose the most appropriate business scheme through the confirmation of private investment environment, survey for demand forecast, consideration for the scope of public and private enterprise, financial structure analysis, risk analysis, evaluation and implementation of technology and environmental and social consideration, suggestion to support government, market sounding.

1.2.2 BASIC POLICY FOR IMPLEMENTING THE SURVEY

(1) Formulating the project based on upper level plan, the policy and strategy of Vietnam

In Vietnam, rapid economic growth which is over 7% in average in last 10 years, and population concentration due to urbanization causes serious solid waste issue in Vietnam especially in urban area. To tackle this issue, various plans formulated both national level and local level. However, most of them are not embodied, and retard of progress of countermeasure for solid waste problems is one of the issues.

Taking heed of this situation, the business plan is discussed in line with the existing upper level plan, policy and strategy, and the project which will become advanced example of solid waste treatment in future Vietnam is formulated.

(2) Analyzing current situation of solid waste treatment, and formulating the project which is contributed to solve confronting problems

The amount of municipal solid waste generated from each household is increasing every year accompanied with growth of population, especially, a large amount of municipal solid waste (approximately 7,000tons/day) is generating from Ho Chi Minh City where population is concentrated. Moreover, according to exponential economic growth, industrial parks are developed around Ho Chi Minh City and Long An province, and a lot of companies including Japanese companies are integrated. Due to rapid industrialization, the amount of industrial solid waste generated from industrial park is increasing. However, looking at the actual circumstance of development of waste treatment facilities, it is a big issue that enough capacity for appropriate treatment for solid waste, which is rapidly increasing is not secured.

Therefore, collecting and analyzing the information of actual condition of current solid waste treatment, and the project for appropriate treatment of municipal solid waste in the region which is expected large increase in the future is formulated.

(3) Creating a plan for the project of facilities development and O&M which can achieve environmental and social effect

Legal framework for solid waste management has been improved as increase of amount of waste generation and risk for environment and health caused by inappropriate waste management. In Law on Environmental Protection (established in January, 1994) amended in November 2005, the chapter related waste management is added separately as reinforcement in regulation. And Prime Minister's Decision "Decision No.64/2003/QD-TTg Approving the plan for thoroughly handling establishments which cause serious environmental pollution" is significant decision which shows strong posture of Vietnamese government towards environment protection. Though in actual condition, lack of appropriate intermediate treatment facilities and landfills, and inappropriate O&M for waste treatment facilities are serious problems facing in Vietnam, and environment pollution by inappropriate waste management become a social problem.

A plan for the project of facilities development and O&M, as countermeasure for various environment pollution caused by waste treatment which is serious problem in Vietnam, is created as good practice.

(4) Clarifying the risk associated with the project, and developing the corporate structure based on appropriate allocation of risk and role between public and private sector

In Vietnam, emergence of foreign companies in waste treatment business, especially incineration treatment, has not progressed much. It is important to clarify the reason for this matter, and to conduct appropriate risk allocation between public and private sector for implementation and securement of sound operation of the project.

In this study, survey for considerable risk to implement the business in Vietnam, and survey for legal system in Vietnam to clarify risk related O&M of waste treatment business are conducted. In sufficient consultations with related agencies, support, restriction, and condition applied to the project are clarified, and the corporate structure based on appropriate risk allocation between public and private sector is built.

(5) Developing economic and feasible plan for the project based on financial and economic analysis

Currently, disposal at landfill is main method for solid waste in Vietnam. However, considering various issues facing in Vietnam, such as reduction of landfill capacity and environment pollution, installation of intermediate treatment facilities which is capable to treat large amount of waste hygienically is one of the solution for those issues. On the other hand, one of the reasons for disposal at landfill taken as mainstream approach is economic. Therefore, securing economic efficiency for continuous intermediate treatment is a major challenge.

Paying adequate attention to market forces related waste treatment, and acquiring necessary information for financial and economic analysis, and economically feasible project with effective for environment and hygiene aspect is created.

1.2.3 CONSIDERATION FOR THE PROJECT PLAN AND FEASIBILITY

For conducting this study smoothly, following points are considered when discussing the project plan and feasibility.

① Consideration for commercialization

The project is planned to be commercialized with PPP/BOT sheme in the future. The risk of doing the project as PPP/BOT business is considered in this study, also countermeasure, mitigation, substitute, and legal feasibility related to expected risk is considered.

② Reduction of construction costs

・The tipping fee and waste disposal fee are main sources of revenue for the project. Due to actual condition of industrial solid waste management in Vietnam, consideration for securing expected revenue is needed. Therefore, for continuous implementation of the project as private business, it is required that initial investment is reduced to a maximum extent. Due to this, on the premise of securing adequate quality of facility design and procurement source, the way of reduction of initial investment cost is considered.

・The construction cost for the incineration facility is calculated in pre-feasibility study by SPC, and is used by construction cost unit of Japanese companies. It is expensive comparing with Chinese companies, but in respect of practical accomplishment, Japanese companies have three times as much experience as. In this study, by researching to not only Japanese companies but also foreign companies including Vietnam and China regarding detail design for facilities and selection of procurement sources, feasibility of reduction of the construction cost is confirmed.

③ Cooperation with related government agency and the donors

・Due to a lack of experience of waste management in Vietnam, which is the same scale with the project, and also the project is the overseas investment business by a Japanese company, there is the possibility that uncertainties related approval and license, regulations prevent progress of the project. This study is carried out with enough discussion with related government agencies, paying attention to conditions for implementation of the project. In addition, related policies are proposed as necessary.

・In the project field, donor's activities are made progress by development of related legislative frame. The information is gathered from the early stage of the project, paying attention to trends of business conditions.

・The output of the project is utilized in the review for overseas investment business by JICA as study material. With this in mind, the information is shared and consulted with JICA.

④ Planning for feasible implementation system and funding sources

・Collaboration with local entities and development of financial scheme is concretely discussed. At the same time, the project is realized by establishment of relationship for wide financial cooperation, considering possibility of investment and loan from public financial institutions in Vietnam and international ones (IFC, ADB etc.).

・In this study, with concretization of project plan and securement of feasibility in mind, for identification of the Partnership Company and concretization of cooperative relationship, the concrete implementation plan of the project is formulated and discussion with related agencies is conducted. After that, finding sources plan is formulated and feasible project plan is proposed.

PART 2

CHAPTER 2 CIRCUMSTANCE SURROUNDING THE PROJECT

2.1 SOCIAL AND ECONOMIC SITUATION

(1) GENERAL INFORMATION

1) Ho Chi Minh City

Ho Chi Minh City is located in Southern, adjacent to Binh Duong Province in the north, Tay Ninh Province in the northwest, Dong Nai Province in the east, Ba Ria-Vung Tau Province in the southeast, and Long An provinces in the west.

Ho Chi Minh City is a special municipality as Hanoi capital, a major center of economic, culture, education and training, science and technology, important political position of the country; the city is an international transport hub as well as a center of industry and multi-disciplinary services in South East Asia. In addition, Ho Chi Minh City belongs to the most dynamic economic region of Vietnam including the Southern Key Economic Zone and the Mekong River Delta, the city is an important economic area not only of the region but also of the whole country.

2) Long An Province

Long An Province is located in the Southern of Vietnam and is adjacent to Ho Chi Minh City and Tay Ninh Province in the east, Cambodia in the north, Dong Thap Province in the west and Tien Giang Province in the south. Long An Province has national boundaries with Cambodia with the length of 137.7 km, with two border gates - Binh Hiep (Moc Hoa) and Tho Mo (Duc Hue).

Long An Province is one of the provinces, which is composed of the Southern Key Economic Zone. The Southern Key Economic Zone is one of the crucial zones, which is defined as a dynamic economic region having particularly important roles in Vietnam's economic development strategy. Geographical location of Long An Province is rather special, because it is located in the Mekong Delta region. The Mekong Delta Focal Economic Zone, which is comprised of CanTho City, An Giang Province, Kien Giang and Ca Mau Province, is also one of the significant zones in Vietnam.

(2) POPULATION

The population of Ho Chi Minh City in 2013 is about 7,818,200 people in total area of 2,095.6 km^2 with around 3,731 people/km^2. The population size is the 1^{st} among the entire 63 cities/provinces in Vietnam.

Ho Chi Minh city consists of 24 districts with 19 urban districts (Dist.1, Dist.2, Dist.3, Dist.4, Dist.5, Dist.6, Dist.7, Dist.8, Dist.9, Dist.10, Dist.11, Dist.12, Go Vap, Tan Binh, Tan Phu, Binh Thanh, Phu Nhuan, Thu Duc, Binh Tan) and 5 rural districts (Cu Chi, Hoc Mon, Binh Chanh, Nha Be, Can Gio).

The population of Long An Province in 2013 is about 1.47 million people in total area of 4,492km^2 with around 327 people/km^2. The population size is the 17th among the entire 63 province in Vietnam.

Long An Province consists of 1 city (Tan An City), 1 town (Kien Tuong town) and 13 districts (Tan Hung District, Vinh Hung District, Moc Hoa District, Tan Thanh District, Thanh Hoa District, Duc Hue District, Duc Hoa District, Ben Luc District, Thu Thua District, Chau Thanh District, Tan Tru District, Can Duoc District and Can Giuoc District) and Tan An City is the provincial capital.

General information of Ho Chi Minh City, Long An Province and surrounding provinces is shown below:

Table2-1 General Information about Ho Chi Minh City, Long An Province and Surrounding Provinces (DN- BD- LA-BRVT)

No	City/Provinces Items	Ho Chi Minh City	Dong Nai Province	Binh Duong Province	Long An Province	Ba Ria-Vung Tau Province
1	Area (km2)	2,095.6	5,907.2	2,694.4	4,491.9	1,989.5
2	Population (people)	7,818,200	2,768,700	1,802,500	1,469,900	1,052,800
3	Number of Districts/ Wards	24 districts (19 urban districts, 5 rural districts)	1 city 1 town 9 districts	1 city 4 towns 4 districts	1 city 1 town 13 districts	2 cities 6 districts
4	Density (people/ km2)	3,731	469	669	327	529

Source: JICA study team

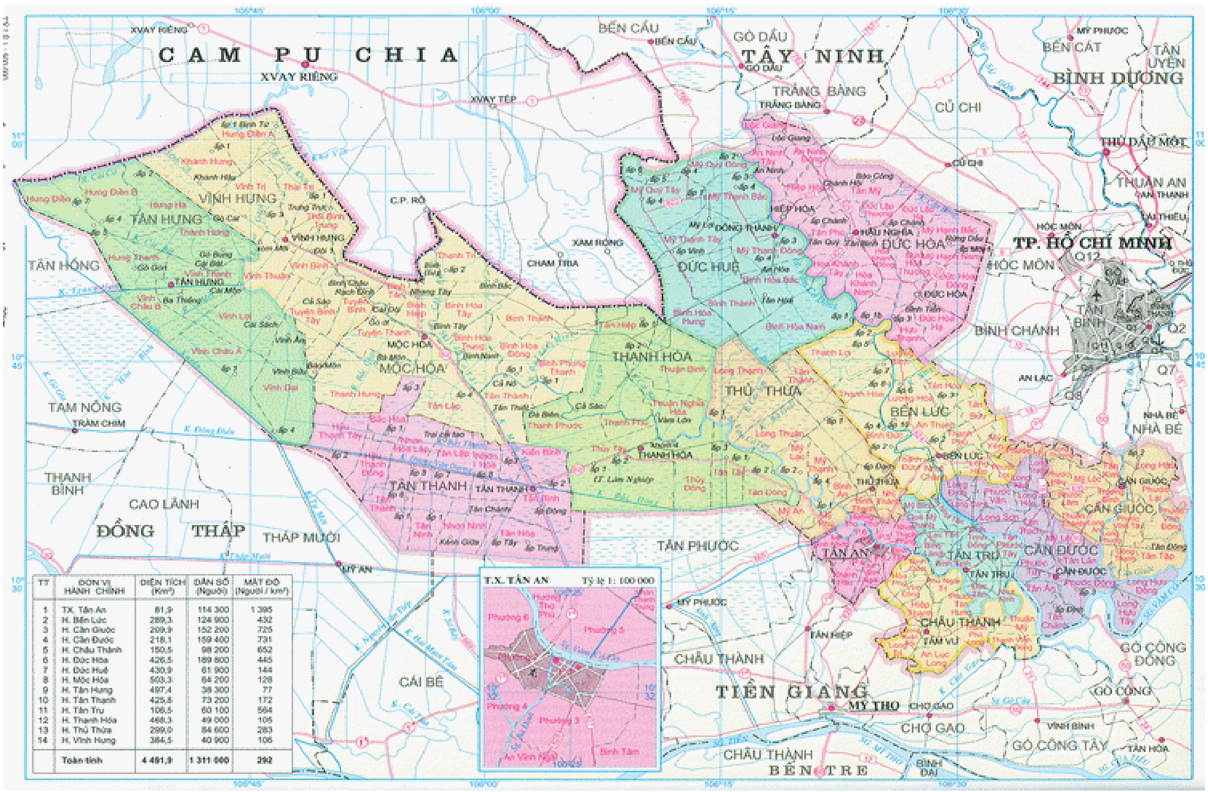


Figure2-1 Administrative Map of Long An Province

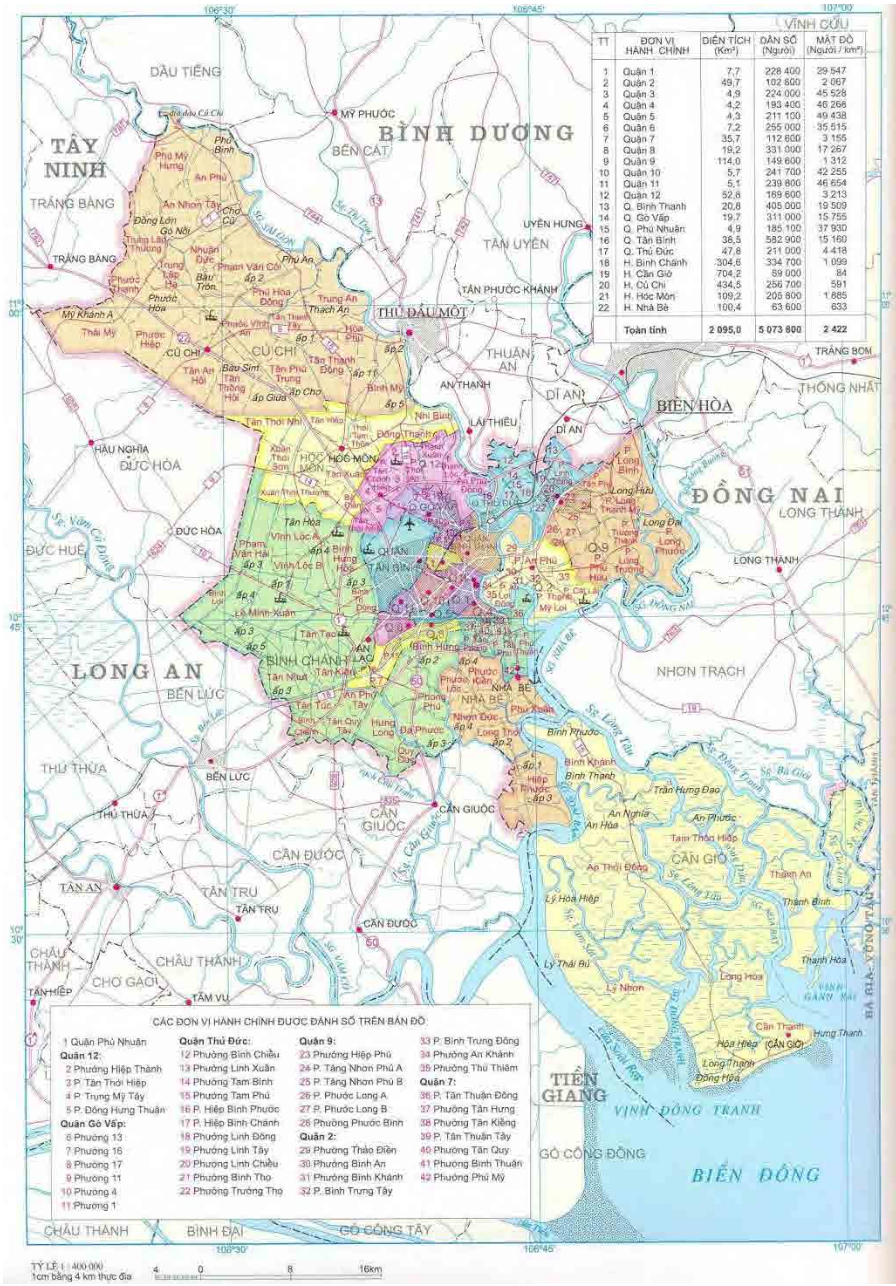


Figure2-2 Administrative Map of Ho Chi Minh City

(3) INDUSTRY

Currently, Ho Chi Minh City has 3 Export Processing Zones (EPZ) and 14 Industrial Zones (IP), in which in which 3 EPZs and 10 IPs are in operation. Besides, there are about 30 industrial clusters with approximately 50% invested and put in operation.

As of 2013, Long An Province has 30 industrial zones and 44 industrial clusters.

Summary on industry in Ho Chi Minh City, Long An Province and surrounding provinces is shown below:

Table2-2 Summary on Industry in Ho Chi Minh City, Long An Province and Surrounding Provinces (DN- BD- LA-BRVT)

No	Items \ City/Province	Ho Chi Minh City	Dong Nai Province	Binh Duong Province	Long An Province	Ba Ria-Vung Tau Province
1	Number of Industrial Parks & Export Processing Zones	3EPZs 14IPs	30IPs	30 IPs	28 IPs	14 IPs
2	Number of Acting Enterprises (*Enterprise*)	110,666	8,255	3,307	10,177	5,456
3	Number of Employees in Enterprises (*person*)	2,371,572	630,046	178,614s	823,008	166,318
4	Annual average capital of enterprises (*billion dong*)	4,191,293	442,958	152,447	467,612	474,678
5	Net turnover from business of enterprises (*billion dong*)	2,816,180	610,458	130,285	592,787	435,156

Source: JICA study team

Table2-3 Numbers of Acting Enterprises in Ho Chi Minh City, Long An Province and Surrounding Provinces (DN- BD- LA-BRVT)

City/Province	2009	2010	2011	2012
Ho Chi Minh	77,700	95,837	104,299	110,666
Dong Nai	6,948	7,288	7,944	8,255
Binh Duong	6,318	7,368	8,600	10,177
Long An	2,741	2,947	3,236	3,370
Ba Ria Vung Tau	2,772	3,270	3,896	5,456

Source: JICA study team

Table2-4 Numbers of Established and Operating IPs in Ho Chi Minh City, Long An Province and Surrounding Provinces (DN- BD- LA-BRVT)

City/Province	Established IPs	Operated IPs	Under Construction/ completing procedures, etc
Ho Chi Minh	17	13	4
Dong Nai	30	24	6
Binh Duong	28	26	2
Long An	30	16	14
Ba Ria – Vung Tau	14	11	3
Total	**119**	**90**	**29**

Source: JICA study team

2.2 NATURAL ENVIRONMENTAL SITUATION

(1) LAND USE STRUCTURE (HO CHI MINH CITY)

The percentage of land in use in Ho Chi Minh City in 2010 is very high with 208,920 ha in total land area of 209,555 ha, accounting for 99.7% of total land area. In Ho Chi Minh City, due to the rapid development of industrialization and urbanization, agricultural land and non-agricultural in 2010 are nearly equal proportion, respectively 56.3% and 43.4%. According to Master Plan of Land Use until 2020, agricultural land is decreasing to 39% to replace mainly land for industrial area development and infrastructure development.

Table2-5 Land Use Structure of Ho Chi Minh City (2010)

Items	2010	
	Area (ha)	Structure (%)
TOTAL NATURAL LAND AREA	209,555	100.0
1.1 Agricultural land	118,052	56.3
- Paddy land	27,594	13.2
- Perennial crop land	32,390	15.5
- Protective forest land	33.285	15.9
- Others	24,783	11.7
1.2 Non-agricultural land	90,868	43.4
- Land used by offices and non-profit agencies	440	0.2
- Land for industrial parks and industrial clusters	4,818	2.3
- Land for landfills, waste treatment sites	644	0.3
- Land for infrastructure development	18,196	8.7
- Others	66,770	31.9
1.3 Unused land	635	0.3

Source: Master Plan of Land Use until 2020 in Ho Chi Minh city

(2) LAND USE STRUCTURE (LONG AN PROVINCE)

The percentage of land in use in Long An Province is very high, 445,931 ha in total land area of 449,240 ha was put into use in 2005, accounting for 99.3% of total land area. The agricultural land is a large percentage of 82.7% in 2007, in which 66.9% for agricultural production land, 14.2% for forest land and 1.6% for aquaculture land. But agricultural land is recently decreasing, the main reason for this is to replace land for residential area development, public works and other non-agricultural land.

Table2-6 Land Use Structure of Long An Province (2005/ 2007)

Items	2005		2007	
	ha	%	ha	%
1. Used land	445,931	99.3	446,017	99.3
1.1 Agricultural land	378,008	84.1	371,600	82.7
- Agricultural production land	304,178	66.7	300,563	66.9
- Forest land	66,718	14.9	63,451	14.1
- Aquaculture land	6,893	1.5	7,366	1.6
- Remaining agricultural land	219	0.05	219	0.05
1.2 Non-agricultural land	67,923	15.1	74,417	16.6
- Residential land	16,505	3.7	17,760	4.0
- Specialized land	35,939	8.0	41,112	9.2
- Land for religious works	193	0.04	195	0.04
- Cemetery land	1,055	0.2	1,092	0.2
- Land of lakes, water surface	14,119	3.1	14,145	3.1
- Remaining non-agricultural land	112	0.02	112	0.02
2. Unused land	3,309	0.7	3,223	0.7
Total land in use	449,240	100.0	449,240	100.0

Source: Long An DONRE

2.3 CURRENT SITUATION OF WASTE TREATMENT

2.3.1 CURRENT SITUATION OF WASTE TREATMENT SECTOR

(1) ADMINISTRATIVE AND LEGISLATIVE FRAME

In Vietnam, the Ministry of Construction (MOC) has jurisdiction over waste management, while the Ministry of Natural Resources and Environment (MONRE) covers environmental issues in general. In addition, other provincial governments and local people’s committees has been directly involved in waste management. In the scheme of local Provincial People’s Committees, several departments have been established in accordance with central government institutions, and are responsible for solid waste administration in each city.

1) Ministry of Natural Resources and Environment (MONRE)

The Ministry of Natural Resources and Environment (MONRE) is a central agency in charge of environmental management and protection in Vietnam. Its major roles in waste management include:

/ To issue guidelines, regulations, and standards for waste management in coordination with other ministries,

/ To compile annual and long-term waste management plans and formulate policies and strategies,

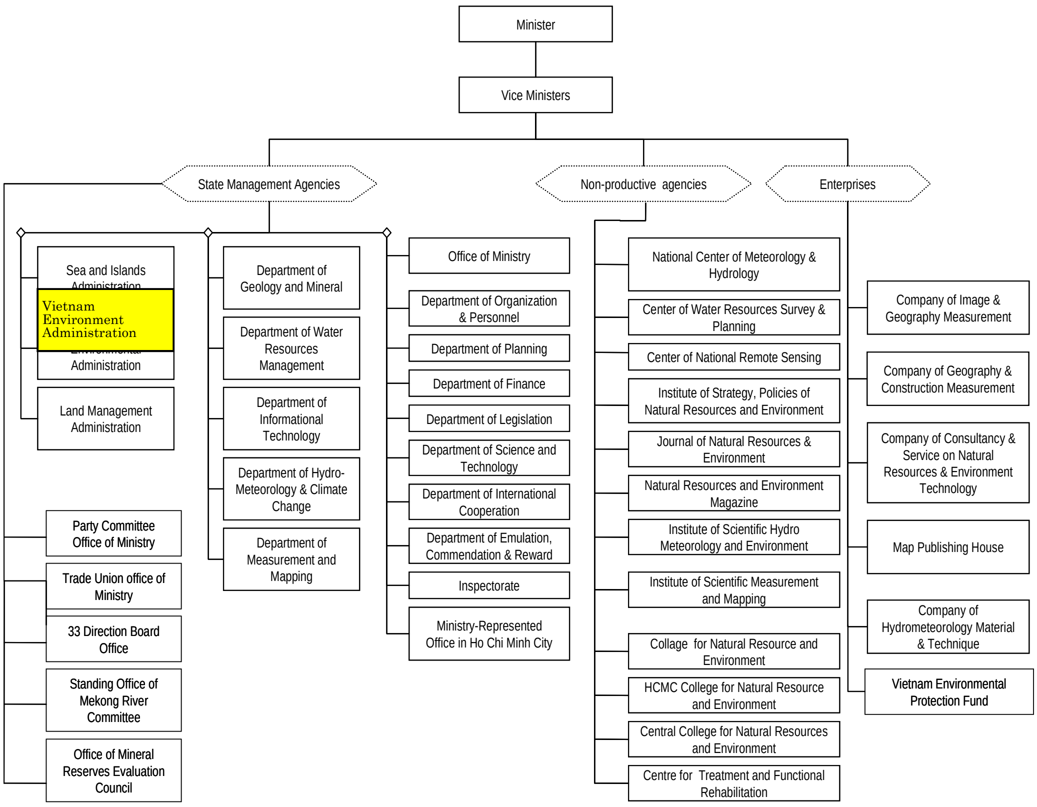
/ To plan and allocate budgets for research and development,

/ To appraise and approve Environmental Impact Assessment (EIA) reports for waste management projects,

/ To inspect and supervise waste management activities, and

/ To raise public awareness and approve recycling and treatment technologies.

Organization chart of MONRE is as shown in the figure below.



Source: JICA study team

Figure2-3 Organization Chart of MONRE and SWM Related Department

2) Ministry of Construction (MOC)

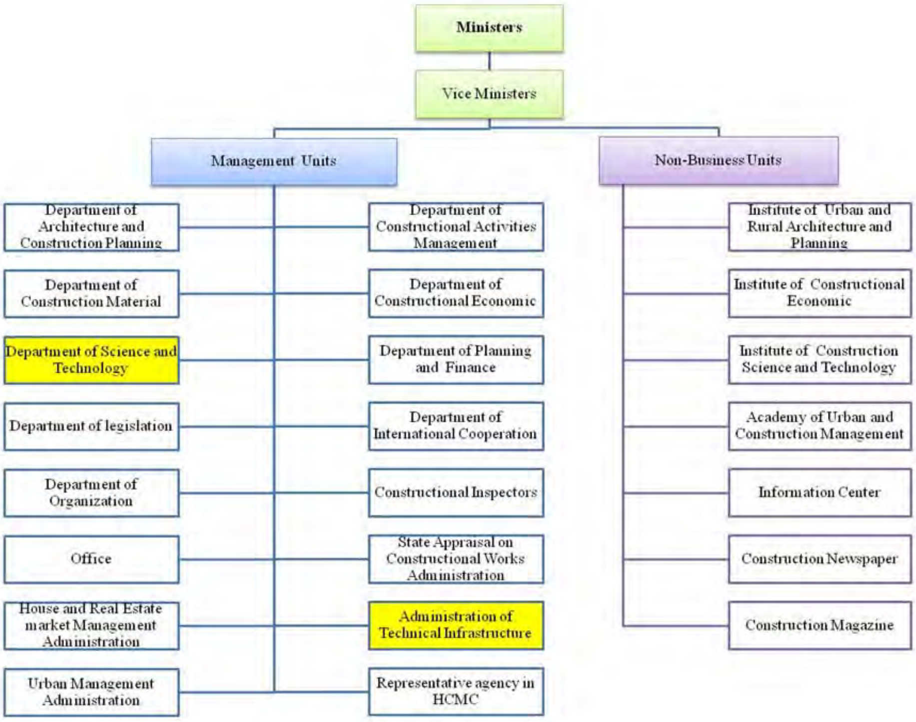
Ministry of Construction (MOC) is a line ministry with the highest authority in municipal solid waste and wastewater primarily in terms of technical oversight of these sectors. Its responsibilities and jurisdiction in solid waste management are as follows:

/ To formulate policy and legislation

/ To make a plan and construct solid waste treatment facilities, and

/ To developing and managing plans for the construction of waste treatment infrastructure nationally and provincially.

Organization chart of MOC is as shown in the figure below.



Source: JICA study team

Figure2-4 Organization Chart of MOC and SWM Related Department

3) Local agencies

Provincial People's Committee (PPC) is an executive unit of local administration, while the Provincial People's Council is a representative of provincial government. Provincial People's Committee has several departments mirroring to the national level ministries. Provincial People's Committee is responsible to oversee local level administration, and their responsibilities in waste management are as follows:

/ To implement plans on annual and long-term environmental protection, direct their agencies in organizing, coordinating with the respective central agencies,

/ To make approval of relevant projects based on the conditions of each locality,

/ To mobilize investment fund from various sources for the projects and work out mechanisms to encourage private participation in the sectors,

/ To direct the Department of Natural Resources and Environment (DONRE) and the Department of Construction (DOC) in carrying out the projects in terms of design, construction, monitoring, EIA, etc.

The Department of Construction (DOC) supervises the implementation of urban development plans of the city/province, organizing the designing and construction of the solid waste treatment facilities, supporting

Provincial People's Committee in making decisions on the projects, and reporting to Provincial People's Committee for approval in coordination with the Department of Natural Resources and Environment.

The Department of Natural Resources and Environment (DONRE) plays important role in the waste management: monitoring of environmental quality; managing and implementing policies and regulations issued by MONRE and Provincial People's Committee; appraising Environmental Impact Assessment (EIA) for the projects; and selecting landfill sites in coordination with The Department of Construction, all of which are then proposed to get approval by Provincial People's Committee.

(2) LAWS/REGULATIONS AND POLICY/PLAN RELATED TO WASTE MANAGEMENT

1) List of laws and regulations

A series of legal instrument stipulating solid waste management has been issued by the Vietnamese government as listed in the table below.

Table2-7 List of Laws and Regulations

Code	Name of Laws and regulations	Date of Issue
Solid waste management		
Order 29/2005/L-CTN	Law on Environmental Protection (No.52/2005/GH11)	2005/12/12
Decree 80/2006/ND-CP	Detailing and Guiding the Implementation of a Number of Articles of the Environmental Protection Law	2006/8/9
Decree 179/2013/NĐ-CP	Sanction of Administrative Violation in the Domain of Environmental Protection	2013/11/14
Decree 59/2007/ND-CP	Solid Waste Management	2007/4/9
Hazardous waste management		
Decision 60/2002/QD-BHKCNMT	Technical Guideline on Burying of Hazardous Waste	2002/8/8
Decree 104/2009/NĐ-CP	Provision of the Commodities Prescribed as Being Dangerous/Toxic and Their Transportation via Road	2009/11/9
Circular 12/2011/TT-BTNMT	Stipulating Hazardous Waste Management	2011/4/14
Medical waste management		
Decision 62/2001/QD-BKHCNMT	Technical Requirement for Incineration of Medical Waste	2001/11/21
Decision 43/2007/QD-BYT	Regulation on Management of Health Care Waste	2007/11/30
QCVN02-2012/BNTMT	National Technical Regulation on the Emission of Health Care Solid Waste Incinerators	2012
Construction and operation of waste treatment facility/Landfill		
Circular 01/2001/TTLT-BKHCNMT-BXD	Guiding the Regulations on Environmental Protection for the Selection of Location for, the Construction and Operation of Solid Waste Burial Sites	2001/1/18
Circular 05/2008/TT-BTNMT	Guiding the Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitment	2008/12/8
QCVN07:2010/BXD	Vietnam Building Code: Urban Engineering Infrastructures	2010/2/5

Code		Name of Laws and regulations	Date of Issue
	QCVN25: 2009/BTNMT	National Technical Regulation on Wastewater of the Solid Waste Landfill Site	2009/11/16
	QCVN40:2011/BTNMT	National Technical Regulation on Industrial Wastewater	2011/12/28
	QCVN19:2009/BTNMT	National Technical Regulation on Industrial Emission of Inorganic Substances and Dusts	2009/11/16
	QCVN20:2009/BTNMT	National Technical Regulation on Industrial Emission of Organic substances	2009/11/16
	TCVN7558:2005	Solid Waste Incinerator: Determination of Total Concentration of Organic Compounds in Flue Gas. Part 1, Part 2	
	QCVN30:2012/BTNMT:	National Technical Regulation on Industrial Waste Incinerators	2012/12/28
Fee for waste treatment and environmental protection			
	Ordinance 38/2001/PL-UBTVQH	Standing Committee of the National Assembly on Prescribing Fees and Charges	2001/8/28
	Decree 57/2002/ND-CP	Details on the Implementation of the Ordinance No. 38/2001/PL-UBTVQH of Fees and Charges	2002/6/3
	Circular 63/2002/TT-BTC	Guiding the Implementation of Provision on Fees and Charges	2002/7/24
	Circular 71/2003/TT-BTC	Guiding the Implementation of the Provision on the Fees and Charges for Solid Waste Collection and Treatment	2003/7/30

Source: JICA study team

In the laws/regulations on waste management in Vietnam, “Law on Environmental Protection”, which is enforced in January 1994, is the basic law. It was amended in November 2005 and enforced in July 2006. Thereby the stipulation for waste management was enhanced. Lots of important rules and regulations related to waste management are promulgated after 1990s.

“Law on Environmental Protection” is the comprehensive laws for environmental protections, it consists of 15 Chapters, and one of the chapters, Chapter VIII, is for waste management. The Chapter VIII is consisted with the Articles 66 up to Articles 85, and basic duty and obligation of waste management, waste collection/transportation, recycling, treatment/disposal are prescribed in this Chapter. In addition, definition of waste is shown in the Chapter I, basic policy and countermeasure for management of ordinary waste generated from medical institution, hazardous waste/wastewater and radioactive waste are described in the Articles 39 of the Chapter V.

In April 9, 2007, “Decree 59/2007/ND-CP Solid Waste Management” was promulgated in addition to Decree for management of hazardous waste and medical waste. Thereby the regulation for waste management was enhanced by an interaction with “Law on Environmental Protection”. The comprehensive guidance and explanation related to solid waste management are described in this Decree. The target waste in this Decree is only solid waste, but regulations on generation, storage, collection/transportation, treatment/disposal, reuse and recycle for municipal waste, industrial waste and medical waste are covered, and solid waste management plan, investment and responsibility of relative agency are described.

Regarding development for waste treatment facility and landfill, criteria for candidate site is preserved and it is required to comply with emission standard and wastewater standard.

2) National Strategy on Integrated Solid Waste Management up to 2025 and Vision 2050

The national strategy on solid waste management in Vietnam is compiled as "PM Decision No.2149/QD-TTG for National Strategy on Integrated Solid Waste Management up to 2025 and Vision 2050" (hereinafter referred to as "the Strategy on ISWM") with the joint work of MOC and MONRE in 2009. The Strategy on ISWM sets the target for the handling of solid waste management; such as municipal waste, industrial waste, medical waste, in the target year of 2015, 2020 and 2025.

In the Strategy on ISWM, MOC and MONRE are sets as ministries in charge for policy making on SWM and/or 3R (Reduce, Reuse, Recycle), and people's committees at the local governments is in charge for implementation of SWM. On the other hand, roles of MPI, MOF, MOIT, MOH, MARD and MIC are prescribed as supporting ministries. In addition, in order to achieve the target of the Strategy on ISWM, action program composed of 10 items is attached in the Strategy as shown in the table below.

Table2-8 Action Program and Role of Related Ministries/Authorities for ISWM

No	Program name	Targets	Completion time	Leading agency	Collaborate agencies
1	Promotion of solid waste prevention, reduce, recycling and reuse	- Formulate and implement the measures on solid waste prevention, reduce, reuse and recycling - Develop the recycling industry	2020	MONRE	MOC, MOIT, MOH, related ministries and industries and people's committee (PC)
2	Enhancement of at-source solid waste sorting	- Formulate the regulations and orientation of at-source solid waste sorting - Scale up model of at-source solid waste sorting	2015	MONRE	MOC, MOIT, MOH, MOF, PC
3	Investment on building the solid waste treatment works at regional level	Build the solid waste treatment areas at regional level	2020	MOC	MOIT, MOH, MPI, MOF, MONRE, MOST, PC
4	Solid waste treatment in the period of 2009-2020	Build factories applying landfilling restriction technology of the household solid waste treatment in all 64 provinces	2020	MOC	MPI, MOF, MONRE, MOST, PC
5	Environmental recovery of landfilling and treatment facilities	- Treat the landfills causing the environmental pollution as stipulated by Decision No.64/2003/Q§-TTg. - Recover and enhance the landfills nationwide to meet the environmental standards	2020	MONRE	MOC, MOF, MPI, PC
6	Strengthening solid waste management in rural areas and craft villages	Strengthen the ISWM in rural areas and craft villages	2020	MARD	MONRE, MOC, PC

No	Program name	Targets	Completion time	Leading agency	Collaborate agencies
7	Establish the system of solid waste database and monitoring	Formulate coherently system of database and solid waste monitoring in the whole country to enhance the effectiveness of solid waste management form central level to local level	2020	MONRE	MOC, MOIT, MOH, PC
8	Community awareness raising	Raising awareness on sorting, reducing, recycling, reusing, etc. for people of all walks of life through the propaganda and education	2015	MIC	MOET, MOIT, MOH, MOC, MONRE
9	Formulation of policies, laws, institutions on ISWM	Finalize the standard system, regulations, technical guidelines, mechanisms, policies, and institutions on ISWM	2015	MOC	MONRE, MOIT, MOH, MOF, MPI, MOST
10	Solid waste disposal from health sector in the period of 2009 to 2025	- Ensuring to 2025, 100% of solid waste emissions from health establishments to be collected and treated to environment standards.	2025	MOH	MONRE, MOC, MOF

Source: National Strategy on Integrated Solid Waste Management up to 2025 and Vision to 2050

3) Plan of Waste Treatment Facilities in Three Focal Economic Zones the North, the Centre and the South until 2020

National plan for the investment of inter-provincial waste treatment facilities in three focal economic zones of the North, the Centre and the South Vietnam until 2020 is stipulated as "Decision No. 1440/2008/QD-TTg dated on October 06, 2008 by the Prime Minister, Plan of Waste Treatment Facilities in Three Focal Economic Zones the North, the Centre and the South until 2020".

Outline of the plan is shown in the table below.

In the plan, two solid waste treatment zones in the Sounthern economic centre, Tan Thanh SW treatment zone and Cu Chi SW treatment zone, are indicated, otherwise, concreate construction plan in alignment with the plan is not draw up. In addition, it is announced that existing landfill site in Cu Chi district is going to stop operating.

Table2-9 Plan Propose 7 Inter-province SW Treatment Zones

No	Interprovince SW treatment zone	Location	Area	Service Scope
I	Northern economic centre			
1	Nam Son SW treatment zone	Nam Son commune, Dong Anh district, Ha noi	140-160 ha	- For industrial SW: Ha Noi, Vĩnh Phuc, Ha Tay, Bac Ninh, Hung Yen - For domestic waste: Hà Noi
2	Son Duong SW treatment zone	Son Duong commune, Hoanh Bo district, Quang Ninh	100 ha	- For industrial SW: Quang Ninh, Hai Phong, Hai Dương - For domestic waste: Quang Ninh
II	Middle economic centre			
1	Huong Van SW treatment zone	Huong Van commune, Huong Tra district, Thua Thien Hue	40 ha	- For industrial SW: Thua Thien Hue and Đa Nang - For domestic waste: Huế city

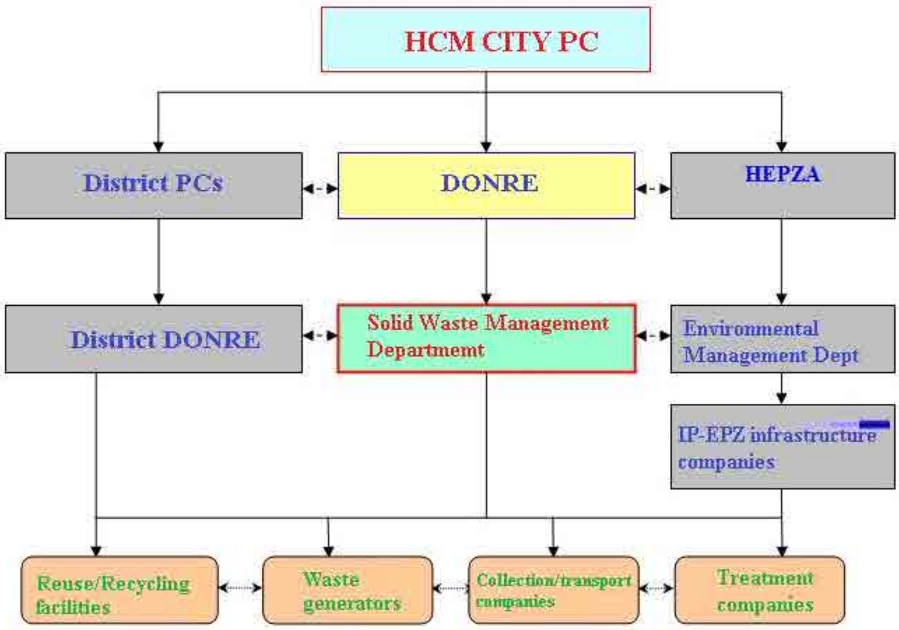
No	Interprovince SW treatment zone	Location	Area	Service Scope
2	Binh Nguyen SW treatment zone	Binh Nguyen commune, Binh Son district, Quang Ngai	70 ha	- For industrial SW: Quang Nam, Quang Ngai - For domestic waste: Quang Ngai
3	Cat Nhon SW treatment zone	Cat Nhon commune, Phu Cat district, Binh Dinh	70 ha	- For industrial SW: Binh Đinh and some western and southern provinces - For domestic waste: Binh Đinh
III	Sounthern economic centre			
1	Tan Thanh SW treatment zone	Tan Thanh commune, Thu Thua district, Long An	1.760ha	- For domestic and industrial SW: Long An and Ho Chi Minh city
2	Cu Chi SW treatment zone	Cu Chi district, Ho Chi Minh	822 ha	- For industrial and hazardous SW: Ho Chi Minh, Binh Duong, Tay Ninh

Source: Decision No. 1440/2008/QD-TTg dated on Octeber 06, 2008 of Prime Minister on approval for plan of waste treatment facilities in three focal economic zones the North, the Centre and the South until 2020

2.3.2 CURRENT SITUATION OF WASTE TREATMENT IN HO CHI MINH CITY

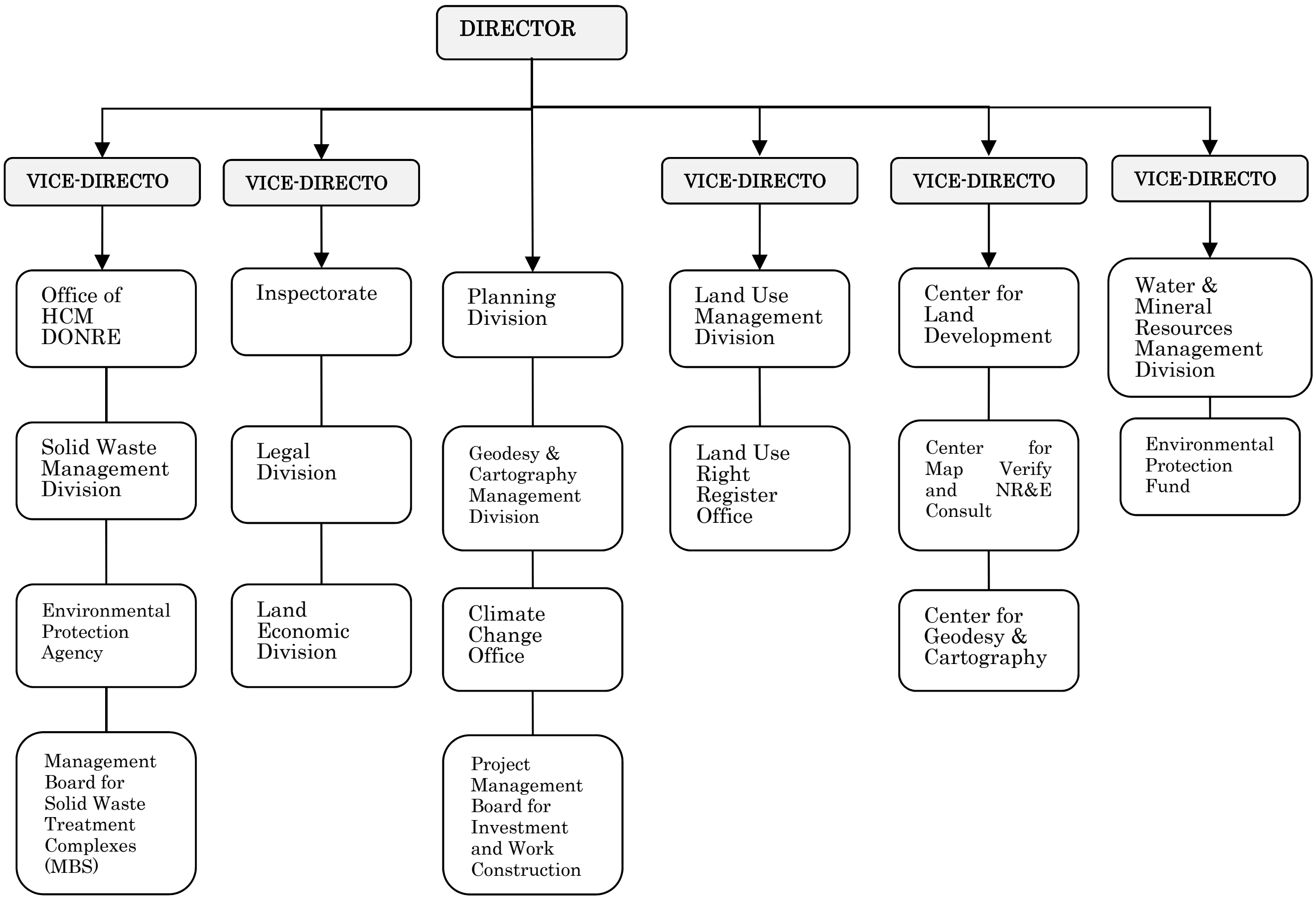
(1) ADMINISTRATIVE AND LEGISLATIVE FRAME

In Ho Chi Minh city, DONRE is assigned to be a managing department for all matters related to solid waste management. In which, the body advising directly the Director of DONRE and performing the state management function of solid waste is Solid Waste Management Division in coordination with (1) Other divisions/boards under DONRE such as Environment Management Division, Management Board for Solid Waste Treatment Complexes (MBS), Environmental Protection Agency (EPA) and (2) other related agencies such as Ho Chi Minh City Export Processing and Industrial Zones Authority (HEPZA), DONREs at district level.



Source: Planning orientation of solid waste management in Ho Chi Minh up to 2020, vision to 2030 (2011.10) (Ho Chi Minh City DONRE)

Figure2-5 Organizational Structure of State Management System in Solid Waste Management at HCMC



Source: http://www.donre.hochiminhcity.gov.vn

Figure2-6 Organizational Structure of HCMC DONRE

(2) MASTER PLAN ON SOLID WASTE MANAGEMENT

1) Amount of municipal solid waste

Amount of municipal solid waste is calculated by unit generation, 1kg/person/day, which is indicated by MOC. According to the result of this estimation, 7,500~8,000 tons/day of municipal solid waste is generated in Ho Chi Minh City in 2010 and a part of that is recycled. It is estimated that 6,500~6,700tons/day are collected.

The changes in amount of municipal solid waste which is calculated in master plan is shown below.

Amount of municipal solid waste in Ho Chi Minh City is increasing year by year according to the population growth and urbanization and amount of municipal solid waste collection in 2010 become 1.6 times as large as that of 2000.

Table2-10 Changes in Amount of Municipal Solid Waste Collection (1992-2010)

Year	Amount of municipal solid waste		Yearly increasing rate
	(tons/year)	(tons/day)	(%)
1992	424,807	1,164	-
1993	562,227	1,540	32.0%
1994	719,889	1,972	28.0%
1995	978,084	2,680	35.8%
1996	1,058,468	2,900	8.2%
1997	983,811	2,695	-7.0%
1998	939,943	2,575	-4.4%
1999	1,066,272	2,921	13.4%
2000	1,483,963	4,066	39.2%
2001	1,369,358	3,752	-7.7%
2002	1,568,476	4,700	14.5%
2003	1,788,500	4,900	14.0%
2004	1,684,023	4,678	-5.8%
2005	1,746,485	4,785	3.7%
2006	1,895,889	5,194	8.5%
2007	1,971,421	5,401	3.9%
2008	2,021,593	5,538	2.5%
2009	2,121,819	5,813	4.9%
2010	2,372,500	6,500	7.4%

Source: Planning orientation of solid waste management in Ho Chi Minh up to 2020, vision to 2030 (2011.10) (Ho Chi Minh City DONRE)

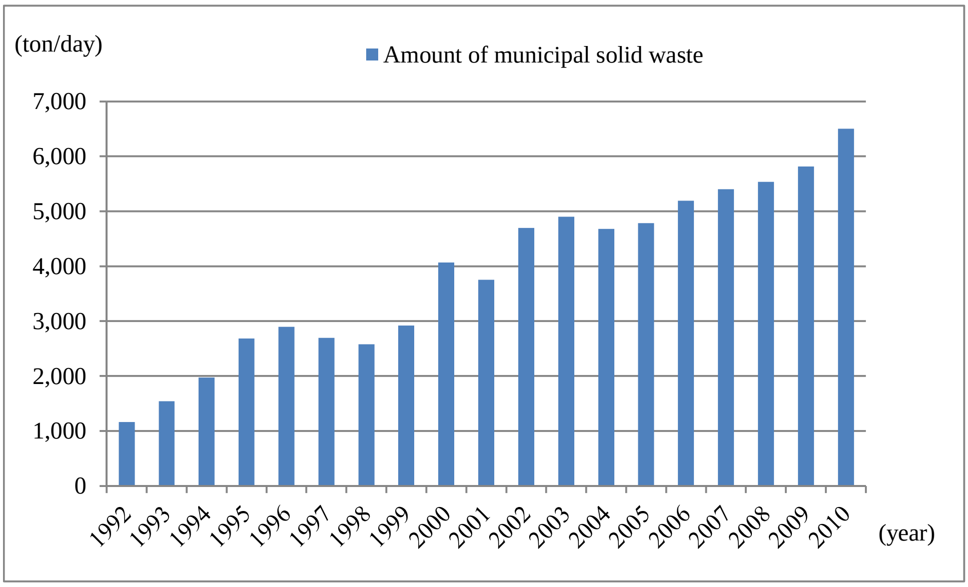


Figure2-7 Amount of Municipal Solid Waste (1992-2010)

2) Waste composition

The results of waste composition analyses, which are sampled at household, school and restaurant/hotel, are shown below. In all sample, the ratio of Food is the highest, accounts for high percent.

Regarding waste generated from household, the ratio of Food is the highest, accounts for 61.0% up to 96.6%. Nylon and Plastic are the next highest. In addition, paper and non-combustible waste such as Debris/soil are about 10% respectively. Regarding waste generated from school, the ratio of Food is the highest, accounts for 23.5% up to 75.8%. On the other hand, the ratios of Nylon, Plastic and Paper are not low, it means lots of combustible waste, which is recyclable, is included. Regarding waste generated from restaurant/hotel, ratio of Food is the highest, accounts for 79.5% up to 100.0%. The ratio of Food accounts for high percent, it means the other wastes are rarely mixed in.

Table 2.11 Composition of Solid Waste from Households, Schools, Restaurants and Hotels

No	Composition	Household	Schools	Restaurants and hotels
		% (ww)	% (ww)	% (ww)
1	Food	61.0 – 96.6	23.5 – 75.8	79.5 – 100
2	Nylon	KĐK – 13.0	8.5 – 34.4	KĐK – 5.3
3	Plastic	0.5 – 10.0	3.5 – 18.9	KĐK – 6.0
4	Fabrics	1.0 – 5.1	1.0 – 3.1	-
5	Soft rubber	KĐK – 0.3	-	-
6	Hard rubber	KĐK – 2.8	-	-
7	Wood	0.7 – 3.1	-	-
8	Styrofoam	KĐK – 1.3	1.0 – 2.0	KĐK – 2.1
9	Paper	0.7 – 14.2	1.5 – 27.5	KĐK – 2.8
10	Glass	1.65 – 4.0	KĐK – 2.5	KĐK – 1.0
11	Metal	0.9 – 3.3	KĐK	-
12	Leather	-	KĐK – 4.2	-
13	Debris, soil	KĐK – 10.5	-	-
14	Porcelain	KĐK – 3.6	-	-
15	Carton	KĐK – 0.6	-	KĐK – 0.5
16	Cans	0.98 – 2	-	-
17	Battery	-	-	-
18	Cotton	KĐK – 2.0	-	-
19	Bamboo, straw, leaves	1 – 2.0	-	-
20	Shells, animal bones	KĐK – 9.0	-	-

Source: Planning orientation of solid waste management in Ho Chi Minh up to 2020, vision to 2030 (2011.10) (Ho Chi Minh City DONRE)

Notes: KĐK – negligible as <0.5% by wet weight ; ww – wet weight ; "-" – not detected

In addition, results of waste composition analyses, which is sampled at 2 landfill sites (Phuoc Hiep landfill, Da Phuoc landfill), are shown below.

Both of the result, ratio of Food is the highest, is over 80%, Phuoc Hiep landfill is 83.0%~86.8%, Da Phuoc landfill is 83.1%~88.9%. The ratios of the others are very low and account for only few percent.

Table 2.12 Composition of Solid Waste from Landfills

No	Composition	Phuoc Hiep landfill (%)	Da Phuoc landfill (%)
1	Food	83.0 – 86.8	83.1 – 88.9
2	Shells	0.0 – 0.2	1.1 – 1.2
3	Bamboo, straw	0.3 – 1.3	1.3 – 1.8
4	Paper	3.6 – 4.0	2.0 – 4.0
5	Carton	0.5 – 1.5	0.5 – 0.8
6	Nylon	2.2 – 3.0	1.4 – 2.2
7	Plastic	0.0 – 0.1	0.1 – 0.2
8	Fabrics	0.2 – 1.8	0.9 – 1.8
9	Leather	0 – 0.02	-
10	Wood	0.2 – 0.4	0.2 – 0.4
11	Soft rubber	0.1 – 0.4	0.1 – 0.3
12	Hard rubber	-	-
13	Glass	0.4 – 0.5	0.4 – 0.5
14	Cans	-	0.2 – 0.3
15	Ferrous metals	0.1 – 0.2	0.1 – 0.2
16	Porcelain	0.1 – 0.3	0.1 – 0.2
17	Debris	1.2 – 4.5	1.0 – 4.5
18	Ash	0.0 – 1.2	-
19	Styrofoam	0.0 – 0.3	0.2 – 0.3
20	Bandages, diapers	0.9 – 1.1	0.5 – 0.9
21	Hazardous waste (oil clout, fluorescent lamps)	0.1 – 0.2	0.1 – 0.2
22	Moisture	52.5 – 53.7	52.6 – 53.7
23	VS (% dry weigh)	81.7 – 82.4	81.7 – 82.4

Source: Planning orientation of solid waste management in Ho Chi Minh up to 2020, vision to 2030 (2011.10) (Ho Chi Minh City DONRE)
Notes: “-“ not detected

3) Existing waste treatment facilities

Main facility for municipal solid waste is landfill and intermediate treatment technology is not adopted actively so far. At present, approximately 15% of municipal solid waste is treated in composting plant and the others is directly disposed in landfill site in Ho Chi Minh City.

List of existing treatment facilities municipal solid waste is shown in the table below.

Table2-13 List of Existing Treatment Facilities for Municipal Solid Waste

No	Name of landfill	Investor	Area (ha)	Operation time	Receiving capacity (tons/day)
1	Da Phuoc	Vietnam Waste solution Ltd., company (UsA)	128.0	Nov 2007	2,500 – 3,000
2	Landfill No.2	CITENCO	19.7	Feb 2008	1,500 – 2,500
3	Plant treating domestic waste to fertilizer (composting plant)	Vietstar Jsc (UsA)	35.0	Dec 2009	600 – 1,200

Source: Planning orientation of solid waste management in Ho Chi Minh up to 2020, vision to 2030 (2011.10) (Ho Chi Minh City DONRE)

There are 45 transfer stations in Ho Chi Minh City. The location of transfer stations are set with considering amount of generated waste and distance to solid waste treatment complexes. The transfer stations have been contributed to collect waste efficiently.

Transport distance to solid waste treatment complexes is shown below.

Table2-14 Transport Distance from the Districts to Solid Waste Treatment Complex

Unit: km

Name of company	Transfer station	Da Phuoc LF	Phuoc Hiep LF	Vietstar
Transportation Enterprise No. 1 (CITENCO)	17.35	40.30	45.81	40.38
Transportation Enterprise No. 2 (CITENCO)	6.19	29.70		37.74
District 1	17.32	23.29	50.35	37.95
District 2	35.00		70.27	
District 3	20.17	23.81		
District 4 – Cong Nong Co-operative	7.50	20.50		
District 5	10.49	21.37		60.20
District 6		25.38		53.92
District 7		27.44		
District 8	11.68	22.46		
District 9		70.89	68.55	69.04
District 10		21.71	53.43	54.18
District 11 – Tan Hoa TSC- Cong Nong Co-operative		24.50	43.55	44.15
District 11 – Public Service Company of District 11	3.41			
District 12			53.46	56.01
TanBinh District	4.47		42.55	43.40
Tan Phu District	9.65			44.01
Binh Tan District		28.85		
Binh Chanh District	12.80	25.98		
Phu Nhuan District	4.03	26.10	43.85	

Name of company	**Transfer station**	**Da Phuoc LF**	**Phuoc Hiep LF**	**Vietstar**
Go Vap District	9.96	51.34	48.33	49.49
Thu Duc District	30.00	62.16	57.88	60.31
Hoc Mon District			38.52	
Binh Thanh District	9.81		51.58	
Nha Be District	61.30	55.66		
Cu Chi District			24.02	

Source: Planning orientation of solid waste management in Ho Chi Minh up to 2020, vision to 2030 (2011.10) (Ho Chi Minh City DONRE)

4) Current situation of industrial waste

Industrial waste is mostly generated at Industrial park or Industrial cluster, it is assumed that huge amount of industrial waste is generated. Amount of Non-hazardous industrial waste generation is 1,500~2,000 tons/day, amount of Hazardous industrial waste generation is 250~350 tons/day, equivalent to approximately 15% of Non-hazardous industrial waste.

Table2-15 Amount of Industrial Solid Waste and Hazardous Waste Generation in HCMC

No	Type of waste	Amount (tons/day)
1	Non-hazardous industrial solid waste	1,500 – 2,000
2	Hazardous waste	250-350

Source: Planning orientation of solid waste management in Ho Chi Minh up to 2020, vision to 2030 (2011.10) (Ho Chi Minh City DONRE)

As of 2011.8, 13 companies have license for treatment/disposal, in which 3 companies, Minh Tan Trade and petroleum transportation Co., Ltd、Duong Dung Trade and Production Co., Ltd、Trung Nam Trade – Production – Services Private Enterprise, have license issued by DONRE of Ho Chi Minh City and 10 companies, Green Environment Production – Services – Trade Co., Ltd、Vietnam Australia Environment JSC、Toan Thang Loi Co., Ltd、CITENCO、Petrolimex Shipbuilding and Commercial Co., Ltd、Tung Nguyen Production – Trade Private Enterprise、Sai Gon Petrolimex Construction Services and Trade Enterprise、Quoc Viet Environmental Science and Technology Co., Ltd、Dai Phat Mechanical Production and Services Co., Ltd、Thanh Lap Environmental Trade and Treatment Co., Ltd , have license issued by MONRE.

4 companies have incinerator for hazardous waste with capacity of 1 up to 7tons/day. All of them are small scale of facilities, therefore total treatment capacity is less than 25 tons/day.

List of hazardous waste treatment companies, which runs business in Ho Chi Minh City, and Status of incinerator for hazardous waste are shown below.

Table2-16 List of Hazardous Waste Treatment Companies

No	Company	Address	Treatment types	Treatment technology	Treatment HZW amount (kg/year)
1	Green Environment Production – Services – Trade Co., Ltd	Binh Chanh	All types	- 02 incinerators, capacity 20m^3/incinerator/h - 01 wastewater treatment system, capacity: 6m^3/h - 01 Solidification system - 09 sludge drying tank with wastewater collection system - 01 oil drum/can treatment system - 01 solvent recovery system - 01 viscosity recovery system	6,500,000
2	Vietnam Australia Environment JSC	Binh Chanh	All types	- 03 incinerators - 01 Oil recycling system - 01 Lead recycling system - 02 Distillation system - 02 Rinse system - 01 solidification equipment - 01 Oil wastewater treatment system - 01 Chemicals wastewater treatment system - 01 wastewater treatment system by biological method	6,970,000
3	Minh Tan Trade and petroleum transportation Co., Ltd	District 7	Waste oil	Treating oil wastewater, oil residue	2,880,000
4	Toan Thang Loi Co., Ltd	District 9	Waste oil	- 04 distillation furnace - 01 Oil wastewater treatment system	120,000,000
5	CITENCO	Binh Tan	All types	02 incinerators (01 Industrial waste incinerator, 01 medical waste incinerator)	190,000
6	Petrolimex Shipbuilding and Commercial Co., Ltd	Nha Be	Oil wastewater	Raw separation system and essential oil - 01 internal combustion equipment	208,034
7	Duong Dung Trade and Production Co., Ltd	Binh Tan	Oil drums	Oil drum treatment/recycling	150,000
8	Tung Nguyen Production – Trade Private Enterprise	Binh Chanh	Oil drums	Oil drum treatment/recycling	170,000
9	Sai Gon Petrolimex Construction Services and Trade Enterprise	Nha Be	Waste oil	- 01 Oil residue separation - 01 Separating oil wastewater - 01 incinerator: 50kg/h	497,500
10	Quoc Viet Environmental Science and Technology Co., Ltd	Binh Chanh	Acid wastewater	01 Acid and heavy metal wastewater treatment system, recycling to iron complex solution for environmental treatment technology	72,000,000

No	Company	Address	Treatment types	Treatment technology	Treatment HZW amount (kg/year)
11	Dai Phat Mechanical Production and Services Co., Ltd	Binh Chanh	Oil drums	Oil drums treatment/recycling	290,000
12	Thanh Lap Environmental Trade and Treatment Co., Ltd	Cu Chi	Transport Treatment	- 01 incineration with capacity 01 tons/day - 01 solidification system - 01 Solvents distillation/recycling system; - 01 Recycling system , capacity 1,000 kg/h, including stirrer, crusher (500 kg/h) - 01 wastewater treatment station	5,930,000
13	Trung Nam Trade – Production – Services Private Enterprise	Binh Chanh	Transport Treatment	- Metal smelting system: 01 incinerator with capacity of 1.2 tons/h; 01 metal refining kiln with capacity of 1.2 tons/h. - Lead battery rinsing system - Wastewater treatment system, 10 m3/day	7,000,000
TOTAL					**219,908,414**

Source: Planning orientation of solid waste management in Ho Chi Minh up to 2020, vision to 2030 (2011.10) (Ho Chi Minh City DONRE)

Table2-17 Operational Status of Incinerator for Hazardous Waste

No	Companies	Descriptions
1	CITENCO	- Hazardous waste treatment system includes **2 incinerators** : + Medical waste incinerator, capacity of 7 tons/day + Industrial waste incinerator, capacity of 4 tons/day *Test operating 21 tons incinerator to enhance handling of hazardous waste*
2	Green Environment Production – Services – Trade Co., Ltd	- Hazardous waste treatment system: Industrial waste/hazardous waste incinerator (two-stage furnace); capacity of 04 tons/day, equipping emission gas and wastewater treatment system; number of **02 incinerators**
3	Vietnam Australia Environment JSC	- Hazardous waste treatment system: incinerator (two-stage furnace) capacity of 6 tons/day, equipping emission gas and wastewater treatment system; number of **02 incinerators**
4	Thanh Lap Environmental Trade and Treatment Co., Ltd	- Incinerator : two-stage furnace, capacity of 01 tons/ day, equipping emission gas and wastewater treatment system; number of **01 incinerators**

Source: Planning orientation of solid waste management in Ho Chi Minh up to 2020, vision to 2030 (2011.10) (Ho Chi Minh City DONRE)

The changes in amount of medical waste collection/treatment are shown below.

Amount of medical waste in Ho Chi Minh City is increasing year by year, amount of medical waste collection/treatment in 2010 become 2.5 times as large as that of 2000, amount of medical waste collection/treatment in 2010 is 11.54 tons/day.

Table2-18 Amount of Medical Waste Collection/Treatment (2000-2010)

Year	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Amount (tons/day)	4.6	5.6	5.8	6.19	6.88	7.64	8.97	10.50	11.38	12.86	**11.54**
Amount (tons/year)	1,681	2,032	2,117	2,260	2,512	2,791	3,274	3,832	4,154	4,693	**4,214**

Source: Planning orientation of solid waste management in Ho Chi Minh up to 2020, vision to 2030 (2011.10) (Ho Chi Minh City DONRE)

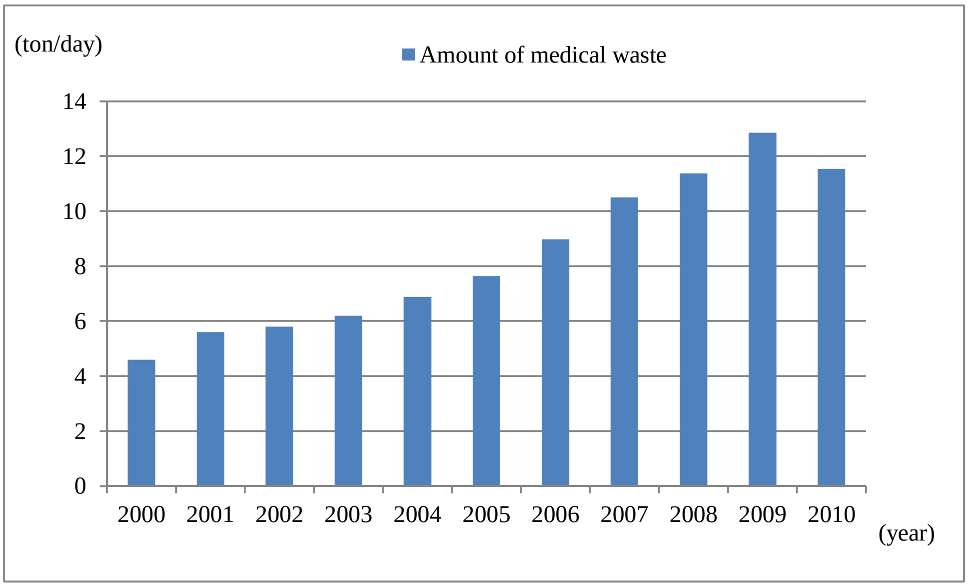


Figure2-8 Amount of Medical Waste (2000-2010)

2.3.3 CURRENT SITUATION OF WASTE TREATMENT IN LONG AN PROVINCE

(1) ADMINISTRATIVE AND LEGISLATIVE FRAME

In Long An province, DONRE is leading agency for solid waste management, DOC is in charge of planning for solid waste treatment facilities.

Roles and responsibilities of each department are shown below.

Table2-19 Roles and Responsibilities of Each Department

Agency	Roles & Responsibilities
DONRE(EPA)	Manage the statistic and inventory of solid waste data Propose solutions to address all activities related to solid waste
DOC	Mainly in charge of Planning for solid waste treatment facilities
DOH	Manage medical waste inside hospitals
DPI	Responsible for investment policy/decisions; receiving, checking and promoting investment projects

DOIT	Responsible for collecting data related solid waste in enterprises located in Industrial Clusters
IPs Economic Authority	Responsible for collecting data related solid waste in enterprises located in Industrial Parks

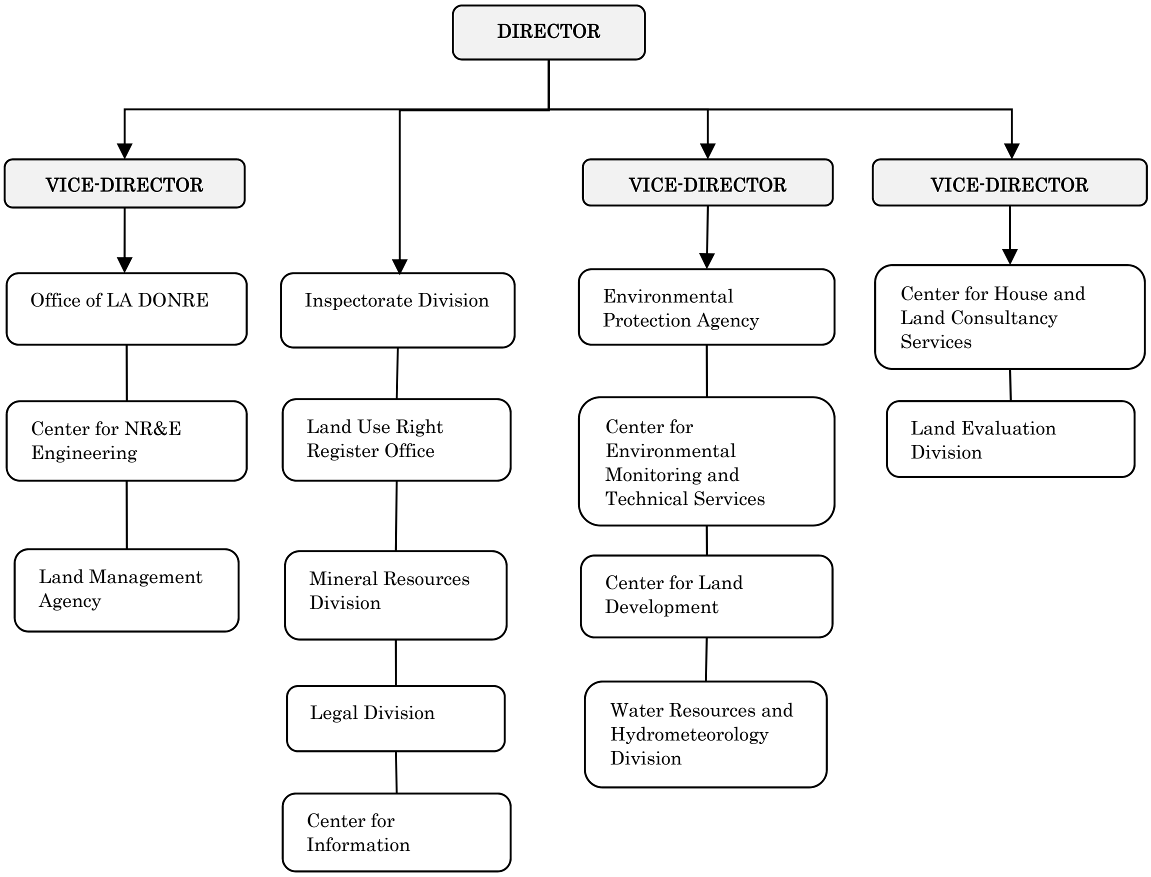


Figure2-9 Organizational Structure of Long An DONRE

(2) MASTER PLAN ON SOLID WASTE MANAGEMENT

1) Current situation of municipal solid waste

Most household waste is not sorted at source, which is collected by mixed and then transported to landfills. The amount of collected domestic solid waste is low and the collection activity is concentrated mainly in Tan An city, townships and markets of districts. The average of collection rate on whole province is only about 42.90%.

In the Master Plan, "Master Plan on Waste Treatment Site in Long An Province in the Period of 2010-2020 and Vision to 2025", which is issued in November of 2011, an amount of municipal solid waste generation in 2009 is estimated, which is shown in the following table. To calculate municipal solid waste generation, the average generation coefficient is set 0.53kg/person/day based on result of field survey. According to Master

Plan, the amount of municipal solid waste generation in Long An province is 769.42tons/day, the amount of collection waste is 330.1tons/day, in which account for 42.90%.

Table2-20 Amount of Waste Generation and Collection of MSW in Long An Province (2009)

No	City/District	Waste generation amount (tons/day)	Collection amount (tons/day)	Collection rate (%)
1	Tan An City	71.25	50	70.18
2	Tan Hung district	26.19	3	11.46
3	Vinh Hung district	26.62	2	7.51
4	Moc Hoa district	37.17	30	80.71
5	Tan Thanh district	40.42	4,5	11.13
6	Thanh Hoa district	28.66	4,6	16.05
7	Duc Hue district	31.32	5	15.96
8	Duc Hoa district	115.73	65	56.17
9	Ben Luc district	79.42	50	62.96
10	Thu Thua district	47.71	10	20.96
11	Chau Thanh district	52.09	5	9.60
12	Tan Tru district	32.27	5	15.49
13	Can Duoc district	90.17	12	13.31
14	Can Giuoc district	90.41	84	92.91
Domestic solid waste from residents		769.42	330.1	42.90

Source: Master Plan on Waste Treatment Site in Long An Province in the Period of 2010-2020 and Vision to 2025

The equipment for collection and transportation of municipal solid waste is not sufficient to carry out collection every day in Long An province. Municipal solid waste has been collected by 12 solid waste collection units and treated in 13 landfills. Solid waste collection units in cities, towns and districts and the list of existing landfills in Long An province are shown in the following table.

Table2-21 Current State of Solid Waste Collection Unit in the Localities of Long An Province

No	City/District	Collection unit
1	Tan An City	Tan An Uban Works JSC
2	Tan Hung district	Kien Tuong Water Supply-Sewerage and Environment Co., Ltd
3	Vinh Hung district	Vinh Hung Urban Works Co., Ltd
4	Moc Hoa district	Kien Tuong Water Supply-Sewerage and Environment Co., Ltd
5	Tan Thanh district	Tan Thanh township Co., Ltd
6	Thanh Hoa district	Kien Tuong Water Supply-Sewerage and Environment Co., Ltd
7	Duc Hue district	Water supply and environment station of district
8	Duc Hoa district	Duc Hoa district's public service company Phuong Nam Co., Ltd
9	Ben Luc district	Ben Luc Water Supply and Urban Service JSC
10	Thu Thua district	Thu Thua Urban Works JSC
11	Chau Thanh district	Chau Thanh Urban Works Co., Ltd
12	Tan Tru district	Phu Cuong company

No	City/District	Collection unit
13	Can Duoc district	Can Duoc Urban Works JSC
14	Can Giuoc district	Can Giuoc Urban Works JSC

Source: Master Plan on Waste Treatment Site in Long An Province in the Period of 2010-2020 and Vision to 2025

Table2-22 Existing Landfills in Long An Province

Unit: ha

No	City/District	Landfill	Area	Used area
1	Tan An City	Loi Binh Nhon landfill (Xuan Hoa 1 hamlet, Loi Binh Nhon commune)	1.5	1.5
2	Tan Hung district	Hung Thanh hamlet, Hung Thanh commune	2.0	2.0
3	Vinh Hung district	Trung Chanh hamlet, Thai Binh Trung commune	0.5	0.5
		Trung Vinh hamlet, Thai Binh Trung commune	0.3	0.3
		Bao Sen hamlet, Khanh Hung commune	1.0	1.0
		Ultilize tunnel exploiting soil as leveling material, Hung Dien A commune	0.5	0.2
4	Moc Hoa district	Go Tranh hamlet, Binh Tan commune	4.4	1.5
5	Tan Thanh district	Go Noi hamlet – Nhon Hoa commune	5.0	3.0
		Dumping area in Hau Thanh Dong commune	3.0	0.5
6	Thanh Hoa district	Waste tunnel in Thanh An commune	0.2	0.2
7	Duc Hue district	KP4, Dong Thanh township	0.3	0.3
8	Ben Luc district	Hamlet No. 9, Luong Hoa commune	1.7	0.8
9	Thu Thua district	Hamlet No.2, Tan Thanh commune	1.5	0.5
10	Chau Thanh district	Collecting and transporting to landfills of Tien Giang province	-	-
11	Tan Tru district	Tan Binh hamlet, Tan Tru township	0.3	0.3
12	Can Duoc district	Area 1C, Can Duoc township	0.56	0.56
13	Can Giuoc district	Transporting to Da Phuoc landfill, Binh Chanh district, Ho Chi Minh city	-	-
	Total		**22.76**	**13.16**

Source: Master Plan on Waste Treatment Site in Long An Province in the Period of 2010-2020 and Vision to 2025

2) Current situation of industrial waste

Proper treatment facilities for industrial waste are not located in Long An province, also, currently centralized solid waste treatment complex has not been planned. But in the master plan, it is reported as followings.

Collection and treatment of non-hazardous industrial waste in Long An province is conducted quite well by the enterprises, the collection rate achieves quite high. The amount of non-hazardous industrial waste generation is 40,356 tons/year. Collection rate of non-hazardous industrial waste is 80-90% corresponding to a volume of 32,284.8 to 36,320.4 tons/year. The handling methods are mostly burning or burying in factories' land.

On the other hand, hazardous industrial waste generated from enterprises such as leather shoes, batteries, iron and steel industries, printing ink, plastic, etc is complicated. Following implementation of Decree No. 59/2007/ND- CP of the Government on solid waste management, there have been 319 enterprises registering hazardous waste generators in Long An province. The amount of hazardous industrial waste generation is about 8,071 tons/year. Collection rate of hazardous industrial waste is about 50% corresponding 4,035.5 tons/year. However, currently, there has not been units serving hazardous waste treatment yet, therefore, the enterprises contract with hazardous waste treatment units of other provinces such as Green environment company, Ngoc Tan Kien company, Tuong lai xanh company, Holcim, etc.
Amount of industrial waste in 2005 and 2009 is showed in following tables.

Table2-23 Amount of Industrial Waste

Unit: tons/year

No	Type of industrial waste	Year	
		2005	2009
1	Non-hazardous industrial waste	24,751	40,356
2	Hazardous industrial waste	4,950	8,071

Source: Master Plan on Waste Treatment Site in Long An Province in the Period of 2010-2020 and Vision to 2025

3) Prediction of solid waste generation

Based on generation rate of municipal solid waste and growth rate of natural population etc, the amount of municipal solid waste is forecasted.
Result of the amount of municipal solid waste in 2010, 2015, 2020 and 2025 is shown in the table below.

Table2-24 Forecast of Municipal Solid Waste in Long An Province

Year	Population (people)	Generation coefficient	Amount	
		(kg/person/day)	(tons/day)	(tons/year)
2010	1,453,095	0.53	767	279,774
2015	1,519,220	0.61	927	338,254
2020	1,572,310	0.72	1,132	413,203
2025	1,610,786	0.85	1,369	499,746

Source: Master Plan on Waste Treatment Site in Long An Province in the Period of 2010-2020 and Vision to 2025

According to “Report on current state of environment in Long An province in period 2006-2010”, generation coefficient of industrial solid waste from industrial park is shown with 104.7 kg/ha/day by actual survey of industrial solid waste composition in Bien Hoa I industrial park, and the amount of hazardous solid waste is 20% of the amount of industrial solid waste. According to ”Report on land management and planning, industrial land use planning in Long An province (2010.7)” by DONRE, the land area planned for industrial parks and industrial clusters of whole province by 2020 is 23,090 ha.

The amount of industrial solid waste amount is forecasted as follows by considering conditions which are mentioned above.

Table2-25 Forecast of Industrial Solid Waste in Long An Province

Year	Planned area (ha)	Fulfill rate (%) *	Fulfill area (ha)	Industrial solid waste amount		
				Non-hazardous (tons/day)	Hazardous (tons/day)	Total
2010	23,090	40	9,236	967	193	1,160
2015	23,090	60	13,854	1,451	290	1,741
2020	23,090	80	18,472	1,934	387	2,321
2025	23,090	100	23,090	2,418	484	2,901

Source: Master Plan on Waste Treatment Site in Long An Province in the Period of 2010-2020 and Vision to 2025
Notes: (*)-To have a basis for calculation, we assumed that the fulfill rate increases over time. By 2025, 100% of IPs and ICs will be fulfilled.

(3) RESULTS OF HEARING SURVEY

According to statistic data and information which is provided by DONRE of Long An province, amount of solid waste generation is shown in the table below.

Table2-26 Amount of Solid Waste Generation in Long An Province (5 last years)

Unit: tons/day

Types	2008	2009	2010	2011	2012
MSW	120.5	144.0	183.00	237.00	270
HZW	6.0	22.1	30.27	60.79	240
IW	12.0	110.5	140.78	263.28	506
Total	**138.5**	**276.6**	**354.05**	**561.07**	**1,016**

Notes:

/ MSW amount in the table is the amount of domestic solid waste in urban areas collected by Public/Urban work companies

/ HZW&IW amount is based on list of registered waste generators

To carry out collection/transportation and treatment/disposal of hazardous waste as business, company is required to have license issued by MONRE or DONRE of Long An province. At present, DONRE of Long An province does not issue license for collection/transportation and treatment/disposal. 21 companies have license for collection/transportation issued by MONRE and 19 companies have license for treatment/disposal issued by MONRE, these companies are deal with hazardous waste generated from Long An province.
List of licensed companies, which runs business in Long An province, is shown in the table below.

Table2-27 List of Licensed Companies (Long An Province)

No	Name of Company	License (by MONRE)		License (by Long An DONRE)	
		HZW Collection/ Transportation	HZW Treatment	HZW Collection/ Transportation	HZW Treatment
1	Vietnam Holcim cement Co., Ltd	○	○	-	-
2	Viet Nam Green Environment JSC	○	○	-	-
3	Ngoc Tan Kien Trade & production Co., Ltd	○	○	-	-
4	Dai Lam Son Co., Ltd (DALASO)	○	○	-	-
5	Tan Phat Tai Co., Ltd	○	○	-	-
6	Vietnam Australia Environment JSC (VINAUSEN)	○	○	-	-
7	Lam Phat Trade , Import and Export, Transportation Private Enterprise	○	○	-	-
8	Tuoi Sang Environment Co., Ltd (Sao Mai Xanh)	○	○	-	-
9	Binh Phuoc Xanh Environmetal Technology Co., Ltd	○	○	-	-
10	Thang Long metallurgy Co., Ltd	○		-	-
11	A Chau Environment production and Trade Services Co., Ltd	○	○	-	-
12	Green Environment production and Trade Services Co., Ltd	○	○	-	-
13	Ho Chi Minh CITENCO	○	○	-	-
14	Phu Ha Environment Co., Ltd	○	○	-	-
15	Ha Loc Co.,Ltd	○	○	-	-
16	Thanh Lap Environmental Trade & Treatment Co., Ltd	○	○	-	-
17	Cat Thinh Xanh JSC	○	○	-	-
18	Bac Nam Engineering Environment Co., Ltd	○	○	-	-
19	Huynh Kim Nhat Environment Trade – Services One member Co., Ltd	○	○	-	-
20	Tan Hong Ngoc Environment One member Co., Ltd	○	○	-	-
21	Thanh Nhan Environmental Treatment Co., Ltd	○		-	-
Total		21	19	0	0

Source: JICA study team

2.4 LEGISLATIVE FRAME ON ENVIRONMENTAL AND SOCIAL IMPACTS AND HAZARDOUSE WASTE MANAMEGMENT

(1) OUTLINE OF LEGISLATIVE FRAME RELATED TO ENVIRONMENTAL AND SOCIAL IMPACTS FOR PROJECT IMPLEMENTATION

1) Law on Environmental Protection

It is widely recognized that the environmental problems caused by urbanization and industrialization are one of challenges to be solved to promote economic development in Vietnam. The constitution, hence, insists the necessity of environmental protection in Chapter 29 and the Law on Environmental protection was enacted in December 27, 1993 (effective in January 10, 1994) as a basic law for environmental protection. This law was amended in most part on November, 2005 (Order 29/2005/L-CTN, Law on Environmental Protection (No.52/2005/GH11)) and the stipulation of waste management was strengthened and elaborated in independent Chapter VIII. In addition, the Strategic Environmental Assessment was firstly prescribed and the Environmental Impact Assessment and the Environmental Protection Commitment were more clearly prescribed.

The wastes regulated in Chapter VIII Waste Management of the Law on Environmental Protection cover not only solid waste but also liquid and gaseous wastes, and further included a prescription of noise, vibration, lights and radiation. Basic duty and obligation of waste management including waste reduction, reuse and recycling are prescribed in such manner that organization and individuals who generate waste are responsible for their waste and local People's Committee is responsible for planning and allocation of municipal waste treatment facility, collective wastewater treatment facility and landfill site. As for hazardous waste management, the Law prescribes hazardous waste management business, hazardous waste segregation, collection, temporal storage, treatment/disposal facility and treatment plan.

Chapter VIII is consisted with the following sections and articles:

Section 1	General provisions on waste management
Article 66	Obligation of waste management
Article 67	Waste collection and treatment
Article 68	Recycling
Article 69	Obligation of the People's Committee
Section 2	Hazardous waste management
Article 70	Record, registration, permission and coding system for hazardous waste management
Article 71	Segregation, collection and temporal storage
Article 72	Transportation of hazardous waste
Article 73	Treatment of hazardous waste
Article 74	Hazardous waste treatment facility
Article 75	Landfill site for hazardous waste

Article 76 Collection, transportation and treatment plan

Section 3 Ordinary solid waste management

Article 77 Classification of ordinary solid waste

Article 78 Collection and transportation

Article 79 Recycling facility, treatment facility and landfill site

Article 80 Plan for collection, recycling, treatment facility and landfill site

Section 4 Wastewater management

Article 81 Collection and treatment of wastewater

Article 82 Wastewater treatment system

Section 5 Management and control of dust, gas, noise, vibration, light and radiation

Article 83 Management and control of dust and gaseous substance

Article 84 Control of greenhouse gases and ozone layer destruction gases

Article 85 Control of noise, vibration, light and radiation

2) National Technical Regulations

Besides Laws, Decrees, and Circulations concerning about waste managements, various technical regulations are set up. Especially National Technical Regulations related with this project are summarized in below.

Table2-28 National Technical Regulations related with the Projects

Area	Regulation	Remarks
Air	QCVN05:2013/BTNMT “National technical regulation on ambient air quality”	Ambient air quality
	QCVN06:2009/BTNMT "National Technical Regulation on Hazardous Substances in Ambient Air"	Ambient air quality （Permissible levels of hazardous substances）
Water	QCVN08:2008/BTNMT “National technical regulation on surface water quality”	Surface water quality
	QCVN09:2008/BTNMT “National technical regulation on groundwater quality”	Underground waste quality
	QCVN25:2009/BTNMT “National technical regulation on wastewater of the solid waste landfill site”	Effluent quality from waste landfill site
	QCVN40:2011/BTNMT "National Technical Regulation on Industrial Wastewater"	Effluent quality of industrial wastewater
Noise	QCVN26:2010/BTNMT “National technical regulation on noise”	Environmental regulation for noise level
Vibration	QCVN27:2008/BTNMT “National technical regulation on vibration”	Environmental regulation for vibration level
Waste	QCVN07:2010/BXD "Vietnam Building Code: Urban	Siting regulation for waste

Area	Regulation	Remarks
	Engineering Infrastructures"	treatment facility
Hazardous waste	QCVN30:2012/BTNMT "National Technical Regulation on Emission of Industrial Waste Incinerators"	Flue gas regulation and technical criteria for industrial waste incinerator
	QCVN07:2009/BTNMT "National Technical Regulation on Hazardous Waste Thresholds"	Threshold levels of hazardous waste
Medical waste	QCVN02:2012/BTNMT"National Technical Regulation on the Emission of Health Care Solid Waste Incinerators"	Flue gas regulation for medical waste incinerator

Source: JICA study team

3) National Technical Regulation on Emission of Industrial Waste Incinerators and Technical Criteria

Technical criteria and maximum allowable levels of emissions are prescribed in National Technical Regulation on Emission of Industrial Waste Incinerators which is the first regulation for industrial waste incinerator in Vietnam. Therefore, industrial waste incinerator is required to have a design, sets of equipment and performance to meet this regulation. This regulation is applied for both hazardous and nonhazardous industrial waste incinerator, equipping with a flue gas treatment units and waste water treatment system. Outline of this technical regulation is as follows:

i. Technical requirements

- Incinerator must have a primary furnace and a secondary furnace. The capacity of each furnace is calculated based on the methods described in appendix of this regulation.
- The inner pressure of the furnace must be negative (less than atmospheric pressure)
- The height of stack is more than 20m to disperse flue gas effectively
- Gas sampling port (diameter: 10cm) must be equipped between the point of 3 m below the stack exit and the point of 7 times length of stack diameter from a connection point of stack and flue gas duct.
- Major specification of the incinerator:
  - Incineration capacity: 100kag/hr and more,
  - Incineration temperature: 650℃ and more for a primary furnace; 1,000℃ and more for a secondary furnace for nonhazardous waste, 1,050℃ and more for hazardous waste, 1,200℃ and more for hazardous waste containing halogenated organic waste with levels above threshold levels,
  - Flue gas residential time in a secondary furnace: 2 seconds and more,
  - Residual oxygen level: 6～15%。
  - Flue gas temperature（at gas sampling port）：180℃ and less,
  - Temperature of outer wall of the furnace: 60℃ and less,
  - Average heat consumption for burning of 1kg waste: 1,000kcaland less,
  - Continuous operation ability: 72hours and more.

- Flue gas regulation（maximum allowable levels: effective from January 1, 2015）
  - Dust 100 mg/Nm^3
  - HCL 50 mg/Nm^3
  - CO 250 mg/Nm^3
  - SO2 250 mg/Nm^3
  - NOx 500 mg/Nm^3（as NO_2）
  - Hg and its compounds 0.2 mg/Nm^3（as Hg）
  - Cd and its compounds 0.16 mg/Nm^3（as Cd）
  - Pb and its compounds 1.2 mg/Nm^3（as Pb）
  - Total of other heavy metals (As, Sb, Ni, Co, Cu, Cr, Sn, Mn, Ti, Zn) and their compounds 1.2 mg/Nm^3
  - HC 50 mg/Nm^3
  - PCDD/PCDF 0.6 ng-TEQ/Nm^3(incinerator capacity: 300kg/hr and more)
    1.2 ng-TEQ/Nm^3(incinerator capacity: less than 300kg/hr)

ii. Operation and measures for incident

- Operational consideration
  - Operation manual of incinerator must be basically developed and complied by incinerator supplier or manufacture. Unless specific operating procedure by producer and careful considered by licensing agency is not provided, the start – up process must obey the following order.
    - Start-up emission treatment system;
    - Heat up all combustion zones. Just some non-hazardous wastes with high calorific value are charged to heat the primary combustion zone up to over 300 ° C and the secondary combustion zone up to over 800 ° C;
    - It is only allowed to charge non-hazardous wastes with low calorific value and hazardous wastes when the temperature of combustion zones reaches specific value, according to regulation in the technical requirements of this regulation.
  - The process for ending operation of incinerator must be performed in following order:
    - Stop loading wastes and provide fuel (if necessary) until wastes are burned off;
    - Stop fuelling the primary combustion zone after waste is completely combusted (no signs of fire);
    - Stop fuelling the secondary combustion zone after there is no more smoke in the primary combustion zone and no more emission exhausted from the stack;

- ✧ Stop the flue gas treatment system and the entire operation of the incinerator when the temperature in the primary combustion zone decreases to under 300 ° C.

- ➢ Industrial wastes must be controlled before being charged to incinerator to ensure normal operation of combustions. It is obligated to prepare proper amount of waste to ensure that the duration of incinerator operation reaches at least 24 hours. Some other requirements are regulated in appendix of this regulation.
- ➢ Prohibited wastes for incineration: radioactive wastes , explosive wastes , corrosive wastes or wastes containing higher content of mercury, lead, cadmium than allowable limits of on QCVN 07:2009 / BTNMT. Wastes containing higher content of organic halogen compounds than hazardous waste threshold as prescribed on QCVN 07:2009 / BTNMT are only allowed to be burned in incinerators granted with hazardous waste management permits by VEA, MONRE.
- ➢ Incinerators whose volume of primary combustion area is over 20 (twenty) m^3 or distance between the furthest point of primary combustion zone and the waste input door is over 2 m must be installed with mechanized equipment for waste charging.
- ➢ Techniques allowing a convenient ash removal from primary combustion area during the operation must be applied to ensure that incinerator can be run continuously and uninterruptedly.
- ➢ It is obligated to prepare the operation record stating type and volume of burned wastes, burning time and name of operators.

- Management of wastes generated from incinerator
  - ➢ Effluent standards for wastewater from incinerator follows the national technical regulation: QCVN 40:2011/BTNMT–National Technical Regulations on industrial wastewater.
  - ➢ Treatment of incinerator residues (bottom ash and fly ash) and sludge are disposed according to the methods prescribed in QCVN07:2009/BTNMT: National Technical Regulation on Hazardous Waste Thresholds, October 7, 2009.
- Incident prevention and response
  - ➢ Plan on fire prevention and response must be formulated and implemented according to fire safety regulations and under the guidance of competent agencies for fire prevention and combating.
  - ➢ Backing-up and responding plans must also be formulated and implemented as (such as regulations on hazardous waste management in the case of hazardous waste combustion).
  - ➢ Beside manual disconnecting mechanism, the combustion zone must be equipped with the automatic – disconnecting mechanism to prevent the abnormal operation or malfunction.
  - ➢ Combustion areas must be designed with the technical measures for being cooled down timely when temperature in the combustion zones increases unexpectedly, extraordinary or suddenly.
  - ➢ Incinerators must be installed with by-pass valve to generate exhaust directly through chimney without running through the emission treatment system when there is an incident.

- Environmental monitoring
  - Incinerator must be installed with automatic and continuous monitoring equipment to measure and record the temperature in the combustion zones, and exhaust gas temperature after being treated.
  - Camera or direct observation window with diameter of 5 cm must be installed to observe the waste incineration process in primary combustion zone.
  - Periodic environmental monitoring for incinerators must be complied with current regulations and requirements of the licensing agency, but the frequency must not be less than 3 months / time.
  - The automatic and continuous monitoring for some parameters in emission and sampling for dioxin / furan parameters are conducted only in case that incinerated wastes contain the higher content of organic halogen compounds than hazardous waste threshold of QCVN 07:2009 / BTNMT or in some other special cases under specific requirements of the licensing authority.

iii. Measurement of flue gas and analysis methods

Methods to sample and analyze pollutant parameters in emission of industrial waste incinerator are implemented under following national standards.

- TCVN 5977:2009 Stationary source emission - Determination of dust value and flow in gas pipes - Manual weight method（measurement of particulate matter）；
- TCVN 6750:2000 Stationary source emission - Determination of the mass concentration of sulfur dioxide – ion Chromatography method（measurement of SO_2）；
- TCVN 7172:2002 Stationary source emission - Determination of the mass concentration of nitrogen oxides - Naphthylethylenediamine photometric method（measurement of NOx）；
- TCVN 7242:2003 Medical waste incinerator. Determination method of carbon monoxide concentration (CO) in emissions（measurement of CO）；
- TCVN 7244:2003 Medical waste incinerator. Determination method of Hydrochloric acid concentration (HCL) in emission（measurement of HCL）；
- TCVN 7557:2005 (Part 1, 2 and 3) Medical Solid Waste Incinerator. Determination method of Heavy metal in gas emission (measurement of heavy metals)；
- TCVN 7556-3:2005 Part 3 Medical Solid Waste Incinerator. Determination method of mass concentration of PCDD/PCDF (measurement of dioxins)。

4) Hazardous Waste Management Regulation

First regulation on hazardous waste management was the Decision issued in 1999 (Decision 155/1999/QDD-TTg: Regulation on Hazardous Waste Management, 1999/7/16) and more detail regulation as well as legal procedures for a business of collection, transportation and treatment of hazardous waste are clarified in the Circular in 2006 (Circular 12/2006/TT-BTNMT: Guiding the Practice Conditions, Procedures for Compilation of Dossiers, Registration and Licensing of Practice and Hazardous Waste Management Identification Numbers, 2006/12/26). Then, all Decision and Circular on hazardous waste management were revised in 2011 and a new Circular was issued as the Circular 12/2011/TT-BTNMT: Stipulating Hazardous Waste Management, 2011/4/14.

(2) ENVIRONMENTAL IMAPCT ASSESSMENT SYSTEM（EIA）

1) Outline of the system

Environmental impact assessment system is stipulated in Chapter 3 of the Environmental Protection Law. Substantial procedures are determined by the Administrative instructions, Decrees (Decree No.80/2006/ND-CP: Detailing and Guiding the Implementation of a Number of Articles of the Environmental Protection Law.) and Circulars (Circular No.08/2006/TT-RTNMT: Guiding the Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitments.) of the Environmental Protection Law.

The main items of environmental impact assessment system are shown below:

i. Target projects

Construction and operation of recycling, treatment and disposal facilities of municipal and industrial waste, regardless of the size or capacity is obliged to be assessed though environmental impact assessment. Target activities are described in the Appendix of Decree No. 80/2006/ND-CP.

ii. Period for preparation of EIA

Environmental impact assessment reports are obliged to be submitted with F/S reports (Article 19-2 of the Law). After the environmental impact assessment report is approved, the permission for investment, construction and development is conceded and issued (Article 22-4 of the Law).

iii. Contents of EIA report

The major components of environmental impact assessment reports are stipulated as follows (Circular No.08/2006/TT-RTNMT: Guiding the Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitments.):

Chapter 1	Outline of Project
Chapter 2	Natural and Social-economic Situation at the Project Site
Chapter 3	Environmental Impact Assessment
Chapter 4	Measures against Environmental Impacts and Risks
Chapter 5	Environmental Protection Measures
Chapter 6	Environmental Protection Facilities, Environmental Management and Monitoring
Chapter 7	Cost Prediction of Environmental Protection Facilities
Chapter 8	Public Inspection and Publicity to Residents
Chapter 9	Data Sources and Environmental Impact Assessment Methods
Chapter 10	Conclusions and Recommendations

2) Appraisal and approval procedure for Environmental Impact Assessment report

i. Review and approval of Environmental Impact Assessment Reports

According to the project type, there are various agencies that have authorities to give a certification or to establish boards to review the environmental assessment reports. First, MONRE is responsible for the case of the projects approved by the parliament, governments or Prime Minister's Decision, or inter-sector or inter-provincial projects; other projects, which are approved by the central government, are under the control of related ministries. Local People's Committees are in charge of projects approved by the People's Committees (Article 21). For example, in the case of power generation facilities, MONRE is responsible as review/approval organization of environmental assessment for more than 300MW of the power generation capacity; DONRE is for less than 300MW. Furthermore, especially in the case of treatment and disposal of hazardous waste facilities, they are all under control of MONRE in terms of review/approval of environmental impact assessment.

ii. Review period

For the project requiring the prime minister, government or the parliament, and the project and sector which is under authorization of the parliament or project related with multiple ministries, the review period is within 45 working days after acceptance of the report. The other project except for above-mentioned projects is within 30 working days after the acceptance of the report. (Decree No. 80/2006/ND-CP Art.12)

iii. Right of the community and residents

The neighboring organization, community, and the individuals of the project site are admitted to send the request paper and the petition to the appraisal agency of the environmental impact assessment. The reviewing organization has responsibility to scrutinize before the environmental impact assessment being made decision of acceptance or rejection. (Article 21-6 of the Law)

2.5 LEGISLATION FRAME AND ORGANIZATION ON INFRASTRUCTURE PROJECT USING PPP FORM

2.5.1 RELATED LAWS AND REGULATIONS FOR WASTE TO ENERGY PROJECT

Related laws and regulation for waste to energy project is outlined in this section. Energy generated either using methane gas recovered at landfill site or using waste heat of waste incineration in Vietnam, is regarded as a one of renewable energy. So far CDM project at the Go Cat landfill site in Ho Chi Minh City using the World Bank's carbon protocol fund is reported as example of the former case and industrial waste incineration project by NEDO is under consideration as example of the latter case. However, recently, especially in the large cities, since many research and survey have been conducted for waste to energy project using municipal waste by foreign companies, the government issued a prime minister decision entitled "Development Support Mechanisms of power Generation Projects Using Solid Waste in Vietnam" in 2014. In this section this Decision is outlined as well as other related laws and support mechanisms for a development and utilization of renewable energy.

(1) SUPPORT MECHANISM FOR POWER GENERATION PROJECT USING SOLID WASTE

i. Target project

In this Decision (Decision No.31/2014/Qd-TTg) target projects for power generation using solid waste are those of waste-to-energy projects burning municipal or nonhazardous waste and those of power generation project by using collected methane gas at landfill site. There are two cases in which all or a part of electricity generated by these projects are sent to a national grid or all of electricity is provided to nearby residents (without connection to national grid).

ii. Plan of the project

Plan of power from solid waste is set up for a period of 10 years and is oriented for the next 10 year period considering the development of technology in the area and experiences so far. The plan must be in line with the national or regional plan for electricity supply plan and grid development plan, considering socioeconomic development plan, landfill development plan and land use plan.

iii. Responsible ministry and agency

Department of Energy submits a plan of waste to energy project to MOIT for appraisal and approval. MOIT is responsible for publicizing, guiding, overseeing and inspecting the approved plan. Budget for expenditure for formation, appraisal, approval, publicizing is provided from a state budget.

iv. Waste to energy project sending power to national grid system

Provincial and urban people's committee under central government control is only allowed to issue certificate of investment for waste to power projects connected to the electricity grid system. Connection to a grid must be in compliance with the provincial electricity development plan. Point of connection is determined between the seller and the buyer according to the agreement. If there is no connection point determined in the provincial electricity development plan, the point is determined through a discussion with electricity transmission units. According to the level of connecting voltage, electricity distribution agencies or transmission units are responsible for setting up transmission lines from the connection point to the national grid.

v. Investor of the project

Investor of the project in this Decision means organization who invests waste to energy project based on the domestic law and the buyer of electricity is the Electricity Authority of Vietnam or authorized units. The seller of the electricity is company that carries out waste to energy project and operates facility. Investor must be issued the investment certificate before starting project planning and obtain written inspection note from authorities after the primary design in accordance with legal regulations in investment management and construction. Besides, in case of the project connecting to a national grid, investor must obtain a electricity purchase agreement from the buyer as well as agreement of connecting with distribution agencies or transmission units. Within 6 months commencing from the electricity selling is offered, the buyer shall sign a power purchasing agreement. The term of this agreement is 20 years. After 20 years, the two parties shall negotiate on extension of the agreement.

vi. Incentives and subsidy for investment capital, tax, and land utilization

Investor is allowed to raise capital from domestic and foreign organizations and individuals under current investment law. The project shall be exempted from import duties for goods imported to form fixed assets, import of raw materials, tools and semi-furnished products which are not available in the domestic market. The reduction and exemption of corporate tax for the project shall be applied. Land use fee or land rents for waste to power facility, transmission line and transformer station of the project are reduced or exempted. Based on the plan approved by competent authorities, provincial People's Committee shall allocate land to investor of the project. The power purchasing prices are VND2,160/kWh（10.05cent/kWh） and VND1,565/kWh（7.28cent/kWh）for the waste incineration project and methane gas utilization project, respectively(excluding VAT). Annually MOIT に shall monitor and propose to adjust the above prices. In the project not connecting national grid, the investor proposes prices and determines the total subsidy for the difference between the price stipulated in this Decision and the actual selling price. This difference is compensated by the Environmental Protection Fund of Vietnam.

vii. Role of related ministry and agency for waste to energy project

MOIT is in charge of providing regulation on the project, appraisal and approval of the project (including modification of the plan) and organizing, guiding and collaborating with provincial People's Committee to examine and supervise the implementation of this Decision. MOIT is also enforcing sales and purchasing of electricity of the project. The Ministry of Finance in collaboration with MOIT and MONRE presides to stipulate subsidy for selling price of the project that does not send electricity to the national grid through the Vietnam Environment Protecting Fund. Provincial People's Committee is responsible in compensation and land clearance, infrastructure, human resources, implementation and development of the project. Also Provincial People's Committee is responsible for presiding and collaborating with relevant agencies to stipulate waste management fee supporting the waste to energy project.

(2) POLICY OF RENEWABLE ENERGY AND RELATED REGULATIONS

MOIT is preparing a master plan for renewable energy development entitled "Master plan on RE development for the period up to 2030 with outlook to 2050" and is expecting approval by the prime minister. Existing laws and regulations concerning about renewable energy development and promotion of the use are summarized in below.

Table2-29 Policy and Legislation related with Development and Promotion of Renewable Energy

Code number	Title	Date
Law No.28/2004/QH11	Law on Electricity 2004	2004/12/3
Law No.52/2005/QH11	Law on Environmental Protection 2005	2005/12/12
Decision 110/2007/QD-TTg	Planning on National Electricity Development in the 2006-2015 period with a vision to 2025	2007/7/18
Decision 1855/2007/QD-TTg	National Energy Development Strategy up to 2020 with outlook to 2050	2007/12/27
Decision 158/2008/QD-TTg	National Target Program to Respond to Climate Change	2008/12/2
Law No.50/2010/QH12	Law on Energy Efficiency and Conservation 2010	2010/6/15

Source: JICA study team

A. Law on Electricity 2004

The law is the first regulation for electric business in Vietnam and presents to promote the development and utilization of power generation by new energy and renewable energy (Article 4, Clause 4.4). Investment incentive and advantage of electric power selling and electricity tariff under instruction of MOF might be obtained for development of power generation facility for renewable energy (Article 13, Clause 1). In particular, power generation and electric transmission by new energy and renewable energy in mountain range and island region is promoted (Article 60, Clause

B. Law on Environmental Protection

In Chapter 33 of the Law on Environmental Protection it is clearly mentioned that development and use of clean energy and renewable energy contribute environmental protection partly. And it is prescribed that organizations and companies who invest development of clean energy and renewable energy are provided preferable tax, subsidy and preferable measures for land acquisition of the project.

C. Planning on National Electricity Development in the 2006-2015 period with a vision to 2025

Plan on construction of power generation facility with capacity of 2,451MW (241MW/y) until 2015 and capacity of 1,600MW between 2016 and 2025, is prepared. This Decision shows framework and concrete countermeasure to realize the plan mentioned above. Target, which is development of small hydropower generation, new energy and renewable energy, is set to disseminate to remote area, mountain range and island region. MOIT should be established measurement of financial support to promote investment for development and dissemination of new energy and renewable energy in collaboration with related agencies.

D. National Energy Development Strategy up to 2020 with outlook to 2050

In a way of thinking of the strategy, enough energy provision is necessary to achieve socio-economic development. For this, it is essential of harmonious development of electricity, oil, natural gas, coal and renewable energy. In particular, utilization of green energy should be promoted prioritizing development of new energy and renewable energy. In the strategy, target of provision ratio of these green energy in a primary energy supply are set, as 3% in 2010, 5% in 2020, 11% in 2050 individually.

However, a kind and type of energy are not evaluated fully so that it is essential to specify the renewable energy to develop, investment plan and exploitation plan, and to establish the system to achieve these purposes. Especially to promote a use of renewable energy in mountain range and island region, activities for information dissemination and technical training are necessary. To support these activities, research and development, financial support for a pilot project, preferable taxation for import goods and a new technology as well as production and dissemination of a new technology and preferable measures for a protection of intellectual property are provided.

E. National Target Program to Respond to Climate Change

This is national plan until 2015 to respond to climate change issue. In the plan, several kinds of policies for impact forecast by climate change and its countermeasure are proposed. Implementation of these policies contributes to realization of sustainable development and low carbon society in Vietnam and international effort for climate change issues.

The lead ministry of this program is MONRE, however plans that should be elaborated by other related ministries are also proposed. Following plans to promote utilization of renewable energy are proposed by MOIT.

Table2-30 Project Plans related with Climate Change Issues by MOIT between 2009 and 2015

Task and project	Lead ministry	Budget（100 million VND）
• Impact evaluation for MOIT related project by rising sea level • Measures against climate change and rising sea level • Consideration of climate change issues into MOIT related policy, plan, program and master plan • Other countermeasures ✓ Energy efficiency and conservation to cope with climate change ✓ Efficient use and energy use of natural resources (natural gas, hydropower) ✓ Development and deployment of the emission reduction technology and energy-saving technology ✓ Development of new energy (geothermal, wind, solar, nuclear energy) ✓ Proposal of climate change adaptation in business activities and implementation of a pilot project	MONRE	800

Source: Adapted from “Tasks and Projects under the National Target Program on Response to Climate Change in the 2009-2015 Period (Appendix of Decision No. 158/2008/QD-TTg of December 2, 2008)

F. Law on Energy Efficiency and Conservation 2010

The law is to stipulate policies and measures to promote energetic efficiency and conservation (EE&C) in Vietnam. The law shows that priority is to increase utilization ratio of green energy and renewable energy (Article 6, Clause 1c). In the law, it is required that study and development of new energy instead of conventional fuel (Article 42, Clause 3f).

This law is consisted with the following 12 Chapters (48 Articles）:

Chapter 1	General provision
Chapter 2	EE&C in manufacturing sector
Chapter 3	EE&C in construction and public lightning sector
Chapter 4	EE&C in transportation sector
Chapter 5	EE&C in agriculture sector
Chapter 6	EE&C in service sector and household
Chapter 7	EE&C in state investment project and responsible agencies
Chapter 8	Management of energy use in main energy user
Chapter 9	Management energy consumption equiment
Chapter 10	Promotion of EE&C
Chapter 11	Responsible ministry for EE&C
Chapter 12	Implementation rule

Basic government policy of EE&C is as follows:

- Integration of EE&C with socioeconomic development,
- Providing necessary incentive including subsidy and support for energy cost to promote EE&C,
- Strengthening research and development of EE&C technologies to help securing energy security and environmental protection, promoting investment for a development of renewable energy considering country's condition,
- Promotion and encouragement to use energy saving products and roadmap for eco-label, step-wise abolishment of non-energy saving product,
- Appropriate investment for information dissemination and education necessary for consulting service for energy efficiency and energy saving at home, organization, and individuals,

Substantial measures to promote those policies are prescribed as the following 3 items.

i. Incentive for EE&C

ii. Prioritization for research and development of EE&C

iii. Repletion of dissemination, education and consultation of EE&C

(3) REGULATION FOR POWER DELIVERY AND TRANSMISSION FACILITY/EQUIPMENT

There are a lot of technical criteria and safety regulation for power generation facility and equipment. Hose related with waste to power project in particular is summarized in below.

Table2-31 Codes related with Power Distribution and Transmission Facility/Equipment

Code	Title	Lead ministry	Date
11 TCN-18-2006	Code on Electric Facility- Part I: General Regulation	MOI	19/2006/QĐ-BCN1 1/07/2006
11 TCN-19-2006	Code on Electric Facility- Part II: Electric Network	MOI	19/2006/QĐ-BCN1 1/07/2006
11 TCN-20-2006	Code on Electric Facility- Part III: Distribution Facility & Transformer Station	MOI	19/2006/QĐ-BCN1 1/07/2006
11 TCN-21-2006	Code on Electric Facility- Part IV: Protection & Automatic	MOI	19/2006/QĐ-BCN1 1/07/2006
QCVNQTĐ-5: 2009/BCT	National Technical Codes for Testing, Acceptance Test for Power Facility	MOIT	40/2009/TT-BCT31 /12/2009
QCVN QTĐ-6:2009/BCT	National Technical Codes for Operating and Maintenance Power system facilities	MOIT	40/2009/TT-BCT31 /12/2009
QCVN QTĐ-7:2009/BCT	National Technical Codes for Installation of Power Network	MOIT	40/2009/TT-BCT31 /12/2009
QCVN QTĐ-8:2010/BCT	National Technical Codes for Low Voltage Electric Network	MOIT	04/2011/TT-BCT16 /02/2011
QCVN01:2008/BCT	National technical regulation on Electric safety	MOIT	12/2008/QĐ-BCT1 7/06/2008
QCVN01:2008/BL DTBXH	National technical regulation on safe work of Steam boiler and pressure vessel	Ministry of Labor, Invalids and Social Affairs	64/2008/QĐ-BLĐT BXH 27/11/2008

Source: JICA study team

(4) REGULATION AND FRAME TO DEVELOP AND PROMOTE RENEWABLE ENERGY

Basic policies of MOIT towards promotion of renewable energy are summarized as below:

- To promote and encourage enterprises to install manufacturing and assembly lines using new and renewable energy such as solar heat boiler, small hydro power, wind power, biogas technology
- To promote domestic production and assembly by transferring higher technologies including solar battery and wind power station from developed countries,
- To give incentive for taxation for imported products and new technologies and protect the right of property through providing financial support for research, experiment, and pilot study of renewable energy,
- To allow joint investment and exploitation of a new and renewable energy expecting benefits for both domestic and foreign company and individuals.

Decisions including various incentives for a renewable energy development are as follows:

- Decision No. 129/2009/QĐ-TTg: The Scheme on Investment Incentive Policy Mechanism in Natural Resources and Environment Protection Sector

- Decision No. 130/2007/QĐ-TTg: Issuing Some Mechanisms, Financial Policies Applying for the Clean Development Mechanism (CDM) Projects
- Decision No. 55/2007/QĐ-TTg: A List of Prioritized Industrial Sectors, Key Industrial Sectors for the Period 2007-2010, with the Vision to 2020 and Some Encouraging Development Policies
- Decree No. 61/2013/NĐ-CP: The Incentive Policies for Business Investment in Agriculture and Rural Development
- Decree No. 80/2010/NĐ-CP: Regulations on International Cooperation, Investment in Science and Technology Sector
- Decree No. 04/2009/NĐ-CP: Incentives and Supports for Environmental Protection Activities

In line with the Decree No. 04/2009/NĐ-CP: Incentives and Supports for Environmental Protection Activity, development of clean energy and renewable energy as well as waste-to-energy projects are regarded as environmental protection activity and following incentives and supports are provided.

- Support for land clearance and rental fee,
- Corporate income tax is fixed at 10% during the project or exempted during the first 4 years of the project and reduced at 50% after that for the project in the region where socio-economic condition are bad,
- Import duty is exempted for material and equipment used in the project, and
- Permission of accelerated depreciation.

(5) REGULATIONS ON INDEPENDENT POWER PRODUCER (IPP)

In Decision No. 30/2006/QD-BCN, process of application, appraisal, evaluation, and selection for investment project of IPP are prescribed. IPP project means power generation project invested by the form of BOT or BOO, without using a state budget. This investment project must be planned in line with the power development plan of the government and approved by MOIT and DOIT in the provinces and government run cities or MOIT and provincial Peoples' Committee for a small hydropower project, in accordance with the Law for Electricity. Investment plan for IPP is managed by the government and investment license is issued by the competent agencies that are prescribed in the Law on Investment or regulations on construction management.

Although investor is selected in principle by tendering proves considering efficiency and sustainability of the project, only small project or power generation project to supply electricity in the mountain range and remote area is selected without tender process. Investor to IPP project (organization or individual) must submit different reports to authorities depending on the project type: Group A (investment report), Group B(investment examination report） and Group C（investment examination and application report）.

In the report of investment and investment application, following basic information must be described:

- Legal ability
- Business registration
- Organization

- Responsible person
- Experience of the project
- Financial status and technical capability
- List of the project in the last 5 years
- Financial status in the last 3 years

and, as project details;

- Construction site
- Objective of the project
- Power generation capacity
- Investment cost
- Date of commissioning
- Regional development plan
- Project schedule
- Compensation cost
- Relocation of residents
- Management of investment
- Project operation methods, etc.

In addition PPP investor needs a electricity purchase agreement between Vietnam Electricity Corporation or whole seller of electricity. Furthermore documents showing financial sources and loan agreement of bank or financial institutions must be submitted together with above reports. Investor's equity for total project cost is at least 30% and this ratio can be changeable for special cases, but not less than 20% even in such vases.

While MOIT appraises project categorized as Group A or project governed by several ministries, DOIT of provinces and cities run by the government appraises project of Groups B and C. The result of appraisal is informed to investor within 30 days for Group A project and within 20 days for Groups B and C. Then investor decides whether project will be put forward or withdrawal.

PART 3

CHAPTER 3 PLAN ON MUNICIPAL SOLID WASTE TREATMENT PROJECT

3.1 BACKGROUND AND NECESSITY OF THE PROJECT

(1) BACKGROUND OF THE PROJECT

In Ho Chi Minh City, the biggest city in South Vietnam, the issue of MSW treatment is deteriorating. Ho Chi Minh City has 7.8 million people, 1.8 million households, over 10,000 hotels and restaurants, and 800 above factories. MSW generated from Ho Chi Minh City is already over 7,000tons/day. Generation amount of MSW is increasing in accordance with population growth and economic development, and it is expected generation amount of MSW will be doubled in 2020. Therefore, sanitary treatment for MSW is required as substitute of land disposal.

(2) NECESSITY OF THE PROJECT FOR INTEGRATED THE WASTE MANAGEMENT SYSTEM

This project encompasses an establishment of an integrated system for waste incineration and power generation treating MSW, which is generated in Ho Chi Minh City.

(1) Solid waste generated from Ho Chi Minh City will be safely and hygienically treated by incinerator of Japanese advanced technologies to reduce the effects on the environment in the open-dumping site and surrounding area.
(2) High-end incineration treatment system will help to drastically reduce the amount of final disposal waste, it would be the way of solving social problems of life expansion of landfill sites in the future.
(3) Power generation by waste as fuel will contribute to power shortages in Vietnam, as people use electricity more than before, because of increasing population and living standards. And it also contributes to reduce environmental burdens by establishment of “Waste to energy” society using recyclable energies.
(4) Ho Chi Minh City has been promoted to install incineration treatment technology of MSW and sets a goal to increase rate of incineration treatment to 10% until the end of 2015.

3.2 OBJECTIVE OF THE PROJECT

Expertise and experiences enriched in establishing waste management system in Japan as well as capitals will be introduced to build systems for incineration of MSW, which is enable a supply of electricity generated by waste incineration. The objective of the project is to contribute to solution of pollution issues, life expansion of for landfill site, and reduction of environmental burden in Vietnam, in addition, to contribute to Vietnam’s economic development including attraction of Japanese companies through the development of recycling industries.

3.3 DEMAND PREDICTION OF THE PROJECT

3.3.1 CURRENT SITUATION OF WASTE GENERATION/TREATMENT (HCMC)

(1) BASIC FLOW OF WASTE TREATMENT

The generation amount of MSW in Ho Chi Minh city is predicted to 7,500 up to 8,000tons/day. CITENCO, 22 District Public Services Companies, Co-operatives and Private system (30 teams) are in charge of collection and transportation of MSW in Ho Chi Minh City, and approximately 7,000tons/day of MSW is collected. Most of collected waste is directly disposed of at Phuos Hiep landfill and Da Phuoc landfill, 2,000tons/day is disposed of at Da Phuoc landfill and 2,000tons/day is disposed of at Da Phuoc landfill. A part of some collected waste is treated at intermediate treatment facility by Viet star company and Tam Sinh Nghia company. Viet star company has composting plant with capacity of 1,200tons/day, Tam Sinh Nghia company has composting plant with capacity of 2,000tons/day and incineration facility with capacity of 500tons/day.

The residue generated from composting plant of Viet star company is disposed of at Phuos Hiep landfill, but the bottom ash generated by incineration treatment at Sinh Nghia company is stored at in-site of facility.

According to the results of hearing survey to related agencies, in terms of capacity of treatment, basic flow of Municipal waste treatment in Ho Chi Minh city is shown below.

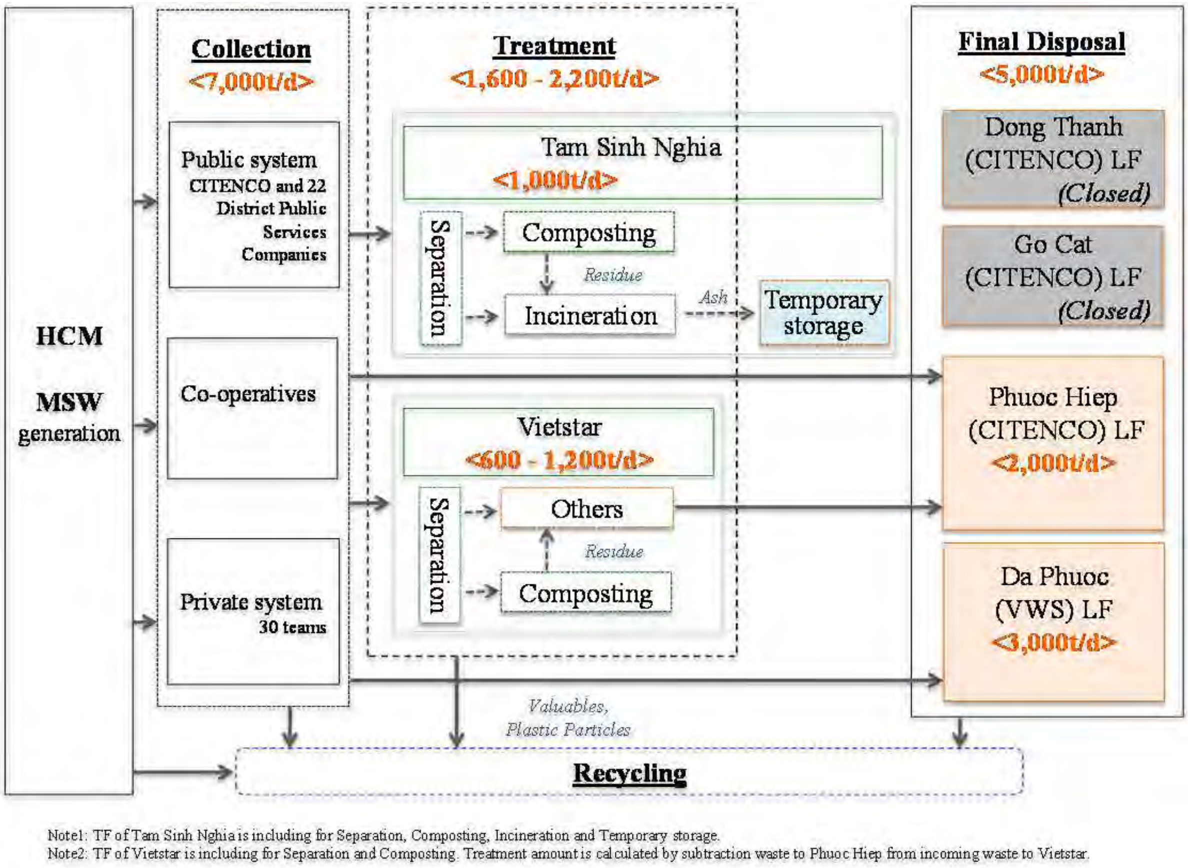


Figure3-1 Basic Flow of Municipal Solid Waste Treatment

List and location of MSW treatment facility in Ho Chi Minh city are shown below.

Table3-1 List of MSW Treatment Facility in Ho Chi Minh City

Process	Facility	Descriptions
Collection/ transportation	Collector	CITENCO, 22 District Public Services Companies, Co-operatives and Private system (30 teams)
	Transfer station	Total: 45 facilities Type 1 (800tons/day) : 2 facilities Type 2 (20-100 tons/day) : 6 facilities Type 3 (100 tons/day) : 4 facilities Type 4 (100 tons/day) : 33 facilities
Intermediate treatment	Composting plant	2 facilities (Tam Sinh Nghia composting plant, Viet star composting plant)
	Incineration facility	1 facility (Tam Sinh Nghia incinartor plant (Note; it is for compost residue))
Disposal	landfill	2 landfills (Phuoc Hiep landfill, Da Phuoc landfill)

Source: JICA study team

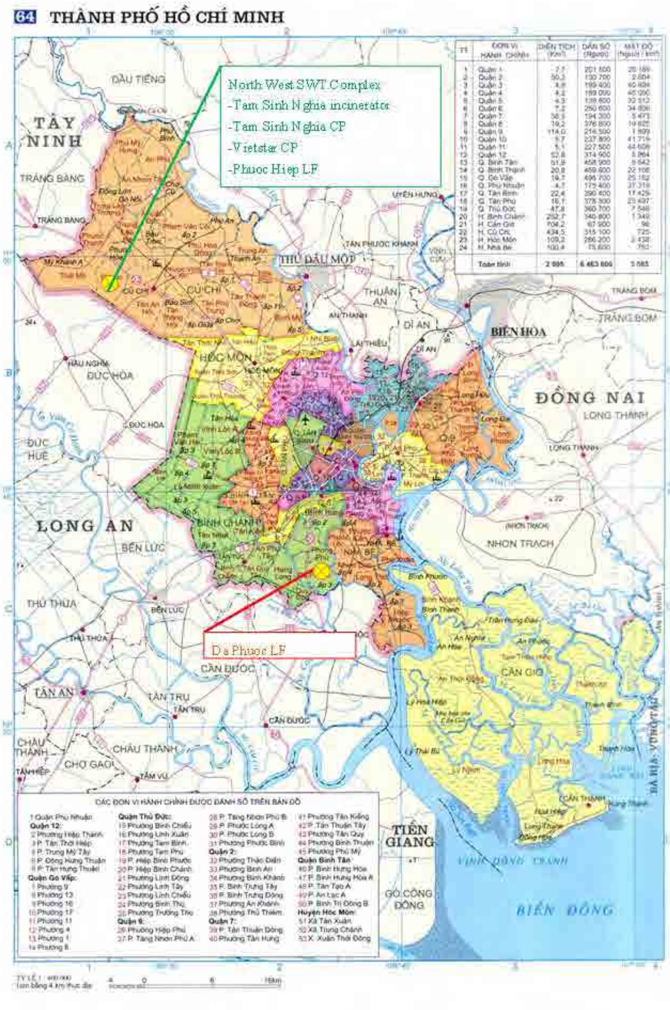


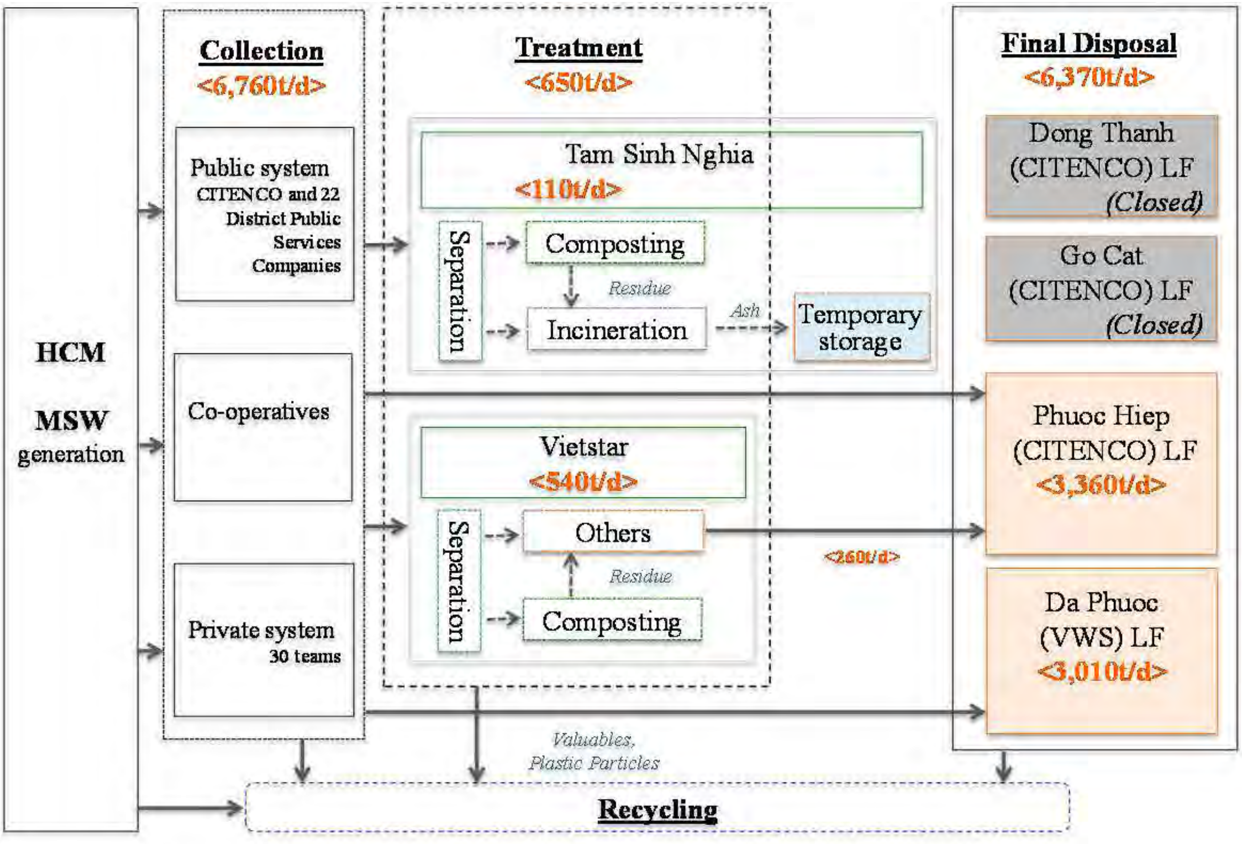
Figure3-2 Location of MSW Treatment Facility in Ho Chi Minh City

(2) WASTE TREATMENT/DISPOSAL AMOUNT (2013)

The generation amount of MSW in Ho Chi Minh city in 2013 is predicted to 7,000 up to 7,200tons/day. About 6,760tons/day are collected by CITENCO, 22 District Public Services Companies, Co-operatives and Private system (30 teams). 3,360tons/day of collected waste is disposed of at Phuos Hiep landfill and 3,010tons/day of collected waste is disposed of at Da Phuoc landfill.

Viet star who has composting plant with capacity of 1,200tons/day is treated to about 540tons/day, Tam Sinh Nghia company who has composting plant with capacity of 2,000tons/day and incineration facility with capacity of 500tons/day is treated to about 110tons/day.

MSW treatment flow in 2013 is shown below.



Note1: TF of Tam Sinh Nghia is including for Separation, Composting, Incineration and Temporary storage.
Note2: TF of Vietstar is including for Separation and Composting. Treatment amount is calculated by subtraction waste to Phuoc Hiep from incoming waste to Vietstar.

Figure3-3 MSW Treatment Flow in Ho Chi Minh City (2013)

Waste amount which is treated by intermediate facilities and is disposed of at landfill in Ho Chi Minh city in 2013 is shown below.

Table3-2 Waste Amount Treated and Disposed by Facilities and Landfill (2013)

Unit: tons

	Jan.	Feb.	Mar.	Apr.	May	Jun.
PHUOC HIEP LF	91,220	82,164	84,069	91,362	101,489	100,644
DA PHUOC LF	93,410	80,964	93,618	89,656	93,714	91,171
Sub-total	184,630	163,128	177,687	181,018	195,203	191,815
VIETSTAR	12,760	10,251	12,743	12,538	13,054	19,083
TAM SINH NGHIA	3,654	3,027	3,635	3,349	3,542	3,414
Sub-total	16,414	13,278	16,378	15,887	16,596	22,497
Total (2013)	201,044	176,406	194,065	196,905	211,799	214,312

	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total Year
PHUOC HIEP LF	99,819	100,787	96,284	99,937	92,730	91,116	1,131,621
DA PHUOC LF	94,292	94,253	91,370	94,162	91,032	91,034	1,098,676
Sub-total	194,111	195,040	187,654	194,099	183,762	182,150	2,230,297
VIETSTAR	19,732	19,754	18,994	18,984	18,516	19,278	195,687
TAM SINH NGHIA	3,476	3,479	3,437	3,556	3,428	3,351	41,348
Sub-total	23,208	23,233	22,431	22,540	21,944	22,629	237,035
Total (2013)	217,319	218,273	210,085	216,639	205,706	204,779	2,467,332

Source: JICA study team based on information from Ho Chi Minh city DONRE

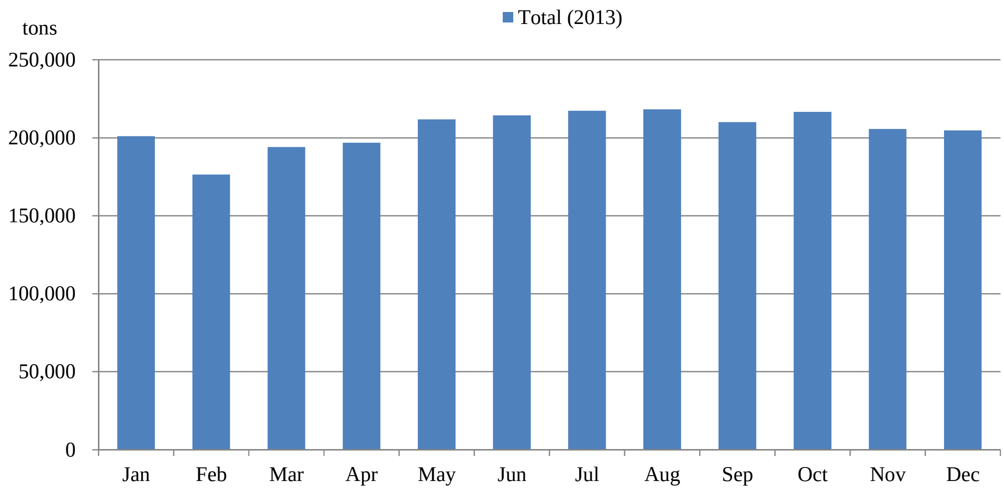


Figure3-4 Waste Amount Treated and Disposed by Facilities and Landfill (2013)

Table3-3 Daily Waste Amount Treated and Disposed by Facilities and Landfill (2013)

Unit: tons/day

	Jan.	Feb.	Mar.	Apr.	May	Jun.
PHUOC HIEP LF	2,943	2,934	2,712	3,045	3,274	3,355
DA PHUOC LF	3,013	2,892	3,020	2,989	3,023	3,039
Sub-total	5,956	5,826	5,732	6,034	6,297	6,394
VIETSTAR	412	366	411	418	421	636
TAM SINH NGHIA	118	108	117	112	114	114
Sub-total	530	474	528	530	535	750
Total (2013)	6,486	6,300	6,260	6,564	6,832	7,144

	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total Year
PHUOC HIEP LF	3,220	3,251	3,209	3,224	3,091	2,939	3,100
DA PHUOC LF	3,042	3,040	3,046	3,037	3,034	2,937	3,010
Sub-total	6,262	6,291	6,255	6,261	6,125	5,876	6,110
VIETSTAR	637	637	633	612	617	622	536
TAM SINH NGHIA	112	112	115	115	114	108	113
Sub-total	749	749	748	727	731	730	649
Total (2013)	7,011	7,040	7,003	6,988	6,856	6,606	6,759

Source: JICA study team based on information from Ho Chi Minh city DONRE

Table3-4 Waste Amount Disposed by Landfill (2013)

Unit: tons

	Jan.	Feb.	Mar.	Apr.	May	Jun.
Direct disposal (PHUOC HIEP LF)	91,220	82,164	84,069	91,362	101,489	100,644
VIETSTAR residue (PHUOC HIEP LF)	11,132	8,838	5,545	6,221	7,642	6,786
Sub-total (PHUOC HIEP LF)	102,352	91,002	89,614	97,583	109,131	107,430
Direct disposal (DA PHUOC LF)	93,410	80,964	93,618	89,656	93,714	91,171
Sub-total (DA PHUOC LF)	93,410	80,964	93,618	89,656	93,714	91,171
Total(LF)	195,762	171,966	183,232	187,239	202,845	198,601

	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total Year
Direct disposal (PHUOC HIEP LF)	99,819	100,787	96,284	99,937	92,730	91,116	1,131,621
VIETSTAR residue (PHUOC HIEP LF)	9,925	8,724	7,783	7,790	8,310	7,661	96,357
Sub-total (PHUOC HIEP LF)	109,744	109,511	104,067	107,727	101,040	98,777	1,227,978
Direct disposal (DA PHUOC LF)	94,292	94,253	91,370	94,162	91,032	91,034	1,098,676
Sub-total (DA PHUOC LF)	94,292	94,253	91,370	94,162	91,032	91,034	1,098,676
Total(LF)	204,036	203,764	195,437	201,889	192,072	189,811	2,326,654

Source: JICA study team based on information from Ho Chi Minh city DONRE

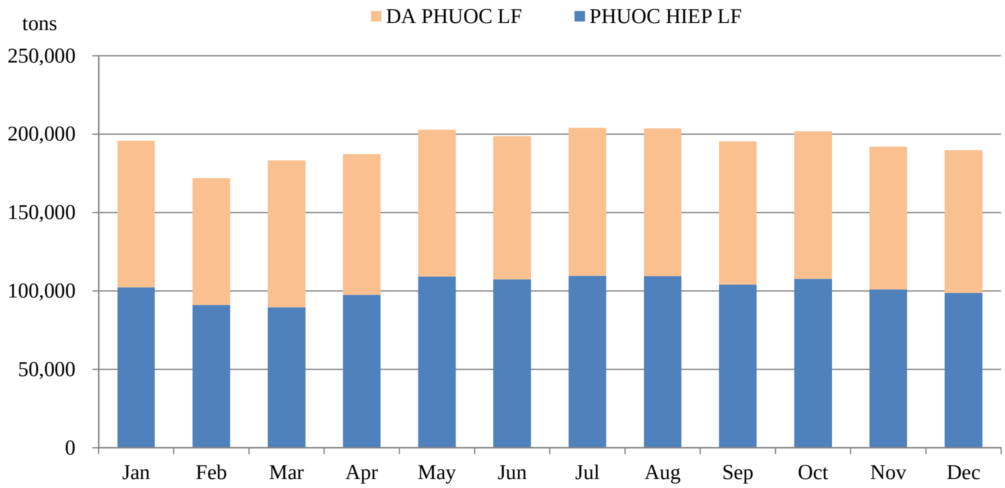


Figure3-5 Waste Amount Disposed by Landfill (2013)

Table3-5 Daily Waste Amount Disposed by Landfill (2013)

Unit: tons/day

	Jan.	Feb.	Mar.	Apr.	May	Jun.
Direct disposal (PHUOC HIEP LF)	2,943	2,934	2,712	3,045	3,274	3,355
VIETSTAR residue (PHUOC HIEP LF)	359	316	179	207	247	226
Sub-total (PHUOC HIEP LF)	3,302	3,250	2,891	3,252	3,521	3,581
Direct disposal (DA PHUOC LF)	3,013	2,892	3,020	2,989	3,023	3,039
Sub-total (DA PHUOC LF)	3,013	2,892	3,020	2,989	3,023	3,039
Total(LF)	6,315	6,142	5,911	6,241	6,544	6,620

	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total Year
Direct disposal (PHUOC HIEP LF)	3,220	3,251	3,209	3,224	3,091	2,939	3,100
VIETSTAR residue (PHUOC HIEP LF)	320	281	259	251	277	247	264
Sub-total (PHUOC HIEP LF)	3,540	3,532	3,468	3,475	3,368	3,186	3,364
Direct disposal (DA PHUOC LF)	3,042	3,040	3,046	3,037	3,034	2,937	3,010
Sub-total (DA PHUOC LF)	3,042	3,040	3,046	3,037	3,034	2,937	3,010
Total(LF)	6,582	6,572	6,514	6,512	6,402	6,123	6,374

Source: JICA study team based on information from Ho Chi Minh city DONRE

Table3-6 Waste Amount Treated by Intermediate Facilities (2013)

Unit: tons

	Jan.	Feb.	Mar.	Apr.	May	Jun.
VIETSTAR	12,760	10,251	12,743	12,538	13,054	19,083
/ Composting	1,628	1,413	7,198	6,317	5,412	12,297
/ Residue(Phuoc Hiep)	11,132	8,838	5,545	6,221	7,642	6,786
TAM SINH NGHIA	3,654	3,027	3,635	3,349	3,542	3,414

	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total Year
VIETSTAR	19,732	19,754	18,994	18,984	18,516	19,278	195,687
/ Composting	9,807	11,030	11,211	11,194	10,206	11,617	99,330
/ Residue(Phuoc Hiep)	9,925	8,724	7,783	7,790	8,310	7,661	96,357
TAM SINH NGHIA	3,476	3,479	3,437	3,556	3,428	3,351	41,348

Source: JICA study team based on information from Ho Chi Minh city DONRE

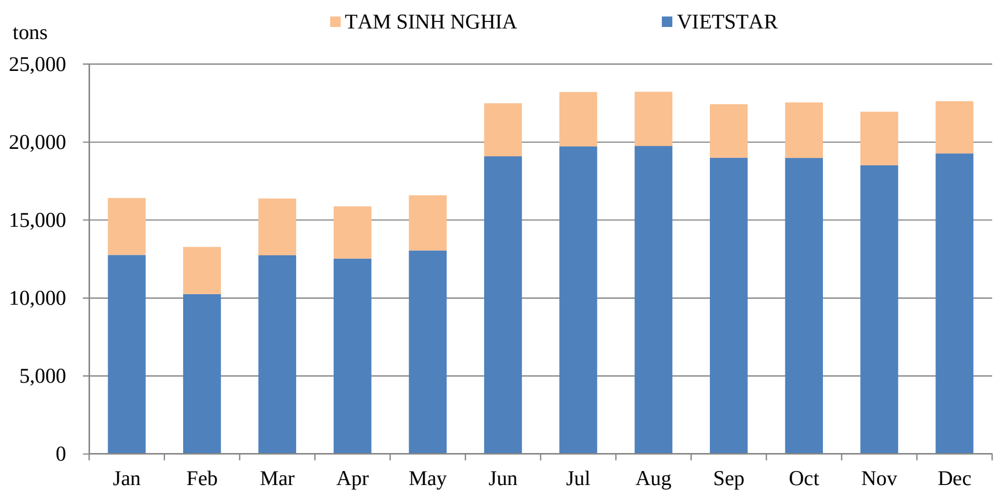


Figure3-6 Waste Amount Treated by Intermediate Facilities (2013)

Table3-7 Daily Waste Amount Treated by Intermediate Facilities (2013)

Unit: tons/day

	Jan.	Feb.	Mar.	Apr.	May	Jun.
VIETSTAR	412	366	411	418	421	636
/ Composting	53	50	232	211	175	410
/ Residue(Phuoc Hiep)	359	316	179	207	246	226
TAM SINH NGHIA	118	108	117	112	114	114

	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total Year
VIETSTAR	637	637	633	612	617	622	536
/ Composting	316	356	374	361	340	375	272
/ Residue(Phuoc Hiep)	321	281	259	251	277	247	264
TAM SINH NGHIA	112	112	115	115	114	108	113

Source: JICA study team based on information from Ho Chi Minh city DONRE

3.4 SCOPE OF THE PROJECT

(1) OVERVIEW OF THE PROJECT

This is a business intended to generate electricity by burning non-industrial wastes of Ho Chi Minh City and gain income from disposal and selling electricity. The initial plan involved Kobelco Eco-Solutions which has constructed and operated many non-industrial waste disposal plants in Japan to design a plant based on latest technologies of Japan. Yet, business negotiation is now underway for the cooperation between Hitachi Zosen Corporation that is also implementing an investigation similar to this investigation and all-Japan team. This review has adopted stoker incinerator of Hitachi Zosen Corporation. Kobelco Eco-Solutions is conducting exploration assuming that Kobelco Eco-Solutions (and its subsidiary, Kobelco Eco-Solutions Vietnam Co., Ltd.) that is experienced in operations related to post-processing and business in Vietnam becomes in charge of the operation.

Currently both Kobelco Eco-Solutions and Hitachi Zosen Corporation have received approvals in principle from DONRE in February 2015. DONRE is now asking them to submit F/S reports.

Table3-8 Overview of Business Details (draft)

Category	Detail
Range of business	Project to generate electricity through the disposal of non-industrial waste
Planned construction site (size)	About 2 to 3 ha within Northwest Solid Waste Treatment Complex (533 ha)
Period of construction	About three years
Wastes to be accepted	Non-industrial waste of Ho Chi Minh City (Sorted waste, compost residue, and dug-up waste are expected.)
Planned processing capacity	600 t/d
Planned amount of electricity to sell	9,000 kW
Facility overview	Stoker incinerator (300 t/day x two furnaces)
Business period	20 years
Business system	JV (SPC) with partners in Japan and Vietnam

Source: JICA study team

(2) COLLECTION AND TRANSPORTATION PLAN

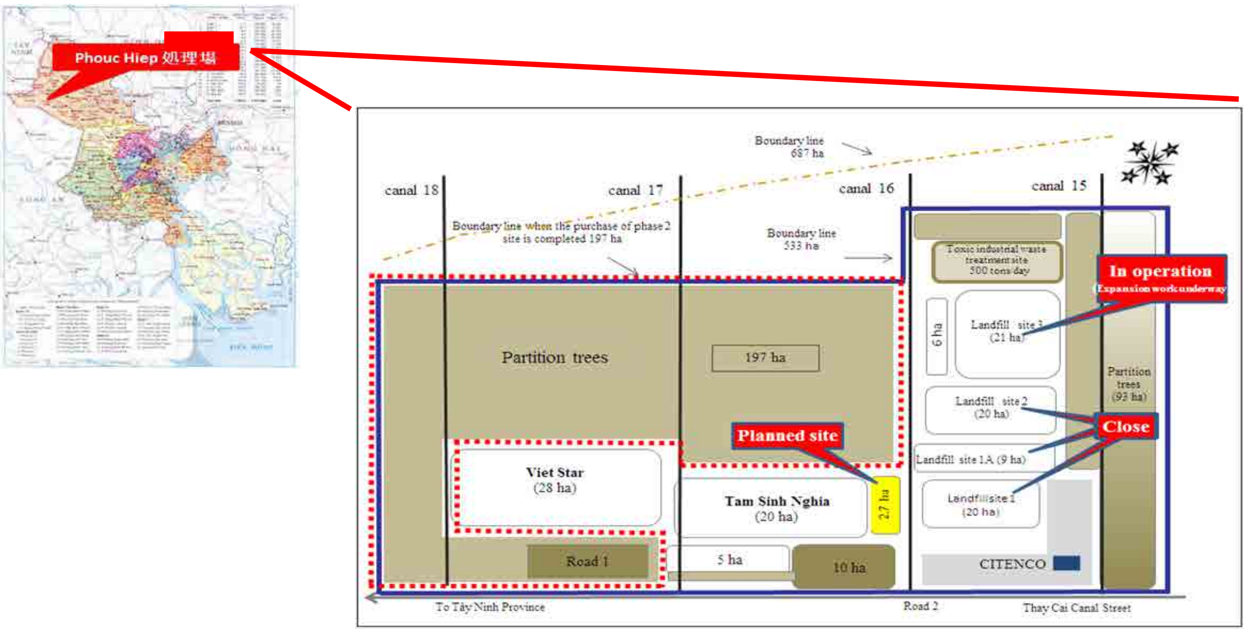
CITENCO, a public corporation run by Ho Chi Minh City, becomes in charge of collecting and transporting non-industrial waste, sorted waste, and dug-up waste. A generator of compost residue (Viet Star in this project) is to collect and transport compost residue.

When we discussed it with DONRE, CITEMCO is responsible for transferring the residue of waste and fly ash etc. because all types of wastes are under the control of DONRE. As for its expense, it referred that Ho Chi

Minh City pays it, which CITENCO is not expected to pay. However, we have to discuss these things again and decide them by staring the project.

(3) PROJECT SITE

Northwest Solid Waste Treatment Complex is now being planned as a project site at this point. This combined waste disposal facility is located about one hour drive from the central Ho Chi Minh City. The facility includes Viet Star and Tam Sinh Nghia which are compost plants and the final disposal site of CITENCO (Phuoc Hiep Disposal Site). There is information that the final disposal site of CITENCO is closed, however an expansion work was implemented in September 2014.Therefore, it is still operating on March 19th, 2015 currently.



Source: JICA study team

Figure3-7 Locations of the Planned Project Site

3.5 APPROPRIATENESS AND SUITABILITY OF TECHNOLOGIES TO BE INTRODUCED

A stoker furnace of Hitachi Zosen Corporation is the technology to be introduced in this project. This stoker furnace has abundant experiences in operating around the world. It is generating electricity through waste incineration in stable operation in many regions. Due to these reasons, the stoker furnace is considered to be appropriate and suitable as the technology to be introduced to Vietnam in this project.

3.6 CONDITIONS OF DESIGN

(1) TARGETED WASTES

Targeted wastes to generate electricity include compost residue, sorted wastes, and dug-up wastes from landfill sites as designated by DONRE. ETM was requested to conduct hearing with Viet Star concerning compost residue and investigate ETM concerning sorted wastes and dug-up wastes. The result is described below.

Table3-9 Composition and Properties of Targeted Wastes

No.	Sources of waste	Type of waste	HHV (Cal/g)	LHV (Cal/g)	Average HHV (Cal/g)	Average LHV (Cal/g)	Average Moisture (%)	Average Ash (%ww)	Average VS (%ww)
1	**Phuoc Hiep landfill**								
	Aug-2012	new waste	1626	1285	1948	1619	62.6	8.6	28.8
	Nov-2012		1758	1413					
	Oct-2013		2109	1774					
	Jan-2014		2297	2001					
	May-2014		1949	1622					
	Jan-2013(1)		1369	987	1369	987			
2	**Dong Thanh Landfill**(2)	landfilled waste	-	-	427	401	56.0	24.0	20.0
3	**Go Cat Landfill**(3)	landfilled waste	-	-	2217	1935	52.0	19.3	28.7
4	**District 1**	3R	-	-	1456	1134	59.9	16.8	23.3
					4336*	4150*	35.4	10.8	54.6
5	**Vietstar Company**								
	Before composting	Before and after composting	-	-	3902	3657	45.0	12.0	43.0
	After composting		-	-	2515	2303	39.0	19.0	42.0

Note:(1) This sample is analyzed mixedheating value sample without analyzing heating value of each composition;
(2)Calculated by data from HCMC's DONRE, 2007;
(3) Sampling at cell 3 and cell 4, at a depth of 1.0 – 5.5m;
(*)The heating value of mixed sample of high heating value components;
HHV: Higher heating value;
LHV: Lower heating value.

Source: Extracted from reports of ETM

1) Compost residue

Compost residue of Viet Star was investigated. The result is described in 5 above. The investigation found that the compost residue had 2,303cal/g, which was enough for a project to generate electricity from burning wastes.

As of the concept of tipping fee for the compost residue, the tipping fee paid to a composting firm upon composting is limited to "the amount reduced through composting," while no payment occurs to compost residue. Therefore, the payment of tipping fee for compost residue does not mean double payment for Ho Chi Minh City.

2) Sorted waste

Sorted wastes are described in 4 above. The calorific value of sorted waste when wastes are sorted to extract wastes suitable for incineration is 4,150cal/g which is extremely high.

3) Dug-up waste

Dug-up waste is described in 2 and 3 above. Both has stopped accepting wastes. Dong Thanh Disposal Site closed about 13 years ago, and a considerable amount of deposit has accumulated. Thus, the site does not have much problem such as odor. Meanwhile, Go Cat Disposal Site closed about five years ago, meaning it is relatively new, and the site has problems such as odor and leaching. When DONRE says dug-up waste, it probably refers to Go Cat Disposal Site. In such case, the waste has 1,935cal/g, which is sufficient.

Under such circumstances, instructions by DONRE are to be received concerning wastes to run the business. Meanwhile, targeted wastes are set as follows by assuming that sorted waste accounts for about 60%, compost residue about 30%, and dug-up waste about 10% based on hearings and investigations. A basic requirement concerning waste is that an assurance must be obtained from People's Committee of Ho Chi Minh City to provide a certain amount of waste to be treated. This matter is going to be finalized through the submission of FS and negotiation concerning permissions.

Table3-10 Physical Composition of Wastes to be used for Power Generation

Category	Physical composition (based on wet weight %)
Kitchen waste	50.77
Shells and bones	1.13
Paper	2.93
Diaper	5.53
Plastic	19.97
Fiber	12.86
Wooden chip	1.02
Rubbers and leathers	3.17
Metals	0.64
Noncombustibles	1.76
Others	0.23

Source: JICA study team

Table3-11 Three Components, Lower Heating Value, and Elementary Composition of Wastes to be used for Power Generation

Category		Unit	Standard waste
Moisture		(%)	56.2
Combustible content		(%)	38.6
Ash content		(%)	5.2
Lower heating value		(kJ/kg)	8,080
		(kcal/kg)	1,930
Elementary composition	Carbon	(%)	53.80
	Hydrogen	(%)	8.17
	Oxygen	(%)	36.07
	Sulfur	(%)	0.10
	Nitrogen	(%)	1.45
	Chlorine	(%)	0.41

*1 Elementary composition indicates combustible contents.
*2 1 kcal is computed as 4.1868 kJ.
*3 Sulfur indicates combustible sulfur.
Source: JICA study team

(2) REQUIREMENTS CONCERNING FACILITIES

1) Overview of waste-to-energy plant plan

The facility incinerates 600 tons/day (300 tons/day in two furnaces) of waste. The waste heat generated upon incineration is collected by boilers to be used for generating power using steam turbines. The generated power is used within the facility, while surplus power is sold to a power company. Among facilities shared among the two furnaces, backup units are being planned for important systems, equipment, and pumps. Important facilities are described in detail below.

2) Waste system

Wastes transported by refuse trucks are weighed with weigh machine. The wastes are then dumped into waste pit and shifted and stirred by waste crane. The waste crane then relocates the wastes inside the waste pit from waste hopper to an incinerator. The wastes are completely burned as they gradually move above a fire grate and go through drying and combustion processes.

3) Incineration gas system

The incineration gas is absorbed through the waste pit, and odorous components generated from wastes are decomposed in the incinerator. The pressure inside the waste pit is kept negative to prevent the gas from being released to the outside. The temperature of the combustion gas needs to be kept high when the quality of waste is bad and low when the quality is good. The temperature is controlled by adjusting the flow of room-temperature air which flows through the bypass between a steam air preheater and the gas air heater. A system to be adopted is capable of properly adjusting the air absorbed by a primary air blower to a suitable temperature for combustion depending on the quality of a given waste and increasing the temperature up to 300°C when low-quality wastes with high moisture are injected.

A secondary air blower absorbs the secondary combustion gas from an incinerator area. A steam secondary air preheater is also in place in the secondary combustion gas line to control the temperature depending on the quality of wastes. The secondary combustion air is blown into the incinerator to prevent excessive increase of the temperature in the incinerator and to keep stable combustion by efficiently mixing and burning incompletely burned gases.

4) Exhaust gas system

Hot combustion gas generated through burning wastes is cooled in a boiler, and the heat is recovered at the same time. Exhaust gas emitted from a boiler and economizer is processed in a cooling tower to remove toxic gases and cooled to a proper temperature. Soot and dust are then removed from the exhaust gas with a bag filter. Calcium hydroxide is sprayed on a flue immediately before the exhaust gas passes through the bag filter to neutralize and remove acid gases such as hydrogen chloride and sulfur oxide. Activated carbon is also blown into this area to absorb and remove gaseous dioxins in the exhaust gas. This exhaust gas treatment system properly treats exhaust gas, which is emitted from a chimney stack via an induced draft fan.

5) Ash system

The ash generated after burning wastes is stored in a bottom ash storage yard via an ash drop-tube and a bottom ash transportation system. The stored bottom ash is stored neatly with a shovel loader and then loaded on trucks and transported to the outside. Collected dust emitted from bag filters and other sections is sent to a fly ash silo with a fly ash conveyor and solidified with cement to prevent scattering before being transported to the outside.

6) Fuel system

This system uses fuel (light oil) for launching the operation of the incinerator, temperature control inside the incinerator upon launching, increasing the incinerator temperature when the temperature drops, and as the fuel of emergency power generator.

7) Steam and condensate system

All steam sent from the boiler is heated in the heater and sent to a high-pressure steam receiver. A part of the high-pressure steam is used as a process steam of the steam air preheater to increase the temperature of combustion air.

Surplus steam is sent to a steam turbine for power generation. A condensing extraction turbine is used in the steam turbine. Emitted steam is cooled and condensed in air-cooling low-pressure evaporative condenser and sent to a deaerator via a condensate tank. Condensate water is also collected from the process steam and sent to a deaerator. The condensate water re-circulates the system from the deaerator as boiler feed water. Pure water is supplied from a pure water system to compensate for the loss within the circulation system.

8) Feed water and wastewater system

Tap water is received for domestic water use and supplied to necessary sections using directly connected systems with pressure pumps for domestic water use. Well water is planned to be used as plant water. The well water is stored in a plant water receiving tank and supplied to necessary sections within the facility by plant water pumps. The plant water receiving tank has necessary functions and capacity to be used as a fire tank as well.

Equipment cooling water is pumped up to an equipment cooling water tower with an equipment cooling water pump and cooled to a necessary temperature. The cooling water is then supplied to equipment to be cooled. After cooling necessary equipment, the cooling water returns to an equipment cooling water tank for recirculation. The reused water is stored in the reuse tank and supplied to necessary sections which use the water as spray water to cool exhaust gases and the bottom ash.

3.7 FACILITY DESIGN OVERVIEW

(1) OVERALL ARRANGEMENT PLAN

Diagrams below describe the arrangement of waste-to-energy facilities.

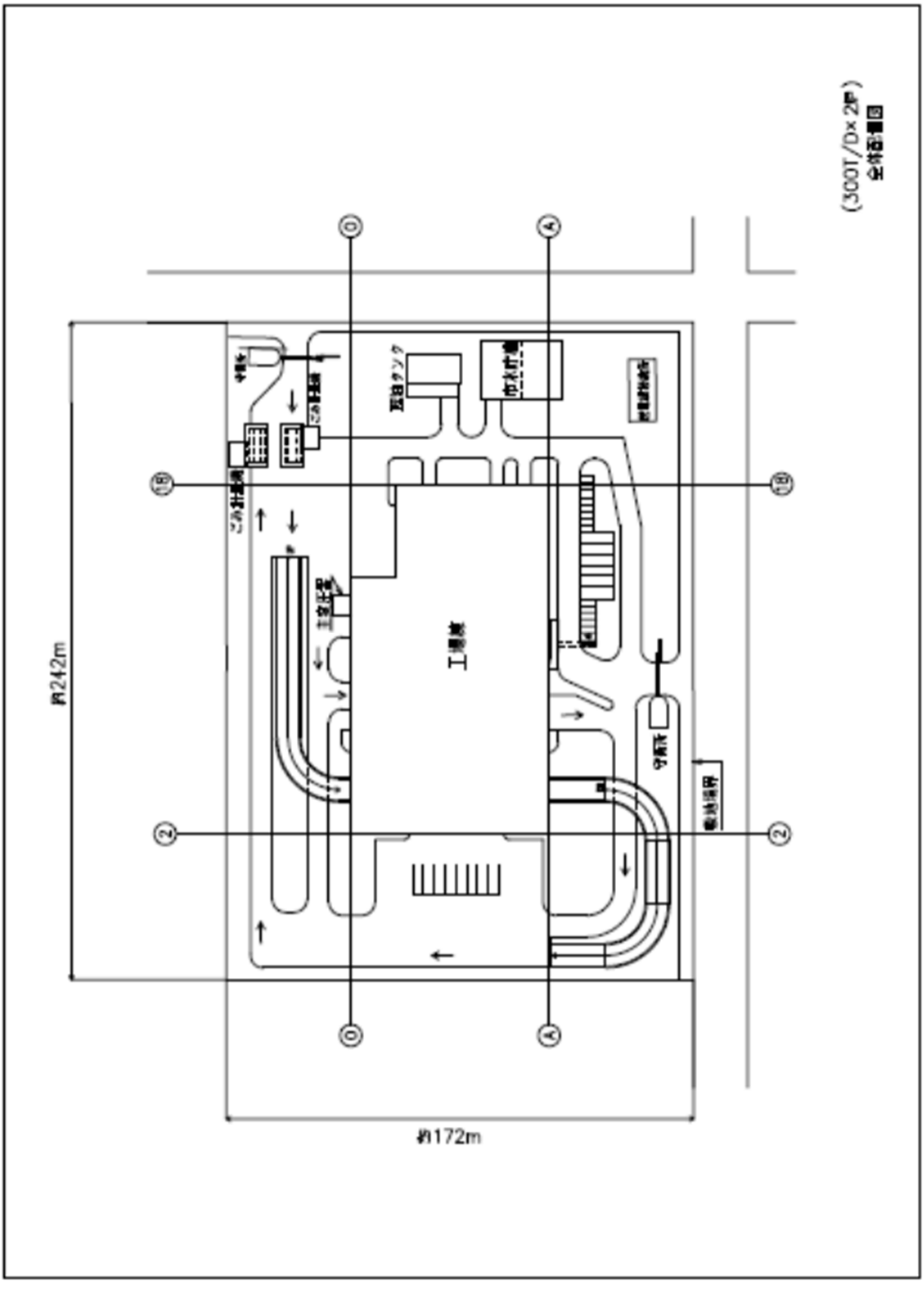


Figure3-8 Overall Arrangement

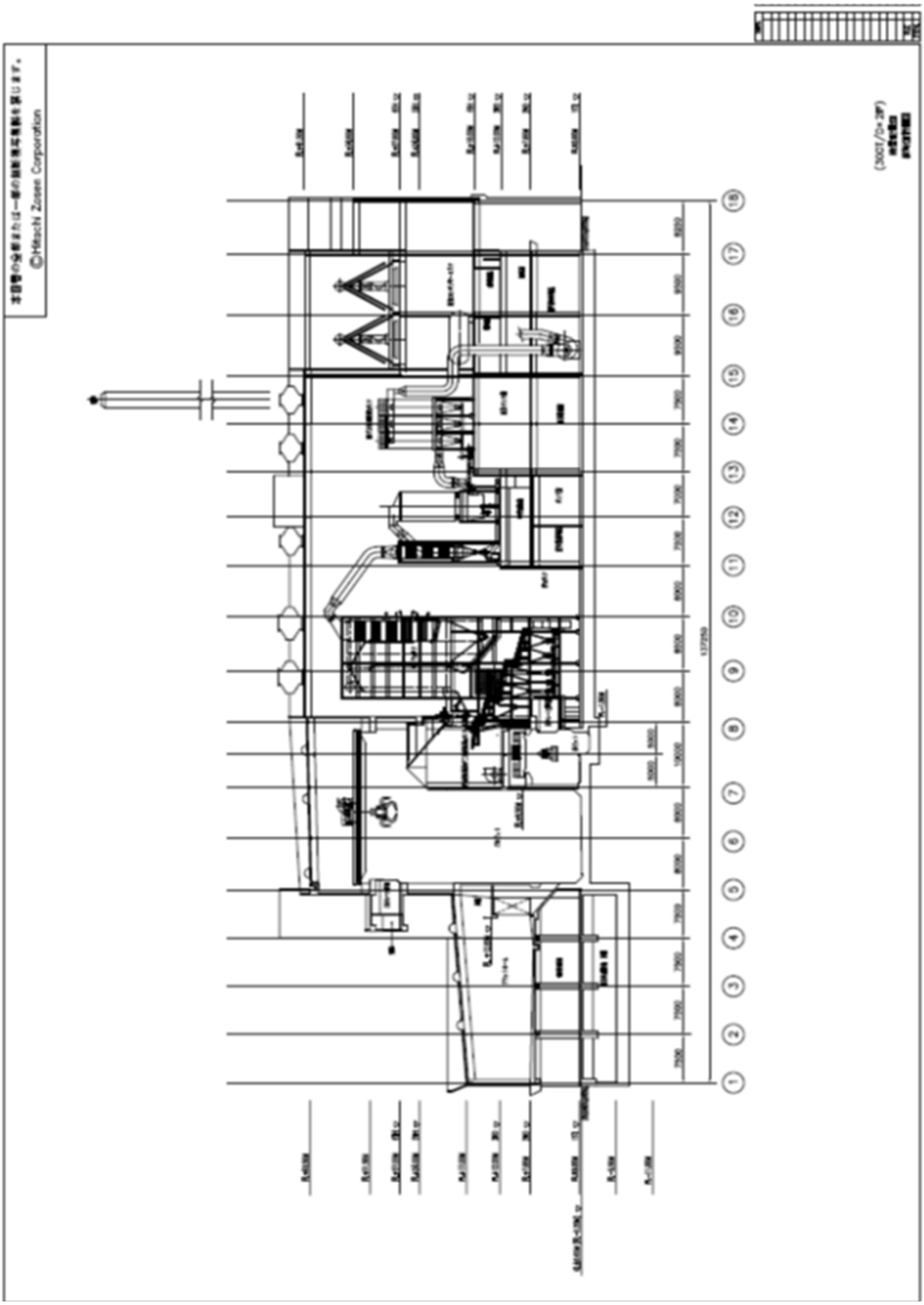


Figure3-9 Arrangement of Equipment (Side view)

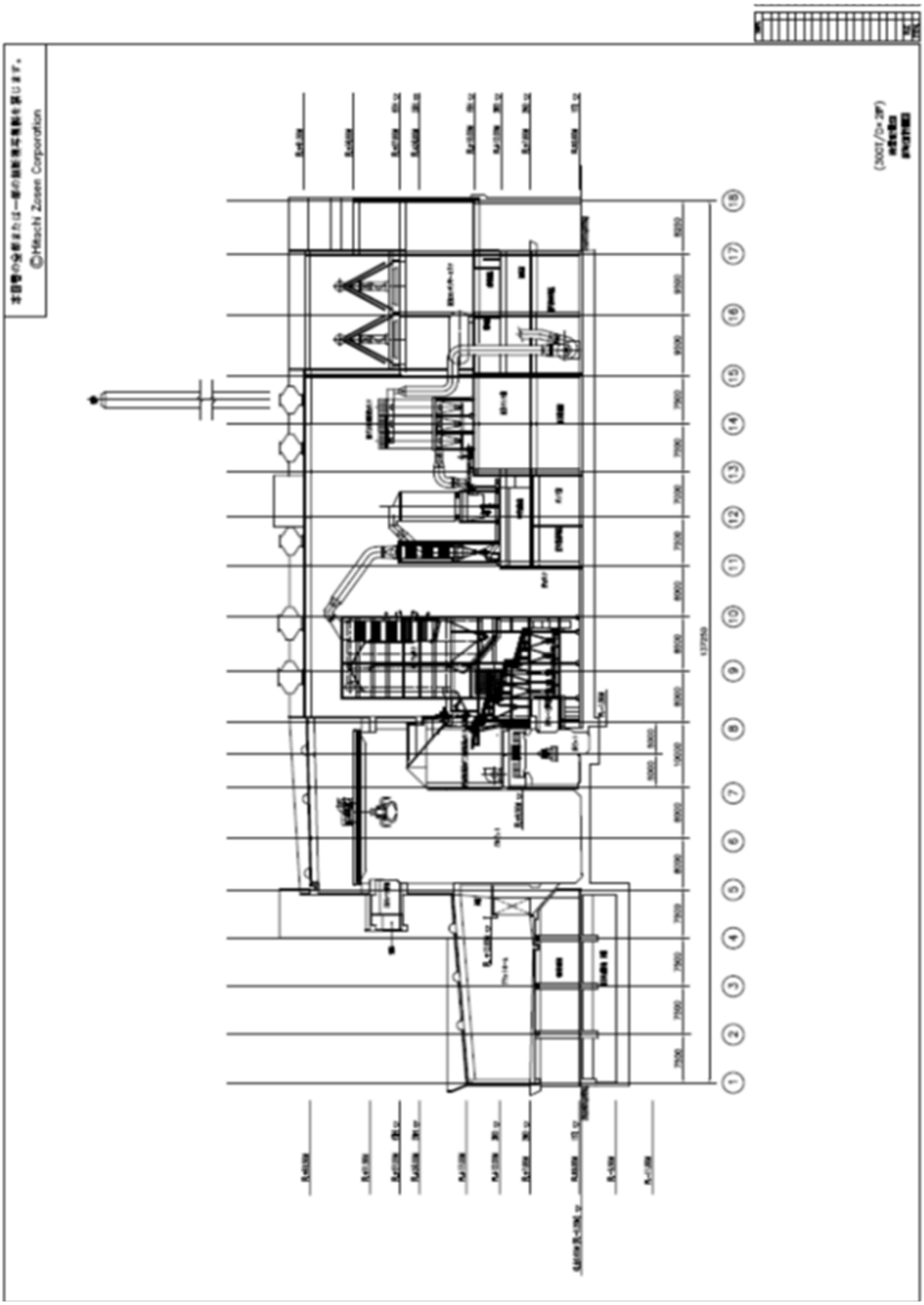


Figure3-10 Arrangement of Equipment (Ground level)

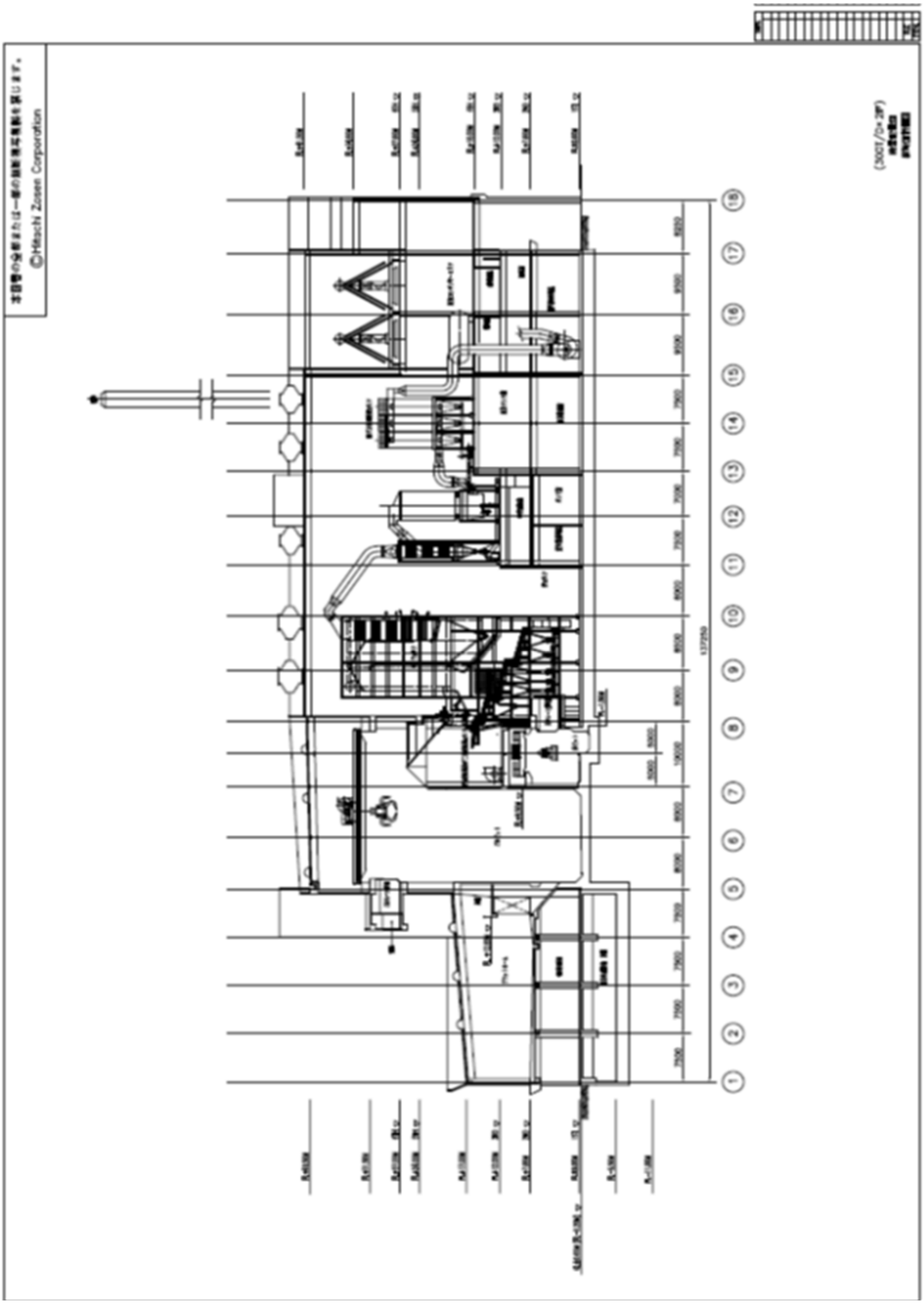


Figure3-11 Arrangement of Equipment (Second floor)

(2) INCINERATION PROCESS FLOW

Diagrams below describe the flow sheet of waste-to-energy facilities.

- Figure 3-12: Waste, Exhaust gas, and Ash Flow Sheet
- Figure 3-13: Exhaust Gas Treatment Flow Sheet
- Figure 3-14: Boiler and Condensate Water Flow Sheet

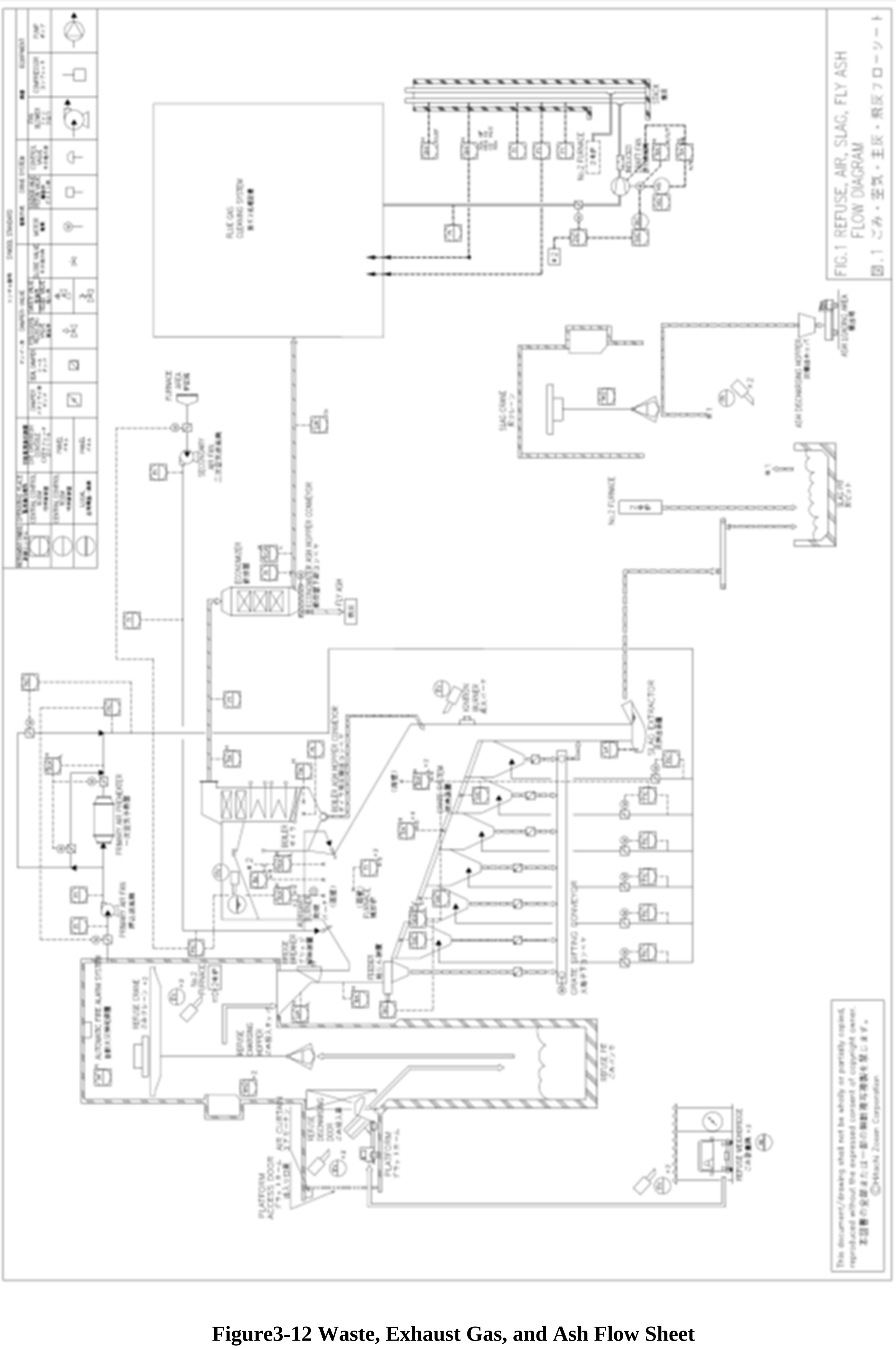


Figure3-12 Waste, Exhaust Gas, and Ash Flow Sheet

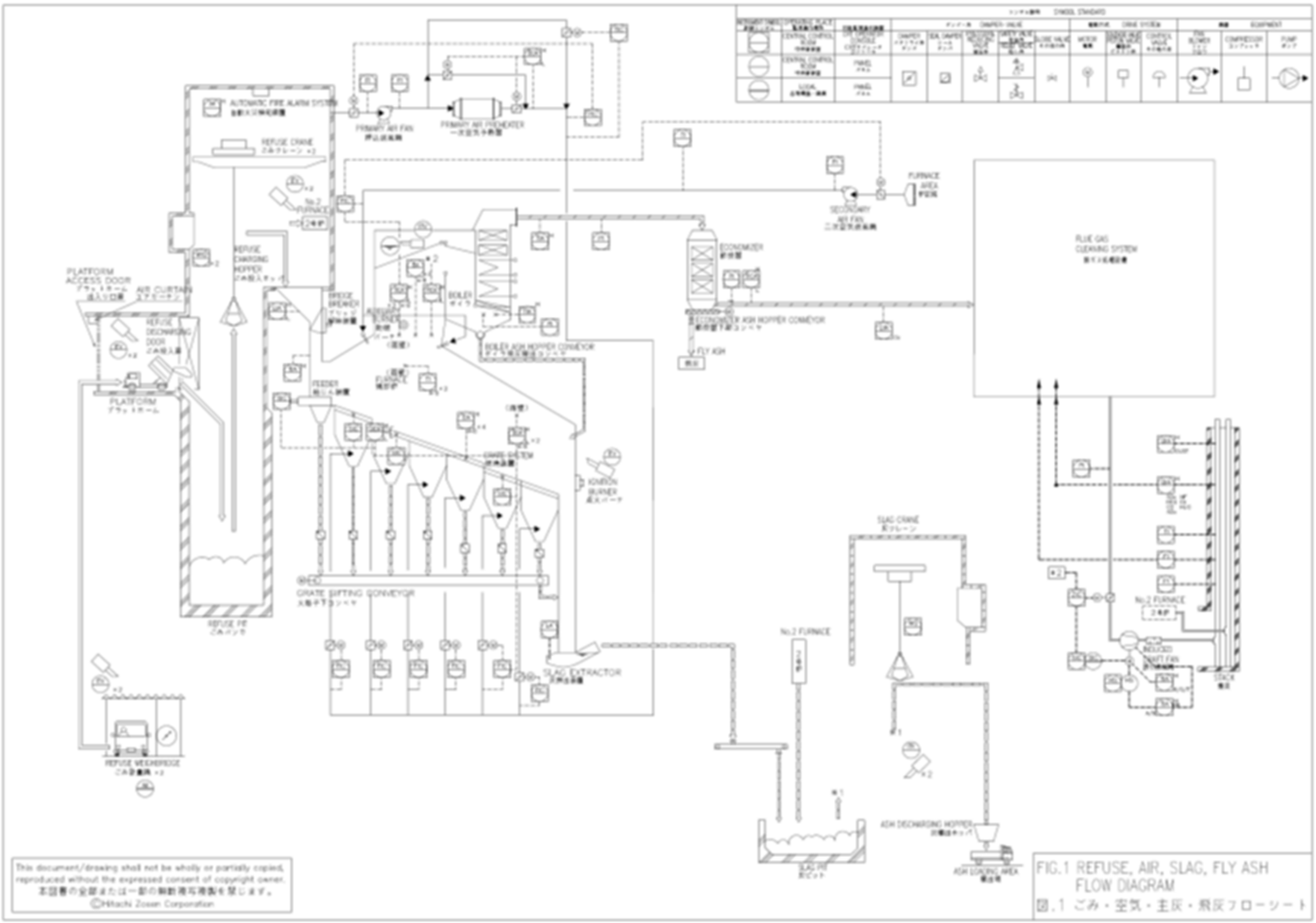


Figure3-13 Exhaust Gas Treatment Flow Sheet

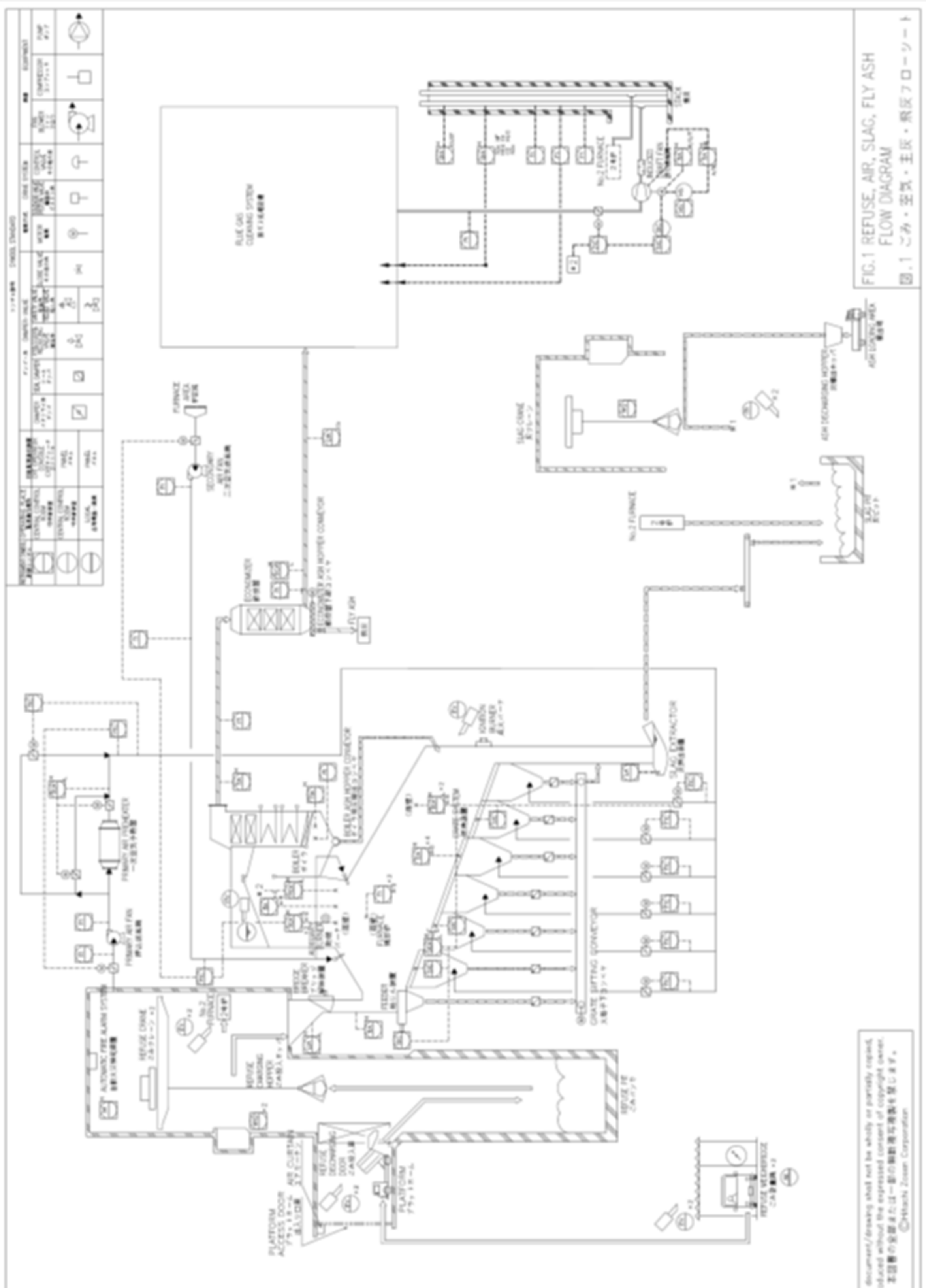


Figure3-14 Boiler and Condensate Water Flow Sheet

CHAPTER 4 FEASIBILITY OF PPP INFRASTRUCTURE PROJECT

4.1 RISKS OF THE PROJECT

(1) SUMMARY OF RISKS ASSOCIATED WITH THIS BUSINESS

Expected risks of this business are listed below.

Table4-1 List of Expected Risks

Types of risks	
Risks concerning sponsors	Poor business performance or bankruptcy of Japanese companies or local companies which are expected to become sponsors causes inability to receive funds from them and run the business.
Risks concerning fundraising	Inability to receive expected financing or subsidy
Risks concerning the completion of construction	Delay in construction schedule caused by poor management of local contractors
Technical risks	Inability to achieve expected results due to incomplete technologies
Risks concerning operation	Inability to run operation as expected after completing construction
Market risks	Inability to collect expected wastes. Inability to sell wastes at expected tipping fee or electricity at expected unit price.
Environmental risks	Negative effects on the surrounding environment caused by waste-to-energy generation
Risks concerning related infrastructures and utilities	Inability to receive the supply of utilities such as electricity and water
Risks concerning accidents and disasters	Inability to implement construction due to accident or disaster
Others	Changes to regulations or systems concerning the business

Source: JICA study team

(2) RESPONSES TO INDIVIDUAL RISKS

1) Risks concerning sponsors

Avoid risks as much as possible by identifying conditions of applicable companies in advance using D&B report or other means. Negotiate with other parties to include clauses in contracts to enable us to terminate the contract and claim compensation for damages in case the business enters into a crisis.

2) Risks concerning fundraising

Regularly contact Ministry of the Environment and secretariat (GEC this year) and describe details of this project and investigate necessary requirements to smoothly receive JCM fund.

We have already described this project a few times to both parties and received positive responses. We are going to regularly provide descriptions and check necessary matters until details are determined.

3) Risks concerning the completion of construction

It is considered that add Kobelco Eco-Solutions Vietnam, which has been running business in this region since the establishment in 2010 and experienced many local constructions and operations, to our team to supervise local vendors and avoid risks concerning the completion of the construction as much as possible.

4) Technical risks

Stoker furnace is a highly reliable technology of which about 1,000 facilities are in service for more than 40 years. Among them, Hitachi Zosen Corporation has the experience in constructing more than 500 stoker furnaces in Japan and overseas. Technical risks can be avoided by using the stoker furnace of Hitachi Zosen Corporation. Kobelco Eco-Solutions also has the experience in selling about 30 fluidized bed furnaces, which is also a highly reliable technology, and there is no problem with using this technology.

5) Risks concerning operation

Avoid risks concerning operation as much as possible by planning the operation by Kobelco Eco-Solutions Vietnam which has the experiences described above. During the commissioning, Japanese SV educate Kobelco Eco-Solutions Vietnam, and then Kobelco Eco-Solutions Vietnam learns how to operate. It is considered that risks concerning operation are lower by doing so.

6) Market risks

Negotiate with Ho Chi Minh City to warrant the supply of wastes. Also negotiate with Ho Chi Minh City to obtain a long-term contract on the tipping fee. Twenty-year purchase warrant for the unit price of selling electricity is determined by the Ordinance of Prime Minister. A contract is to be concluded with EVN based on the determined purchase price.

7) Environmental risks

Avoid environmental risks as much as possible by using above technologies which are highly reliable in Japan and operating properly.

8) Risks concerning related infrastructures and utilities

Water is abundant and there is no concern, since a canal is flowing near the project site, and the region has abundant groundwater. In terms of electricity, high-voltage power cable is necessary when selling electricity.

This matter is under investigation. It is considered that a support from Ho Chi Minh City may be requested if necessary.

9) Risks concerning accidents and disasters

It is consider that avoid risks concerning accidents and disaster as much as possible by planning the supervision by Kobelco Eco-Solutions Vietnam which has the experiences described above. Specifically, Kobelco Eco-Solutions Vietnam plans the construction procedure which is suitable for constructing in Vietnam based on the construction procedure and a track record in Japan. Moreover, abundant human resources about experiencing construction management are mobilized, and then safety controllers are stationed and they manage it thoroughly. They also have any measures to prevent the work delay by taking drainage measures and the proper work procedure.

10) Others

A business was initially planned to be started by completing ordinary procedures. Yet, a so-called new PPP law was enacted, and procedures based on the new PPP law are going to be investigated. Another investigation is also going to be conducted to see whether the business can be launched without using the new PPP law.

4.2 FUNDRAISING PLAN

(1) EXPLORATION OF GOVERNMENT AID PROGRAMS

Unlike Japan, U.S., or European countries, the price of selling electricity and process cost are low in Vietnam, and exploration of government aid programs is necessary. Thus, government aid programs are being explored as follows.

1) Aspects related to JCM of Ministry of the Environment

The following two subsidies related to JCM of Ministry of the Environment are examined.

“the following two subsidies related to JCM of Ministry of the Environment are examined. Cost are low in Vietnam, and exploration of government be used since Vietnam is applicable. This subsidy provides half of the initial cost of a project. Yet, a basic rule of this subsidy is to start business within three years. Thus, this program needs to be used carefully when running a project with a long-term construction period such as the construction of a waste-to-energy plant.

Meanwhile, two subsidies related to JCM of Ministry of the Environment are examined. Cost are low in Vietnam, and exploration of government be used since Vietnam is applicable the use of shared fund with JICA. Although this subsidy program is targeted to a fuzzy target that is half the cost of “equipment which contributes to reduce CO2 emissions,” this program is suitable for this business because (i) it allows simultaneous use of the subsidy of Ministry of the Environment and JICA financing and that the period of implementation is within five years, which is slightly longer than "Facility Aid Program for Projects based on Bilateral Credit System."

Table4-2 Overview of the JCM-Related Subsidy Systems of Ministry of Environment

Names of systems	Facility Aid Program for JCM Project	Cooperative Fund Aid Program for Assistant Project JICA etc.
Source of budget	Office of Market Mechanism, Climate Change Policy Division, Global Environment Bureau, Ministry of the Environment	International Cooperation Office, International Strategy Division, Global Environment Bureau, Ministry of the Environment
Executing organizations	Global Environment Centre Foundation (GEC)	Global Environment Centre Foundation (GEC)
Objectives and overview	This program is intended to help for introducing the facility and equipment to reduce the emissions of CO2 from energies using advanced low carbon technologies in developing countries which are expected to introduce JCM.	For JCM project which is cooperate with project JICA etc. help, it is to help the project to reduce the emission of CO2, spread the advanced low carbon technology, and promote low carbonization in the wider field than before.
Upper limit of the budget	Half of the cost associated with equipment to which subsidy is granted (listed below) (a) Main construction cost, (b) peripheral construction cost, (c) cost of machineries and equipment, (d) cost of measurement and test, (e) cost of facilities, (f) cost of official procedures, and (g) other necessary costs which are approved by the Centre	Half of the cost of whichever the smaller in the comparison between the applicable cost to which the subsidy is granted and the standard cost notified by the Association
Total budget	2.4 billion yen per year and 3-year (total 7.2 billion yen) *To be increased to 9.0 billion yen in FY2015	1.8 billion yen per year and 4-year (total 7.2 billion yen)
Targeted businesses and fields	Development of facilities which enable a business to reduce CO2 emissions from energy uses	Projects to reduce the emissions of greenhouse gases by cooperating with projects which are receiving JICA overseas investment or loan

Source: JICA study team

2) Aspects concerning NEDO

The following two aspects are examined concerning the NEDO subsidy.

Both of these are demonstration projects. A characteristic of these projects is that the ownership once belongs to NEDO, followed by a purchase by the business owner ("Demonstration Project of International Energy Consumption Efficiency Technology and System Demonstration Project" includes voluntary disposition from NEDO to the national government of the counterpart or other organizations.).

"Both of these are demonstration projects. A characteristic of these projects is that the ownership once belongs to NEDO, followed by a purchase by the business owner ("Demonstrrogram can be used for Vietnam. A new aspect of this program is that it requires the project to involve "operations which have not been commercially wide-spread in a target country." Waste-to-energy plants have not been commercially wide-spread yet in Vietnam.

Meanwhile, these are demonstration projects. A characteristic of these projects is that the ownership once belongs to NEDO, followed by a purchase by the business owner ("Demonstrrogram can be used for Vietnam. A new aspect of this program is that it reqno problem in eligibility.

In terms of the subsidy of this project, however, applicable ministry (government organization) of the target country needs to conclude MOU with NEDO.

Table4-3 Overview of NEDO-Related Subsidy Projects

Names of systems	Demonstration Project of International Energy Consumption Efficiency Technology and System	Global Warming Mitigation Technology Promotion Project (JCM)
Objectives and overview	- To demonstrate technologies and systems outside of Japan based on various needs, energy policies, and regulations of different countries by using established technologies of Japan as the core tool - In addition to the demonstration of technologies, lead a project to acquire profit by selling Japanese technologies and systems after the demonstration to lead a project to ensure energy security of Japan, promote environmental measures, accelerate overseas operations of the energy industry, and cultivation of markets.	- Accelerate the spread and deregulation activities of advanced low-carbon technologies, products, systems, services, and infrastructures to help developing countries of implement sustainable development. - Apply the methodologies of measurement, report, and verification (MRV) to the contribution of Japan on reducing and absorbing greenhouse emissions to quantitatively and properly evaluate the contribution to use it to achieve the emission goal of Japan.
Upper limit of the budget	Total cost of labor cost, expenses, and indirect cost	Total cost of machineries and equipment which is a main expense
Total budget	22.0 billion yen (FY2014)	6.0 billion yen (FY2014)
Period of implementation	About four years	Within three years
Targeted businesses and fields	Development of facilities which enable a business to reduce CO2 emissions from energy uses	Projects to reduce the emissions of greenhouse gases by cooperating with projects which are receiving JICA overseas investment or loan
After completion	A commissioned business purchases demonstration facilities, or NEDO transfers the facilities to the national government of the counterpart without a charge.	The commissioned business purchases demonstration facilities as a basic rule.
Targeted countries	No limit	Countries which signed JCM bilateral document

Source: JICA study team

3) JICA overseas loan

The overview of JICA overseas loan is described below.

Table4-4 Overview of JICA Overseas Loan

Names of systems	Overseas loan
Administration	Japan International Cooperation Agency (JICA)
Objectives and overview	Overseas investment and loan are effective for promoting the development implemented by private companies and other organizations in developing countries as the overseas economic assistance project of Japan International Cooperation Agency (JICA). It also supports projects through two financial aspects including "investment" and "loan" when projects face financial difficulties when working with ordinary banks alone.
Upper limit of the budget	- Loan Ratio of loan: 70% (up to 80%) Redemption period: 20 years (up to 25 years) - Investment Direct investment in local companies or organizations The investment ratio is 25% or less.
Period of application	Any time
Currency to be loaned	JPY or USD: Two-step loan via local banks may be used for currencies of developing countries.
Targeted businesses and fields	1. Acceleration of infrastructures and growth 2. Reduction of MDGs and poverty 3. Alleviation of climate change
Targeted countries	Targeted ODA countries
URL	http://www.jica.go.jp/activities/schemes/finance_co/loan/

Source: JICA study team

(2) FUNDRAISING

As described above, unlike Japan, U.S., or European countries, the price of selling electricity and process cost are low in Vietnam. Thus, an exploration of government aid programs is necessary to run businesses.

Multiple briefing sessions concerning this project and hearing concerning subsidy were held with Global Environment Centre Foundation (GEC) and Low Carbon Society Promotion Association. As a result, “Subsidy Fund for Leapfrog Type Development,” a joint fund of JICA and Ministry of the Environment, is considered as a program to use due to the following two reasons: (1) The project is targeted to plants with a long construction period; and (2) Both subsidy and loan can be used.

A total cost of the project is estimated to be 62.50 million USD, among which 57.50 million USD is expected as EPC cost. Fund is planned to be raised as follows: two-step loan involving 30% of the EPC cost (17.25 million USD) from JCM facility subsidy and remaining 40% from a local bank (banks) mediated by JICA, in addition to 30% capital fund. There is a necessity to contact local banks and investigate conditions to use the two-step loan.

This subsidy program last year received three applicants, of which one was accepted. This means that there are only a few applicants in comparison to the size of the subsidy in this program. We are now contacting Ministry of the Environment and the secretariat. They said that the application is now in progress, and details cannot be described. We have visited Ministry of the Environment two to three times last year to describe the project and GEC (Osaka) five to six times and received good responses from both parties.

In terms of the capital fund, Kobelco Eco-Solutions and Japanese partner (or local partner in some cases) are expected to provide a joint fund.

4.3 FINANCIAL ANALYSIS OF THE PROJECT

(1) COST OF THE PROJECT

The stoker furnace of Hitachi Zosen Corporation with the capacity of 600 tons/day (two furnaces with 300 tons/day) is being planned to be installed. The expected EPC cost is 57.50 million USD. In addition, the expense of five million USD is expected before the start of the project. Thus, the total cost of the project is expected to become 62.50 million USD. Meanwhile, the expected amount of subsidy is 17.25 million USD which is 30% of EPC. The expected capital fund is 13.575 million USD which is 30%.It is expected that the remaining 40%, or 31.675 million USD is borrowed as a loan.It is also expected to be acquired from the JICA overseas loan.

(2) UNIT COST OF COMMISSIONED PROCESSING

As a result of hearing at DONRE, processing firm in Ho Chi Minh City, and public companies, the unit cost of commissioned processing is now 20.3 USD/ton. DONRE mentioned that the unit cost of commissioned processing was 25 to 30 USD for "waste-to-energy project" in the meeting. This indicates that the understanding on waste-to-energy operation is steadily spreading. The unit cost is set as 26 USD/ton in this process. In terms of price hike rate, the consumer price index is increasing at the rate of 5.2% a year, which may be set as an annual rate. Yet, the price is set to increase by 5% every three years in this process, since the public fees in Vietnam are often increased every few years by taking into account of CPI.

The price of 26 USD/ton is high in comparison to the current price. Thus, the price is going to be negotiated with DONRE in the future.

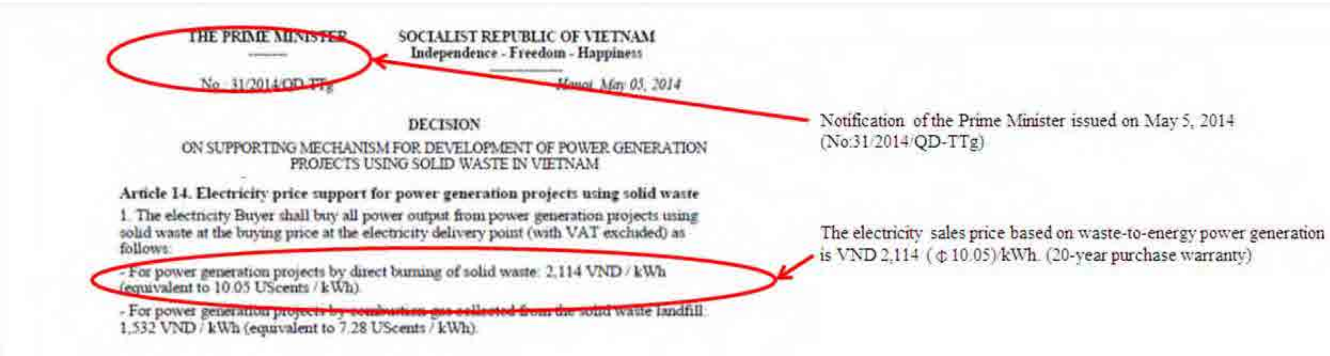
Table4-5 Unit Cost of Processing

	Company name	Category	T/F	Processing capacit
1	Tam Sinh Nghia	Composting/incin	20.3$/t	1,000 t/d
2	Viet Star	Composting	20$/t	1,200 t/d
3	Vietnam Waste Solutions	Landfill	20$/t	3,000 t/d
4	CITENCO	Landfill	17$/t	2,000 t/d

Source: JICA study team

(3) SALES RATE OF ELECTRICITY

The sales rate of electricity generated by a waste-to-energy plant is 10.05 UScents/kWh as a fixed rate for 20 years in accordance with the notification of Prime Minister No31/2014/QD-TTg issued on May 5, 2014. The same concept as the unit cost of commissioned processing is adopted for the rate of increase in price. Meanwhile, EVN TARRIF is raised by 7.5% in average starting March 16, 2015.



Source: Extracted from the notification of Prime Minister No31/2014/QD-TTg

Figure4-1 Setup of Sales Price of Electricity

(4) OPERATION, UTILITIES, AND COST

Four-team, three-shift system is adopted as the operation system with five members in each team. The total number of people in the system becomes 46 including supervisors and office staff. Japanese SVs will be assigned at the start of the operation. The operation system will be developed to be run only by local staff in the future.

The expected cost of this operation is 7.23 million USD for the first year, and the ratio of cost increase is expected to be 5% until the sixth year and 3% for years after that.

Fuels include light oil for launching the plant, prevention of corrosion in boilers, production of pure water for boilers, and chemical agents for exhaust gases. Well water is going to be used in plants, and tap water for domestic water use. These costs are expected to be 8.44 USD/ton.

Clasue7 on Article 19 REGULATIONS ON COLLECTION OF LAND RENT AND WATER SURFACE RENT (No: 46/2014/ND-CP) says that the project site is free loan for environmental field. DONRE also confirms it but it is unofficial. So no cost is expected to occur.

Table4-6 Assumptions Concerning Financial Analysis

Category	Conditions	Remarks
Business period	20 years	BOT agreement with Ho Chi Minh City
Amount of waste to be processed	600 t/d	300 days x 24 hours = 7,200 hours of operation
Waste treatment consignment fee (T/F)	26 USD/ton *raised by 5% every three years	
Amount of electricity to sell	64,800,000 kWh/year	Electricity sales capacity 9.0 MW x 7,200 hours
Electricity sales price	10.05 USCent/kWh *raised by 5% every three years	The Notification of Prime Minister No31/2014/QD-TTg issued on May 5, 2014
Depreciation	20 years for civil engineering and seven years for machineries and electric works	Fixed rate method
Taxes and dues	Exemption of corporate tax for four years after generating profit (0%) Favorable tax rate for up to 13 years after generating profit x 50% tax discount (5%) Favorable tax rate for up to 15 years after generating income (10%) Standard tax rate until 20th year (20%)	Favorable treatment in specifically encouraged field of investment
Debt	Based on VND, 10% annual rate	Local banks
Fluctuation of commodity prices	Cost of hiring local people, 5% inflation for commodities	

Source: JICA study team

(5) RESULT OF FINANCIAL ANALYSIS

Result of financial analysis computed based on above assumptions is described below.

The expected construction period of the plant is three years. The rate of operation is going to be gradually increased from 80% in the first year of operation and 85% in the second year. The operation rate is expected to become 100% in the sixth year and after that.

As a result, the project IRR becomes 14.73% and the equity IRR 19.88%.

Table 4-7 Result of Financial Analysis

HCMC MSW Treatment Project (Stoker 300t/d x 2)

Loan Agreement — Construction Period (Year -3 to Year -1) — 1st Installment (Year 1)

(Unit US$)

Project Year		Year -3	Year -2	Year -1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10
Calendar Year		2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028
MSW Treatment Capacity					480 ton/day	510 ton/day	540 ton/day	552 ton/day	570 ton/day	600 ton/day	600 ton/day	600 ton/day	600 ton/day	600 ton/day
Capacity Utilization Rate					80.0%	85.0%	90.0%	92.0%	95.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Power Generation					9,080 kW	9,648 kW	10,215 kW	10,442 kW	10,783 kW	11,350 kW	11,350 kW	11,350 kW	11,350 kW	11,350 kW
Capacity Utilization Rate					80.0%	85.0%	90.0%	92.0%	95.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Price Increase Rate for Treatment Fee					5.0%	0.0%	0.0%	5.0%	0.0%	0.0%	5.0%	0.0%	0.0%	5.0%
Accumulated Rate					5.0%	5.0%	5.0%	10.3%	10.3%	10.3%	15.8%	15.8%	15.8%	21.6%
Price Increase Rate for Power Sales					5.0%	0.0%	0.0%	5.0%	0.0%	0.0%	5.0%	0.0%	0.0%	5.0%
Accumulated Rate					5.0%	5.0%	5.0%	10.3%	10.3%	10.3%	15.8%	15.8%	15.8%	21.6%
Cost Increase Rate					5.0%	5.0%	5.0%	5.0%	5.0%	5.0%	3.0%	3.0%	3.0%	3.0%
Accumulated Rate					5.0%	10.3%	15.8%	21.6%	27.6%	34.0%	38.0%	42.2%	46.4%	50.8%
Tipping Fee (Unit Rate)	$ 26.00 /ton				$ 27.30 /ton	$ 27.30 /ton	$ 27.30 /ton	$ 28.67 /ton	$ 28.67 /ton	$ 28.67 /ton	$ 30.10 /ton	$ 30.10 /ton	$ 30.10 /ton	$ 31.60 /ton
Electricity Sales Price (Unit Rate)	¢ 10.05 /kWh				¢ 10.55 /kWh	¢ 10.55 /kWh	¢ 10.55 /kWh	¢ 11.08 /kWh	¢ 11.08 /kWh	¢ 11.08 /kWh	¢ 11.63 /kWh	¢ 11.63 /kWh	¢ 11.63 /kWh	¢ 12.22 /kWh
Gross Revenue					**9,044,519**	**9,721,395**	**10,398,270**	**11,202,471**	**11,628,902**	**12,339,621**	**12,956,602**	**12,956,602**	**12,956,602**	**13,604,432**
Tipping Fee					3,931,200	4,176,900	4,422,600	4,746,924	4,901,715	5,159,700	5,417,685	5,417,685	5,417,685	5,688,569
Electricity Sales Price					6,898,802	7,329,978	7,761,153	8,330,304	8,601,944	9,054,678	9,507,412	9,507,412	9,507,412	9,982,783
Net Electricity Sales Price					5,113,319	5,544,495	5,975,670	6,455,547	6,727,187	7,179,921	7,538,917	7,538,917	7,538,917	7,915,863
Total Cash Operation Cost					**1,974,510**	**2,088,428**	**2,204,243**	**2,276,475**	**2,365,992**	**2,488,089**	**2,517,156**	**2,547,094**	**2,577,931**	**2,609,693**
Variable Cost					3,000,843	3,076,803	3,152,763	3,272,421	3,317,997	3,393,957	3,487,695	3,487,695	3,487,695	3,586,120
Electricity Cost					1,785,483	1,785,483	1,785,483	1,874,757	1,874,757	1,874,757	1,968,495	1,968,495	1,968,495	2,066,920
Total Variable Cost less Power Cost					1,215,360	1,291,320	1,367,280	1,397,664	1,443,240	1,519,200	1,519,200	1,519,200	1,519,200	1,519,200
Fixed Cost					759,150	797,108	836,963	878,811	922,752	968,889	997,956	1,027,894	1,058,731	1,090,493
Gross Income					**7,070,009**	**7,632,967**	**8,194,027**	**8,925,996**	**9,262,911**	**9,851,532**	**10,439,446**	**10,409,508**	**10,378,671**	**10,994,739**
Project Cost	***45,250,000***	***16,961,667***	***11,326,667***	***16,961,667***										
Land Cost	*0*	*0*	*0*	*0*										
EPC Cost incl. Contingency	*40,250,000*	*15,295,000*	*9,660,000*	15,295,000										
Pre-Operation Cost (Expenses)	*5,000,000*	*1,666,667*	*1,666,667*	1,666,667										
Gross Cash Flow		-16,961,667	-11,326,667	-16,961,667	**7,070,009**	**7,632,967**	**8,194,027**	**8,925,996**	**9,262,911**	**9,851,532**	**10,439,446**	**10,409,508**	**10,378,671**	**10,994,739**
Interest Expenses for Long Term Loan (PL)		748,786	1,616,785	2,597,485	3,618,008	3,434,818	2,926,465	2,761,594	2,596,723	2,431,851	2,015,094	1,868,541	1,721,989	1,575,437
Interest Expenses for Short Term Loan		7,500	7,500	7,500										
Building depreciation					1,610,000	1,610,000	1,610,000	1,610,000	1,610,000	1,610,000	1,610,000	1,610,000	1,610,000	1,610,000
Land depreciation					0	0	0	0	0	0	0	0	0	0
Amortization on Pre-Operation Cost					0	0	0	0	0	0	0	0	0	0
CIT		0	0	0	0	0	0	0	0	0	0	340,718	346,548	352,334
Net Cash Flow after Tax		-16,969,167	-11,334,167	-16,969,167	**7,070,009**	**7,632,967**	**8,194,027**	**8,925,996**	**9,262,911**	**9,851,532**	**10,439,446**	**10,068,790**	**10,032,122**	**10,642,405**
Cumulative Net Cash Flow		-16,969,167	-28,303,333	-45,272,500	-38,202,491	-30,569,524	-22,375,497	-13,449,501	-4,186,590	**5,664,941**	**16,104,388**	**26,173,178**	**36,205,300**	**46,847,705**
NPV:Discount Rate=10%	**34,661,754**													
IRR (20 years after tax)	**14.73%**													
Payback Period (year)	**9 years**													
Working Capital	300,000	300,000	0	0										
Financing Structure	50,513,057	18,010,453	12,943,452	19,559,152										
Interest rate														
Equity for Project Cost	13,575,000	5,088,504	3,398,004	5,088,492										
Equity for IDC (0% of IDC)	0	0	0	0										
Equity advance to cover working capital	0	0	0	0										
Equity Total	**13,575,000**	5,088,504	3,398,004	5,088,492										
Cummulative Equity		5,088,504	8,486,508	13,575,000										
Loan for Project Cost	31,675,000	11,873,163	7,928,663	11,873,175										
Loan for IDC (100% of IDC)	4,963,057	748,786	1,616,785	2,597,485										
Loan for Working Capital	300,000	300,000	0	0										
Loan Total	**36,938,057**	12,921,949	9,545,448	14,470,660										
Cummulative Loan (incl. IDC*100%)		12,921,949	22,467,397	36,938,057	36,938,057	34,806,155	32,974,253	31,142,351	29,310,449	27,478,547	25,646,645	23,814,743	21,982,841	20,150,939
Principal Repayment (incl. W. C. Loan)	36,938,057				2,131,902	1,831,902	1,831,902	1,831,902	1,831,902	1,831,902	1,831,902	1,831,902	1,831,902	1,831,902
Principal Balance after Repayment		12,921,949	22,467,397	36,938,057	34,806,155	32,974,253	31,142,351	29,310,449	27,478,547	25,646,645	23,814,743	21,982,841	20,150,939	18,319,037
Interest Payment					3,618,008	3,434,818	2,926,465	2,761,594	2,596,723	2,431,851	2,015,094	1,868,541	1,721,989	1,575,437
Cash available for Shareholders		-5,844,790	-5,022,289	-7,693,477	1,320,099	2,366,247	3,435,660	4,332,500	4,834,286	5,587,778	6,592,451	6,368,347	6,478,231	7,235,066
IRR on Equity (20 years after tax)	**19.88%**													

Project Year	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20
Calendar Year	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038
MSW Treatment Capacity	600 ton/day	600 ton/day	600 ton/day	600 ton/day	600 ton/day	600 ton/day	600 ton/day	600 ton/day	600 ton/day	600 ton/day
Capacity Utilization Rate	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Power Generation	11,350 kW	11,350 kW	11,350 kW	11,350 kW	11,350 kW	11,350 kW	11,350 kW	11,350 kW	11,350 kW	11,350 kW
Capacity Utilization Rate	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%
Price Increase Rate for Treatment Fee	0.0%	0.0%	5.0%	0.0%	0.0%	5.0%	0.0%	0.0%	5.0%	0.0%
Accumulated Rate	21.6%	21.6%	27.6%	27.6%	27.6%	34.0%	34.0%	34.0%	40.7%	40.7%
Price Increase Rate for Power Sales	0.0%	0.0%	5.0%	0.0%	0.0%	5.0%	0.0%	0.0%	5.0%	0.0%
Accumulated Rate	21.6%	21.6%	27.6%	27.6%	27.6%	34.0%	34.0%	34.0%	40.7%	40.7%
Cost Increase Rate	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%	3.0%
Accumulated Rate	55.4%	60.0%	64.8%	69.8%	74.9%	80.1%	85.5%	91.1%	96.8%	102.7%
Tipping Fee (Unit Rate)	$ 31.60 /ton	$ 31.60 /ton	$ 33.18 /ton	$ 33.18 /ton	$ 33.18 /ton	$ 34.84 /ton	$ 34.84 /ton	$ 34.84 /ton	$ 36.58 /ton	$ 36.58 /ton
Electricity Sales Price (Unit Rate)	¢ 12.22 /kWh	¢ 12.22 /kWh	¢ 12.83 /kWh	¢ 12.83 /kWh	¢ 12.83 /kWh	¢ 13.47 /kWh	¢ 13.47 /kWh	¢ 13.47 /kWh	¢ 14.14 /kWh	¢ 14.14 /kWh
Gross Revenue	**13,604,432**	**13,604,432**	**14,284,654**	**14,284,654**	**14,284,654**	**14,998,886**	**14,998,886**	**14,998,886**	**15,748,831**	**15,748,831**
Tipping Fee	5,688,569	5,688,569	5,972,998	5,972,998	5,972,998	6,271,648	6,271,648	6,271,648	6,585,230	6,585,230
Electricity Sales Price	9,982,783	9,982,783	10,481,922	10,481,922	10,481,922	11,006,018	11,006,018	11,006,018	11,556,319	11,556,319
Net Electricity Sales Price	7,915,863	7,915,863	8,311,656	8,311,656	8,311,656	8,727,239	8,727,239	8,727,239	9,163,601	9,163,601
Total Cash Operation Cost	**2,642,408**	**2,676,104**	**2,710,811**	**2,746,560**	**2,783,381**	**2,821,306**	**2,860,369**	**2,900,604**	**2,942,046**	**2,984,732**
Variable Cost	3,586,120	3,586,120	3,689,466	3,689,466	3,689,466	3,797,979	3,797,979	3,797,979	3,911,918	3,911,918
Electricity Cost	2,066,920	2,066,920	2,170,266	2,170,266	2,170,266	2,278,779	2,278,779	2,278,779	2,392,718	2,392,718
Total Variable Cost less Power Cost	1,519,200	1,519,200	1,519,200	1,519,200	1,519,200	1,519,200	1,519,200	1,519,200	1,519,200	1,519,200
Fixed Cost	1,123,208	1,156,904	1,191,611	1,227,360	1,264,181	1,302,106	1,341,169	1,381,404	1,422,846	1,465,532
Gross Income	**10,962,024**	**10,928,328**	**11,573,842**	**11,538,094**	**11,501,273**	**12,177,580**	**12,138,517**	**12,098,282**	**12,806,784**	**12,764,099**
Gross Cash Flow	**10,962,024**	**10,928,328**	**11,573,842**	**11,538,094**	**11,501,273**	**12,177,580**	**12,138,517**	**12,098,282**	**12,806,784**	**12,764,099**
Interest Expenses for Long Term Loan (PL)	893,053	801,458	709,863	618,268	526,673	435,078	343,482	251,887	160,292	68,697
Building depreciation	1,610,000	1,610,000	1,610,000	1,610,000	1,610,000	1,610,000	1,610,000	1,610,000	1,610,000	1,610,000
Land depreciation	0	0	0	0	0	0	0	0	0	0
Amortization on Pre-Operation Cost	0	0	0	0	0	0	0	0	0	0
CIT	390,465	422,949	425,843	462,699	465,491	1,872,920	2,026,501	2,037,007	2,047,279	2,207,298
Net Cash Flow after Tax	**10,571,559**	**10,505,379**	**11,147,999**	**11,075,395**	**11,035,782**	**10,304,660**	**10,112,017**	**10,061,275**	**10,759,505**	**10,556,801**
Cumulative Net Cash Flow	**57,419,264**	**67,924,643**	**79,072,642**	**90,148,037**	**101,183,819**	**111,488,479**	**121,600,496**	**131,661,771**	**142,421,276**	**152,978,077**
Cummulative Loan (incl. IDC*100%)	18,319,037	16,487,135	14,655,233	12,823,331	10,991,429	9,159,527	7,327,625	5,495,723	3,663,821	1,831,919
Principal Repayment (incl. W. C. Loan)	1,831,902	1,831,902	1,831,902	1,831,902	1,831,902	1,831,902	1,831,902	1,831,902	1,831,902	1,831,919
Principal Balance after Repayment	16,487,135	14,655,233	12,823,331	10,991,429	9,159,527	7,327,625	5,495,723	3,663,821	1,831,919	(0)
Interest Payment	893,053	801,458	709,863	618,268	526,673	435,078	343,482	251,887	160,292	68,697
Cash available for Shareholders	7,846,604	7,872,019	8,606,234	8,625,225	8,677,207	8,037,681	7,936,632	7,977,486	8,767,311	8,656,184

4.4 ECONOMIC ANALYSIS

(1) ASSUMPTION FOR ECONOMIC ANALYSIS

This Project aims to expand the capacity of incinerator for burning household garbage (solid waste) that comes from daily activities in households in Ho Chi Minh City (HCM), the largest city in the southern part of Viet Nam. Implementation of this Project may result in a definite underlying improvement and preservation of environmental sanitation in HCM. In addition, this Project is designed to generate electric power using waste heat produced from disposal of municipal waste by incineration, and to deliver for EVN, the Electricity Authority of Viet Nam, the excess of electricity over the on-site use for sale.

(2) ECONOMIC EFFECTS

1) Economic effects on the improvement in environment/extension of lifetime of landfill sites

In almost of the cities including HCM, among various environmental problems concerning municipal waste, it is definitely pointed out that the problem of increase in waste generation amount becomes still more evident as a prevalent environmental issue. For example, landfill capacity has become tight more and more as an increase of waste to be disposed of in the landfill sites. Similarly, there are various environmental problems in the processing from collection, transportation, storage, intermediate treatment, to final processing. Among others, problems in the processing from construction to operation and management of landfill site shall be pointed out; such as noise pollution caused by transport vehicles coming and going to landfill sites, smell and air pollution, soil contamination, groundwater contamination by leakage of toxic substance, etc.

In HCM which is the project target city, around 7,000 – 8,000 tons of household waste is produced every day at present. It is further estimated that an increase in population and concentration will involve a bigger increase in generation amount by 2020. However, city's waste management is forced to rely on landfilling at the existing landfill sites (Phuoc Hiep and Da Phuoc Landfill Sites) on one hand and on the other hand number of registered companies who have incineration facility are limited, as a result of which the incineration capacity in HCM is limited to a few dozens tons in total at present.

Under these circumstances, introduction of the incinerator for disposal of municipal solid waste based on the proposal from the Japanese manufacturer involved in the environmental-related plant construction and business, associated with the operation of the incineration facility in safe and environmentally-responsible manners will have the effects on reduction of damage to the environmental in and around the landfill sites. In addition to the impact on environmental improvement as cited above, this Project is expected to lead to the extension of lifetime of the existing final disposal sites where there is a concern about residual landfilling capacity.

2) Economic effects on waste-to-energy (WTE)

In Viet Nam, with a few exceptional projects such as the CDM project using the existing landfill site in HCM and the WTE project in Hanoi City, no full-scale WTE project has been operated. These situations raised a number of important issues for development and promotion of renewable energy. In HCM, the supply of electricity could not keep up with the electric power demand that has continuously and rapidly increased with the recent economic growth.

Given these situations as stated above, this WTE project will have the financial income from selling the surplus amount of electricity (9,000 kWh) to the investors if it could be sold out to EVN on one hand and on the other hand economic effects attributable to the implementation of this Project to be captured as saving benefits in terms of increase in alternative source of energy.

4.5 STAKEHOLDER ANALYSIS

Main businesses related to non-industrial wastes in Ho Chi Minh City are listed below.

Table4-8 Main Relevant Businesses

No	Name of business	Type of business	Detail
1	CITENCO	Transportation of wastes Landfill	Public company of Ho Chi Minh City. This company is transporting wastes and also operating a final disposal site of non-industrial wastes in Phuoc Hiep disposal site. This company is processing 2,000 tons of wastes from Ho Chi Minh City in a day. There is a media report that this final disposal site is going to be closed.
2	Tam Sinh Nghia	Composting Incineration	Composting business. This company has a composting plant within Phuoc Hiep disposal site to compost wastes and burning compost residue in a simple stoker furnace licensed by an European company. This company is processing 1,000 tons of wastes from Ho Chi Minh City in a day and intended to expand the processing volume to 2,000 tons in the future. This company is interested in waste-to-energy but now focusing on expanding their facilities.
3	Viet Star	Composting	Composting business. This company has a composting plant within Phuoc Hiep disposal site. This company is processing 1,200 tons of wastes from Ho Chi Minh City in a day. This company is interested in cooperating with our project but aiming to purchase a waste incinerator under their own license.
4	Vietnam Waste Solutions	Landfill	This is a landfill company funded by an American company run by people of Vietnamese descent. This company is running Da Phuoc disposal site and processing 3,000 tons of wastes from Ho Chi Minh City in a day. This company has been planning to construct a landfill site in Thu Thua, Long An Province for a few years. There was a media report that the construction had started around November 2014. They seemed to have been planning to further increase the waste treatment volume. Yet, there was a media report that the deputy director of the Ho Chi Minh PC commented that the processing capacity could not be allowed to increase since it may violate competition laws in January 2015. They are not interested in cooperating with our project at this point.

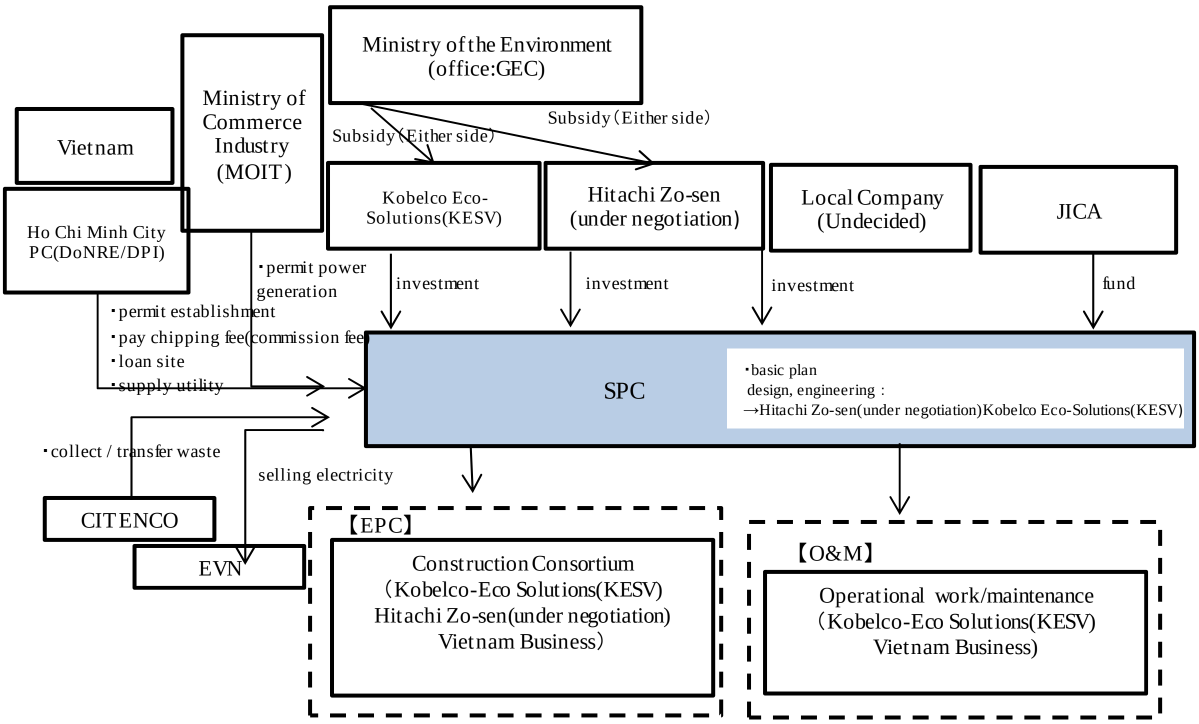
Source: JICA study team

CHAPTER 5 IMPLEMENTATION PLAN ON THE PROJECT

5.1 PROJECT IMPLEMENTATION STRUCTURE

SPC is going to be established in Vietnam for the implementation of this project. Expected investors include Kobelco Eco-Solutions and another Japanese company. A negotiation is now underway with Hitachi Zosen Corporation to which basic plans of the plant is commissioned.

As discussed above, we are considering to apply for "Subsidy Fund for Leapfrog Type Development." Kobelco Eco-Solutions, a Japanese company, is going to receive a subsidy program of Ministry of the Environment and SPC the JICA loan.

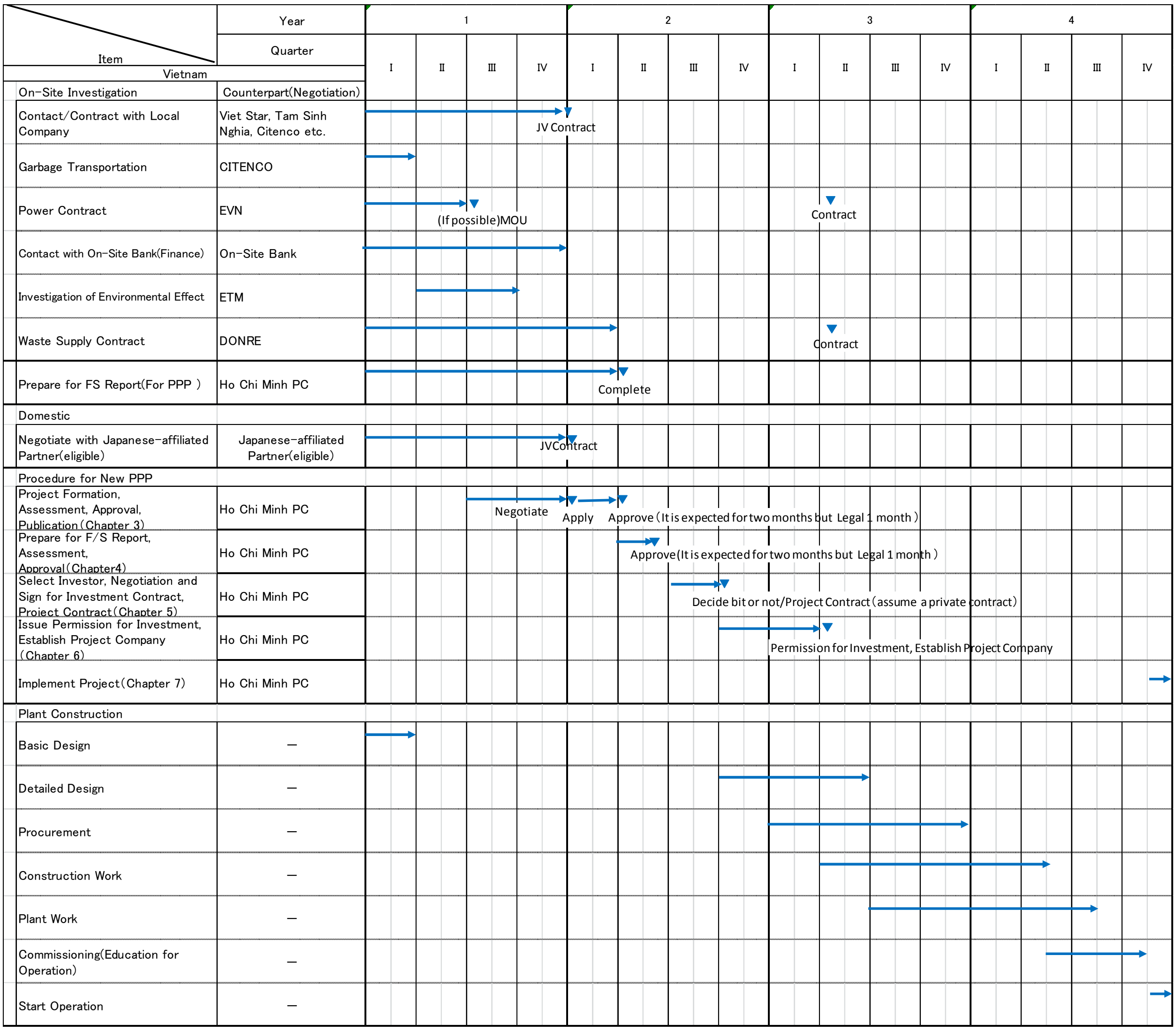


Source: JICA study team

Figure5-1 Operation System of a Non-industrial Waste Treatment System

5.2 OPERATION SCHEDULE

Operation schedule is described below. One year is planned for design, from a year and half to two years for the construction, and about half a year for trial operation and education. The business operation is expected to start in three to four years after the start of the design.



Source: JICA study team

Figure5-2 Operation Schedule

5.3 OPERATION, MAINTENANCE, AND MANAGEMENT SYSTEM

(1) UTILITIES

This is a waste incinerator which burns 600 tons/day of waste and expected to generate 11,350 kW of energy. Among the generated power, 2,350 kW is consumed within the facility, and 9,000 kW is going to be sold.

Daily use of combustion aid is not necessary for burning currently expected wastes. Combustion aid is expected to be used only when starting the operation which occurs four times a year after regular inspections. Well water is going to be used as the plant water. Tap water is going to be purchased for domestic water use. Consumption of oil and grease is expected for hydraulic equipment and motors. Other materials to be used include chemical agents to prevent corrosion and scaling on boilers and condensers, calcium hydroxide to purify exhaust gas, and chemical agents for pure water production system of boilers.

Table5-1 Utility Cost

Category			Amount of consumption @MCR	Unit	Remarks
Amount of electricity	Electricity to be sold		9,000	kW	
	Electricity to be generated		11,350	kW	
	Electricity consumed by incineration and		2,350	kW	
Fuel	Amount of combustion aid (light oil)		0	kg/year	
	Amount of combustion aid upon starting		121,337	kg/year	Four times/year/incinerator
Service water	Tap water		175	m3/day	
Oil and grease	Hydraulic fluids		3,250	L/year	
	Lubricant		750	L/year	
	Grease		50	kg/year	
Chemical agent	Chemical agent injection system	Boiler compounds	7.92	kg/day	Trisodium phosphate (Na_3PO_4)
		Oxygen scavenger	1.24	kg/day	Sodium bisulfite ($NaHSO_3$)
		Condensate treatment agent	2.06	kg/day	
		Boiler preservative	258	kg/year	Oxygen scavenger 229 kg/year Condensate treatment agent 29 kg/year
	Exhaust gas treatment system	Calcium hydroxide	912	kg/day	
		Activated carbon	278	kg/day	
	Pure water production system	Sodium sulfite	0.16	kg/day	
		Hydrochloric acid (35%)	36.8	kg/day	
		Caustic soda (20%)	58.7	kg/day	
		Cation exchange resin	39	L/year	
		Anion exchange resin	109	L/year	
	Other chemical agents, etc.	Deodorizer	876	L/year	
		Pesticide	329	L/year	
		Cooling water of the equipment cooling tower	8.1	kg/day	

Source: JICA study team

(2) OPERATION SYSTEM

The operation system is based on 24-hour operation with four-team, three-shift system. A supervisor is assigned to each shift, and the currently expected system consists of 46 people. One Japanese staff is assigned to each leader of the operation team during the trial operation period and for the first half of the year of operation for education. Local staff is assigned to run the entire operation system after this period.

Table5-2 Operation System

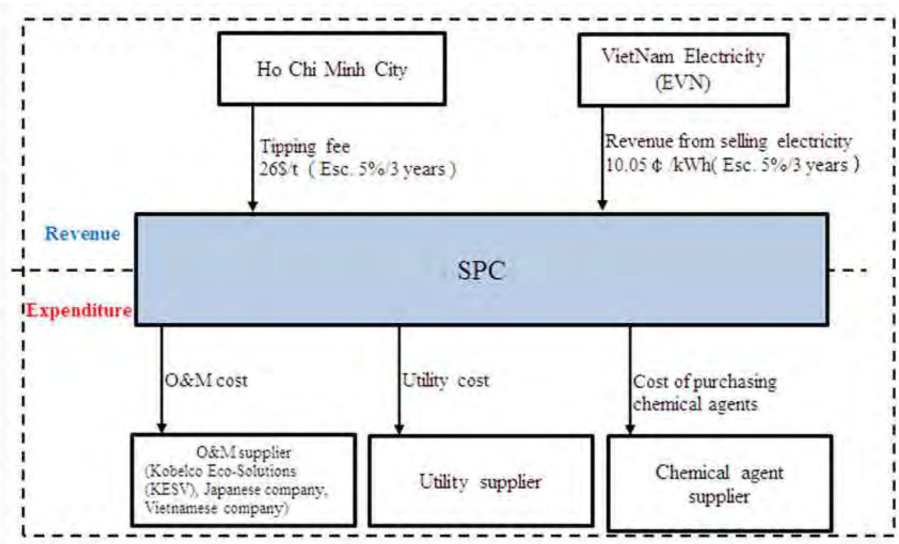
Supervisors, etc.	Number of staff	Operator	Number of staff	Office staff	Number of staff
Business supervisors, etc.	1	Waste crane operator*	4	Office staff	5
Plant manager	1	Incinerator and boiler operator*	8		
Mechanical engineer	1	Electric facility management staff*	4		
Electric engineer	1	Mechanical management staff*	4		
General supervisor of operation	1				
Facility maintenance supervisor	1	Maintenance and inspection staff	2		
Chemical analysis staff	1	Waste shovel loader	8		
Weighing scale staff	1	Ash shovel loader	1		
Platform control staff	2				
Subtotal	10	Subtotal	31	Subtotal	5
				Total	46

※four group eight hours shifts

Source: JICA study team

(3) REVENUE AND EXPENDITURE

Based on the above information, the revenue and expenditure system of this project is planned as follows.



Source: JICA study team

Figure5-3 Revenue and Expenditure Flow of a Non-industrial Waste Treatment System

5.4 PERMISSIONS AND LICENSES CONCERNING THE IMPLEMENTATION OF THE PROJECT AND ACQUISITION SCHEDULE

This project was initially planned to be constructed as an ordinary investment project without submitting an application based on the new PPP law. Yet, we also investigated the new PPP law, since the new PPP law was enacted in April 2015, and the project became likely to be constructed under the new PPP law. The new PPP law is likely to require international competitive bid, and procedures are still unclear. Thus, we are going to explore ways to construct the project as an ordinary investment project as initially planned.
This section describes a method to construct the project as an ordinary investment project in the first half, followed by a method based on the new PPP law in the second half.

(1) ESTABLISHMENT OF SPC

Law No.60/2005/QH11 on Enterprise (so-called the project as an ordinary inlicable to the establishment of SPC. Style of a company includes one-person limited liability company, two-or-more-person limited liability company, and company limited by shares. The company limited by shares requires three or more investors; thus, foreign investors usually select a limited liability company.
Expected investors of this project include Kobelco Eco-Solutions, Japanese partner companies, and local companies in Vietnam in some cases; thus, the company limited by shares is also included in consideration.

Table5-3 Styles of Company in Vietnam

Category	Limited liability company		Company limited by shares
	One-person limited liability company	Two-or-more-person limited liability company	
Number of investors as founders	One	Two to 50 (50 or less)	Three or more (No limit)
Investor	An organization or an individual	An organization or an individual	An organization or an individual
Designated capital fund	The equity of an investor depends on paid-in capital.	The equity of an investor depends on paid-in capital.	The equity depends on the number of shares owned.
Issuance of shares	Impossible	Impossible	Possible
Increase and decrease of capital fund	The capital cannot be reduced as a rule. License replacement procedure is required when increasing the capital. •The capital can be increased by accepting additional investment by investors and receiving investment from a third party. •The company must be changed to a two-or-more-person limited liability company within 15 days after	The capital can be increased and decreased.	The capital can be increased and decreased. •The capital of common stocks invested to a company cannot be recovered except for cases when the company retrieves the stock or transfer the stock to a third party.

Category	Limited liability company		Company limited by shares
	One-person limited liability company	Two-or-more-person limited liability company	
	contracting an additional investment when receiving investment by a third party.		
Range of responsibility	Range of paid-in capital	Range of paid-in capital	Range of paid-in capital
Transfer of capital	A part or all of an equity can be transferred. (A procedure to change the company to a two-or-more-person limited liability company is required when a part of the equity is transferred, and the number of investors becomes two or more.)	A part or all of an equity can be transferred. Yet, a transfer to a current investor is prioritized. The equity may be transferred to an external investor if no other investor buys back the equity within 30 days of submitting an offer to transfer the stocks.	♦When transferring equity from a founding investor to investors besides founding investors The equity must not be transferred within the first three years of the foundation of the company without an agreement in a general assembly of shareholders. ♦When transferring to people other than above Equity can be freely transferred (except for multiple voting stocks.)
Regulations concerning payment	Follow investment schedules designated in investment certificates and articles of association. The investment may be paid by diving it to multiple times.	Follow investment schedules designated in investment certificates and articles of association. The investment may be paid by diving it to multiple times.	Founding stockholders must pay the investment within 90 days after the investment certificate is issued. A founder must have 20% of the common stock.
Organizational system	♦When the founder is the organization Management structure of the company: •When there is one assigned representative, the person acts as the chairperson, president, and auditor. •When there are two or more assigned representatives, they act as the general assembly of employees, president, and auditor. ♦When the founder is an individual The management structure of the company consists of the chairperson and president (The chairperson can also act as the president.).	President, chairperson of the general assembly of employees (The president can also act as the chairperson.), general assembly of employees, and auditors' meeting (installed when there are 11 or more employees or upon a request from internal control)	General assembly of employees, board meeting and president, auditors' meeting (installed when there are 11 or more individual shareholders or when there is a corporate shareholder that owns 50% or more of the total stocks)
Supervising organization of administrators	The chairperson or the general assembly of employees has the highest decision-making authority.	The general assembly of employees has the highest decision-making authority.	The general assembly of shareholders has the highest decision-making authority.
Legal representative	President, chairperson, or the chairperson of the general assembly of employees (The president can also act as the chairperson.)	President, chairperson, or the chairperson of the general assembly of employees (The president can also act as the chairperson.)	President or the chairperson of the board meeting (The president can also act as the chairperson.)
Modification of company styles	The company may be changed to a two-or-more-person limited liability company or a company limited by shares.	The company may be changed to a one-person limited liability company or a company limited by shares.	The company may be changed to a limited liability company.

Source: JETRO y be changed to a limited liability company.ty company or a company lim

(2) ACQUISITION OF AN INVESTMENT CERTIFICATE

Law No. 59/2005/QH11 on Investment (so-called ity company.ty company or a company limited by shares. shares.as the chairperson.)areholders or when there is a no other investor buys back the equity within 30 days of submitting an offer to transfusiness administration including the amount of investment, articles of association, capital fund, details of business, locations to inject the investment, employment plan, environmental measures, project designs, and construction must be prepared to apply for the issuance of an "investment certificate (investment license)."

This is a large project of which the cost exceeds 300 billion VND (about 1.5 billion JPN), and the investment is not targeted to industrial park or a similar site. Thus, People's Committee of Ho Chi Minh City is the organization to issue the investment certificates. The period for accepting an investment certificate issuance application depends on the Planning and Investment Bureau of Ho Chi Minh City.

Table5-4 Investment Certificate in Vietnam

	Ordinary investment		Investment projects involving infrastructure development in industrial park, export processing zone, and high-tech zone
	Investment in industrial park, export processing zone, high-tech zone, and special economic zone	Investment other than ones listed on the left	
Organization to issue investment certificates	Administrative Committee	Local People's Committee	Administrative Committee (Local People's Committee if not available)
Organization to issue investment certificates Organization to accept application		Planning and Investment Bureau of Local People's Committee	Administrative Committee (Planning and Investment Bureau of Local People's Committee if not available)

Source: JETRO le)estment Bureau of Local People's Committent Staff Office in Vietnam"

Since this project is applicable as a special investment promotion category, the following investment incentives become applicable after passing an examination by Planning and Investment Bureau.

- Favorable corporation tax rate (for 15 years, no tax for the first four years and 50% discount for the following nine years)
- Reduction or exemption of import/export tax
- Reduced tax rate for fixed property tax
- Exemption of land lease fee (limited to a case when a land is directly loaned from the government)

Table5-5 Favorable Investment System in Vietnam

Tax rate	Conditions	Period of application (annual)	Period of tax exemption (number of years)	Period of 50% tax discount (number of years)
10%	Acquisition of a company which makes a new investment in the following fields: Scientific research and technological development, investment based on the high-tech law, high-tech application which belongs in the high-tech list for favorable development, development of advanced technologies and high-tech companies, investment in venture companies aiming to develop advanced technologies which belong in the high-tech list for favorable development as designated by laws concerning advanced technologies, investment in the construction and administration of a training office for advanced technologies and high-tech companies, investment in the development of especially important national infrastructures based on laws, production of software products, production of composite materials, light-weight construction materials, and rare materials, **generation of** regenerated energy, clean energy and **energy through waste treatment**, and development of bio-technologies.	15	4	9

Source: Extracted from a table in JETRO “Manual for Establishing a Company or Resident Staff Office in Vietnam”

(3) PROJECT CONSTRUCTION BASED ON THE NEW PPP LAW

As mentioned above, detailed procedures based on the new PPP law have not been released yet. Thus, this section describes an ordinary procedure.

Step 1

Information concerning the project is released based on Chapter III of Decree No. 15/2015/NĐ-CP. Prefectural People's Committee is responsible for evaluating and approving of the project within 30 days after receiving an application which satisfies requirements.

Step 2

F/S report is prepared, evaluated, and approved based on Chapter IV of Decree No. 15/2015/NĐ-CP. Prefectural People's Committee (chairperson) is responsible for evaluating and approving of the project within 30 days after receiving an application which satisfies requirements.

Step 3

Negotiation occurs concerning the investment contract, which is then signed. Project contract is released based on Chapter V of Decree No. 15/2015/NĐ-CP.

Step 4

Project management’s company is established based on the procedure of issuing Investment Registration Certificate and Chapter VI of Decree No. 15/2015/NĐ-CP. Prefectural People's Committee is in charge of the issue, adjustment and cancellation of the project’s certificate.

Step 5

Project is executed based on Chapter VII of Decree No. 15/2015/NĐ-CP. Prefectural People's Committee is responsible for keeping business site to execute the project.

Step 6

Financial report and transfer of the project are based on Chapter VIII of Decree No. 15/2015/NĐ-CP. Investors must do the final settlement of accounts about capital investment for the project’s construction within 6 months after completing the project. Moreover, they must pay their debts and publish the transfer, procedure and period for all rights, obligation and work until a year before the transfer or the period specified on the project contract.

CHAPTER 6 ENVIRONMENTAL AND SOCIAL IMPACTS RELATED TO INDUSTRIAL WASTE TREATMENT PROJECT

6.1 SOCIETY AND NATURAL SITUATION AT CANDIDATE SITE

(1) SOCIAL CONDITIONS

The HCMC Northwest Solid Waste Treatment Complex is located on the territory of Cu Chi District in the Northwest with total area of 434, 5 km2 natural. It borders on Trang Bang District (Tay Ninh Province) in the North; Ben Cat District (Binh Duong Province) in the East – Northeast with Saigon River as a natural boundary; Duc Hoa District (Long An Province) in the West and Southwest; Hoc Mon District in the South.

The district has 20 communes and one town. In which, Tan Phu Trung Commune has the largest area with total area of 30.7761 km2 and Cu Chi Town has the smallest area with total area of 3.79 km2. Cu Chi Town is about 35 km far from the city center along Highway No. 22. It has the famous Cu Chi tunnels during the Vietnam War and also Ben Duoc – Cu Chi Monument.

With respect to traffic, Cu Chi has Trans Asia Highway (TAH) (Highway No. 22) that runs along the whole length of the district connecting Cambodia through Moc Bai border gate economic in Tay Ninh Province. So, Cu Chi becomes a bridge of economic exchange and road traffic connection between HCMC and the key economic regions and industrial parks.

1) Overview of socio-economic conditions

Total district population is 381,796 people with many different ethnic groups namely majority of Kinh, negligible proportion of other peoples (Chinese; Khmer, Tay, Thai). The population density is 879people/km2. The whole district has approximately had 1102 operating businesses including 03 State-owned enterprises, 1,028 non-state enterprises and 71 foreign-owned enterprises.

- With respect to agriculture, Cu Chi has about had 12,612 ha for rice cultivation with a capacity of 44.7 quintals/ha, a yield of 56,133 tons including winter spring, summer autumn seasons and crops. For cash crops, Cu Chi has about had 3,881 ha with a yield of 102,153 tons that is the largest in the city.
- With respect to livestock, the district has reached the highest proportion compared to other districts throughout the city with a yield of about 3,677 buffaloes, 73,705 cows 153,125 swine.
- With respect to education, the district has about had 38 pre-schools with 491 classes and 70 schools with 1,517 classes. Thus, there are approximately 1.8 kindergartens; and 3.3 junior high schools in each commune/town.
- With respect to health, the district has about had 24 health facilities.

2) Economic condition

Estimated value of total production reached 19,319.941 billion Dongs, increased by 16.31%, in which small industry and handicrafts – industry production increased by 16.40%, trade - services increased by 19.27%, agriculture increased by 8.43%.

a. Industry production

In 2013, the value of industrial production, small industry, and handicrafts was estimated about 14,938.814billions, achieved 100.77% of the year target. There were 406 new enterprises theirs subsidiaries established, 50 enterprises moved from other places; 56 enterprises and theirs subsidiaries dissolved, 87 enterprises moved away.

There were 16 disputes occurred in 13 enterprises (12 foreign-owned enterprises, 01 domestic enterprises), decreased by 03 cases compared to the same period in 2012, with 4,994/12,624 workers stopped working (in which there were 2,170 employees from other provinces). Causes of disputes were mainly resulted from delayed payment of salaries, not enough payment of annual leaves, extended payment of salaries for workers, inadequate implementation of social insurance, health insurance, overtime working beyond the law.

Electricity for production and daily domestic activities are provided with 832 million kWh, increased by 9.79% compared to the same period, 23.5 million kWh saved, achieved 138.23% of the expected target.

b. Cooperated Trade – Service and Economy

The value of production - trade - service is estimated about 3,147.743 billion Dongs, reached 101.51% of the year target. In 2013, there were 02 cooperatives established. Currently, there are 27 cooperatives including 07 cooperatives in good operation, 06 cooperatives in fairly good operation, 06 cooperatives in fair operation, 02 cooperatives in pending approval period, 03 cooperatives in poor operation (now stopped operation), 01 cooperative founded in 2011 but it has not yet operated due to a lack of capital.

c. Agricultural production

The total value of agricultural, forest and seafood production is estimated approximately 1,233.384 billion Dongs, achieved 100.40% of the year target including cultivation occupied 39.42%; livestock occupied 60.58%.

The total cultivation area was 37.567ha, increased by 201ha compared to the same period. Vegetables reached 8,354 ha, increased by 954ha compared to the same period. Orchids, ornamental plants focused on developing with total area of about 419ha including 162ha of orchids and 3,434 ha of fruit trees.

Total cattle of buffaloes and dairy cows was 79,692, reached 107.40% of the target, increased by 10,468 compared to the same period including 62,307 dairy cows (increased by 8,163 compared to the same period), 31,153 lactating dairy cows. The total herd of swine was 206,630, decreased by 10,406 compared to the same period. There were 56,000 crocodiles, 817 porcupines, 20,683 pythons, 5,900 monitor lizards, 3,187 snakes, 4,280 turtles.

Aquaculture area reached 238 ha, mainly fish, the tortoise feeding area is restoring, the aquarium fish feeding area of about 21 ha with many species. Seafood production in 2013 was estimated approximately 7,000 tons.

The prevention of diseases for cattle and poultry, and from crop damages was interested in doing. LMLM vaccination in cattle reached 86.04% for buffaloes and cows, reached 85.66% for swine.

3) Culture, sports

The construction activities of the cultural life are prospering, the district now continues to encourage the residential areas in building traditional corners, the model people team, self-managed worker team.

Moreover, the district organized many activities in the field of culture, information, sport serving the needs of enjoyment, entertainment of local inhabitants, especially during the Lunar New Year 2013 and on major holidays with good achievements. Additionally, the district organized 55 sports competitions in district level with about 10 thousands athletes attended.

4) Education

In 2013, the proportion of mobilizing five-year-old children to go to school and six-year-old children to Grade 1, completing the primary school to go to Grade 6 reached 100%; graduating from secondary school to go to Grade 10 and equivalent levels, reached 95.14%; the proportion of pupils attending secondary school reached 98.78%, ones attending high school reached 95.45%. Compared to 2012, the pupils' record and the pupils admitted to public universities increased.

5) Health

Health care and protection for people have been interested in doing and there was 853 people infected with dengue fever, decreased by 389 people compared to the same period in the previous year.

(2) NATURAL CONDITIONS AT HO CHI MINH CITY

1) Temperature

Ho Chi Minh City locates in the tropical monsoon climate with near equatorial, has rainy season from May to November and dry season from December to April.

The average temperature of a year is about 28℃ and relatively high. The average temperature range of a month is 25℃ - 30℃. The highest temperature is in April and sometimes reaches over 39℃, the lowest period is from the end of December to the beginning of January and reaches under 16℃.

Table6-1 Average Monthly Temperature Observed at Tan Son Hoa Station

Unit: ^{0}C

Year	2007	2008	2009	2010	2011	2012	2013
Yearly average	**28.2**	**27.9**	**28.1**	**28.6**	**28.1**	**28.6**	**28.4**
January	27.3	27.2	25.9	27.3	26.9	27.6	27.3
February	27.2	27.3	27.7	28.4	27.6	28.2	29.0
March	28.8	28.2	29.3	29.4	28.3	29.5	29.3
April	30.1	29.5	29.4	30.3	29.1	29.3	30.4
May	28.9	28.2	28.5	31.3	29.5	29.2	29.8
June	28.7	28.6	29.2	29.3	28.5	28.7	28.9
July	27.7	28.3	28.0	28.3	27.9	28.3	28.1
August	27.7	27.7	28.6	27.9	28.4	29.1	28.3
September	27.7	27.7	27.6	28.6	28.1	27.5	27.6
October	27.5	28.0	27.7	27.5	28.1	28.2	27.7
November	26.9	27.2	28.4	27.2	28.1	28.8	28.1
December	27.6	26.9	27.5	27.4	27.2	29.1	26.6

Source: HCMC Statistical Yearbook, 2013 (HCMC Statistics Office, 2014).

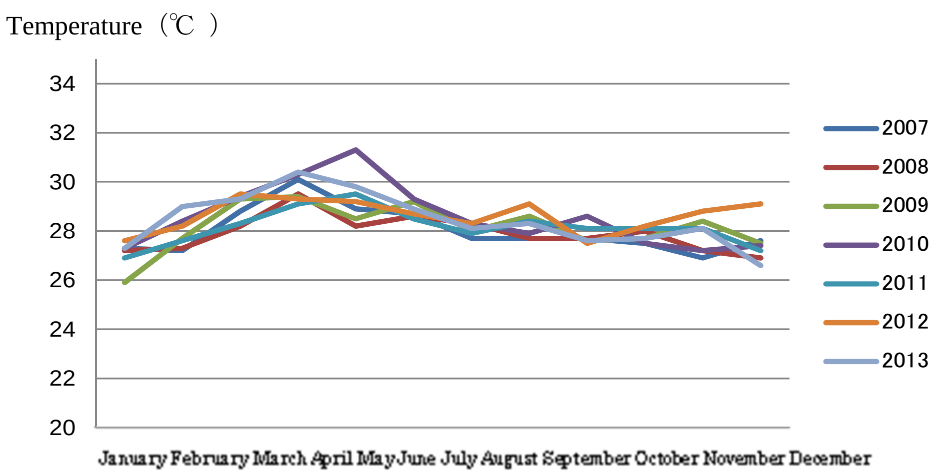


Figure6-1 Average Temperature Data Recorded at Ho Chi Minh City

2) Precipitation

The average precipitation of a year is about 1,940mm, the rainy days of a year is about 150 – 160 days. The rainfall account for 90% of the total rainfall during the whole year is from May to November. While the highest precipitation of a year is 330mm, the lowest is less than 1mm.

Table6-2. Average Monthly Rainfall Observed at Ho Chi Minh City

Unit: mm

Year	2007	2008	2009	2010	2011	2012	2013
Total	**2,340.2**	**1,813.1**	**1,979.9**	**2,016.2**	**1,953.8**	**1,883.0**	**1,980.5**
January	0.4	9.5	0.3	23.0	9.4	18.0	38.1
February	-	1.5	21.4	-	-	68.7	0.1
March	59.3	58.9	57.8	3.9	40.3	36.4	10.1
April	7.7	127.0	187.0	9.9	181.9	144.4	18.3
May	327.9	246.9	318.5	8.8	124.4	72.2	196.8
June	188.8	147.2	83.2	160.0	213.1	270.6	173.3
July	414.3	331.2	223.0	294.3	281.5	200.4	175.8
August	301.0	297.8	323.9	400.6	244.4	113.4	260.7
September	495.4	202.6	325.1	373.7	232.1	407.9	411.2
October	391.2	165.6	249.0	321.8	232.6	434.4	407.4
November	147.1	167.1	141.2	379.9	321.1	91.2	257.4
December	7.1	57.8	49.5	40.3	73.0	25.4	31.3

Source**:** HCMC Statistical Yearbook, 2013 (HCMC Statistics Office**,** 2014).

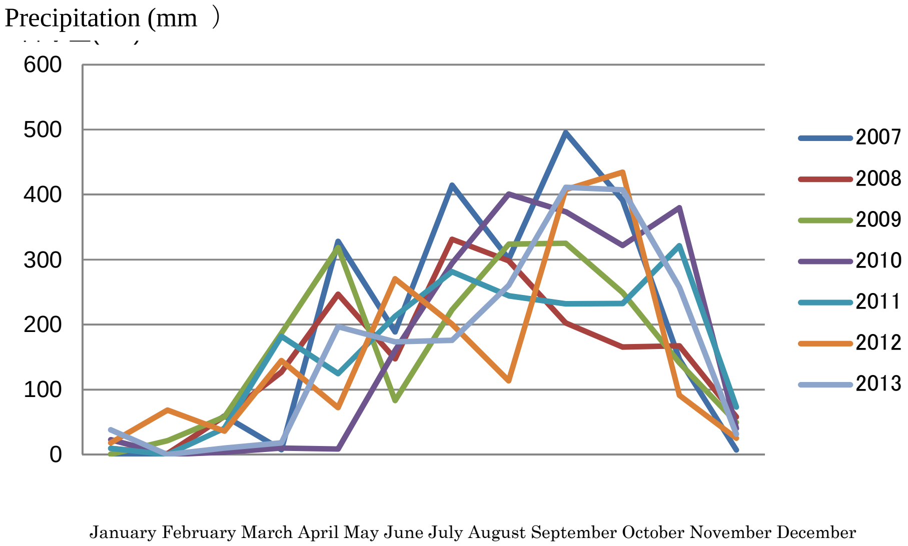


Figure6-2 Average Rainfall Data Recorded at Ho Chi Minh City

3) Humidity

The average humidity of a year is from 74% to 77%, the highest is about 85% and the lowest is about 67%.

Table6-3 Average Monthly Humidity Observed at Ho Chi Minh City

Unit: %

Year	2007	2008	2009	2010	2011	2012	2013
Yearly average	**76**	**77**	**76**	**74**	**75**	**73**	**74**
January	69	71	70	71	70	68	68
February	68	69	73	70	68	69	61
March	71	71	71	68	67	67	68
April	69	73	76	70	70	74	69
May	80	81	81	70	75	74	75
June	80	78	77	76	77	77	79
July	83	79	79	79	79	77	80
August	82	83	80	80	80	75	80
September	83	83	83	76	81	82	82
October	82	81	80	79	80	76	81
November	76	79	73	80	77	74	76
December	72	73	74	73	70	67	72

Source: HCMC Statistical Yearbook, 2013 (HCMC Statistics Office, 2014).

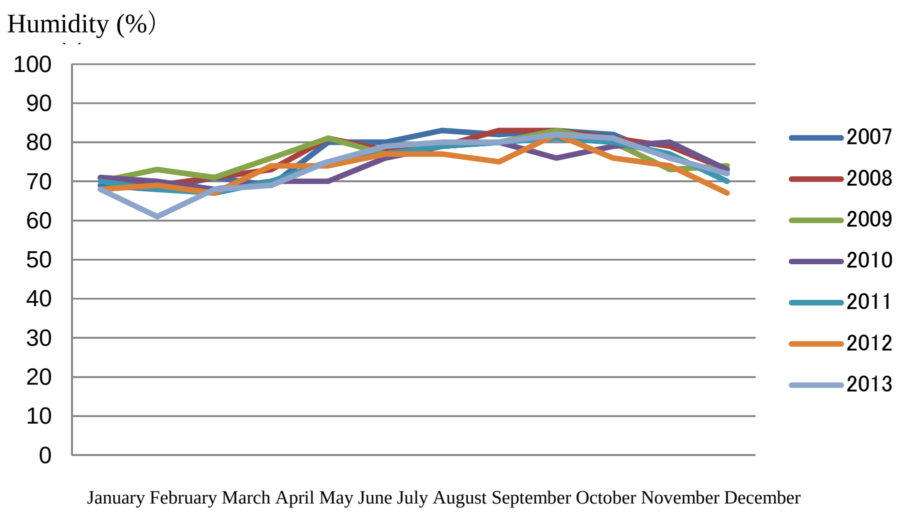


Figure6-3 Average Humidity Data Recorded at Ho Chi Minh City

4) Sunlight duration

The average hours of monthly sunlight duration is from 157hours to 173 hours.

Table6-4 Average Monthly Sunlight Duration Observed at Ho Chi Minh City

Unit: hour

Year	2007	2008	2009	2010	2011	2012	2013
Total	**1,891.0**	**1,989.6**	**2,003.0**	**2,073.7**	**1,892.9**	**2,131.6**	**2,023.4**
January	113.3	156.3	174.4	157.1	120.1	141.1	161.8
February	193.6	135.6	168.1	245.3	188.9	176.8	192.6
March	229.5	216.7	236.9	239.6	157.8	208.6	243.7
April	213.5	188.3	186.7	240.8	187.0	217.3	186.8
May	182.5	165.7	155.9	210.4	165.0	198.2	192.9
June	128.0	172.8	191.6	177.0	163.6	164.3	147.8
July	147.7	218.7	149.2	150.0	162.6	182.1	150.8
August	135.8	161.0	155.7	141.2	198.1	218.9	185.9
September	130.8	142.6	116.9	155.2	144.8	118.7	110.7
October	147.0	152.4	132.3	102.7	154.3	154.1	156.6
November	127.5	145.4	147.7	130.6	141.0	164.9	172.3
December	141.8	134.1	187.6	123.8	109.7	186.6	121.5

Source: HCMC Statistical Yearbook, 2013 (HCMC Statistics Office, 2014).

(3) NATURAL CONDITIONS AT PLANNED PLANT

1) Topography and Geology

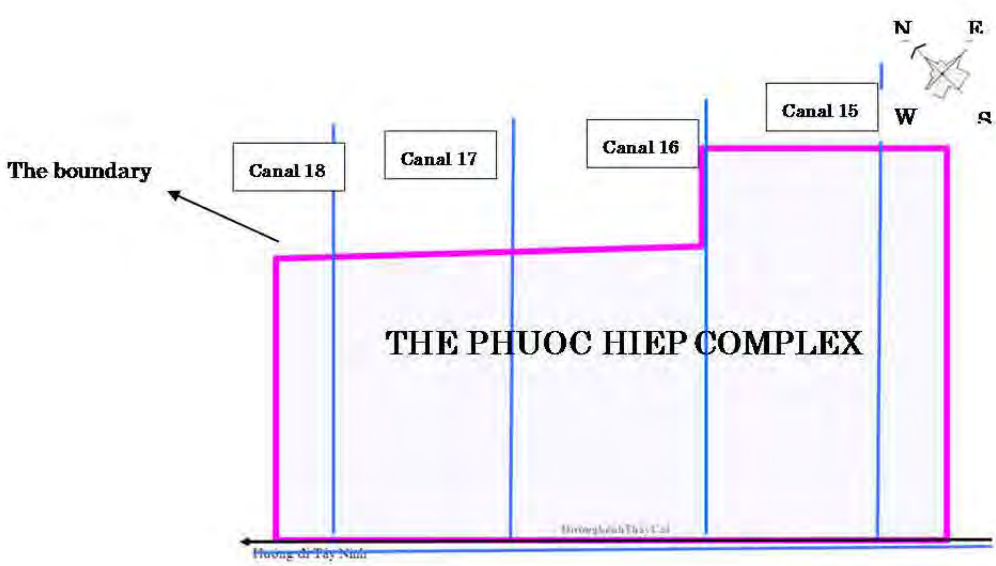
The topography at Phuoc Hiep Treatment is relatively flat and it has an average height ranging from 0.1 to 0.5m above sea level. There are primarily sedge grass, part rice, eucalyptus and some fruit trees around the area. According to geologic drilling result in the boreholes made by Bach Khoa Consulting J.S Company dated May 2008, as for the stratum in the construction site N-value is 0-1 which is silt clay, yellowish brown, soft and plastic. At the construction of the plant, it may need doing more detailed investigation and introducing the basement.

2) Climate

Project area is located in Phuoc Hiep Commune, Cu Chi District, HCMC. It is in the tropical monsoon climate with near equatorial and high temperature through the year. While the rainy season is from May to November, the dry season is from December to April.

3) Groundwater and Surface water

Groundwater level is decreased in the sunny season and is increased in the rainy season. It is observed about 15 - 40m below the ground. The Complex is adjacent to Thay Cai canal and divided by some canals such as canal15, canal16, canal17 and canal18.These are irrigation and drainage canal sections for local area as well as the Phuoc Hiep Complex.

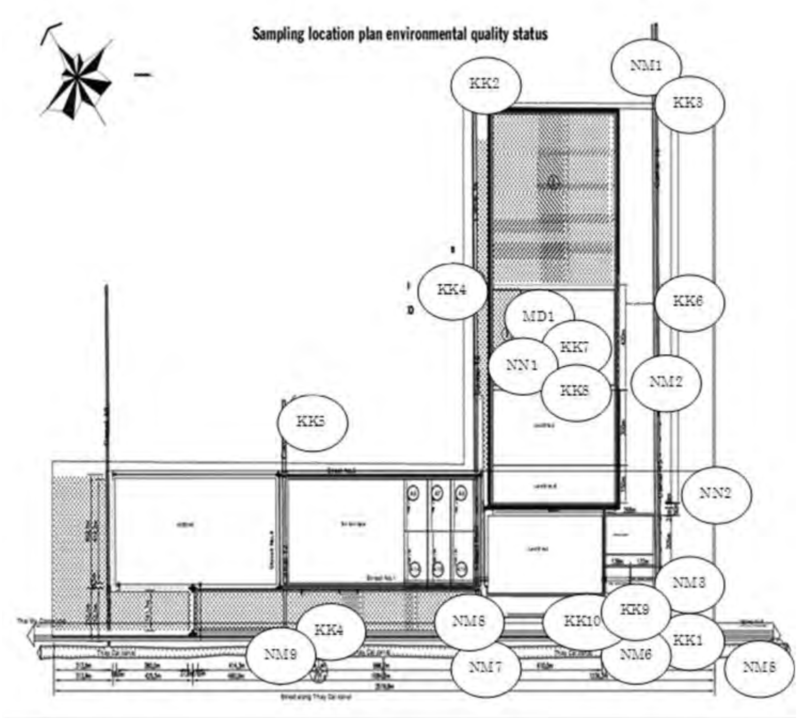


Source: JICA study team

Figure6-4 The Phuoc Hiep Complex

(4) ENVIRONMENTAL QUALITY STATUS

Environmental quality status at the majority point of the Phuoc Hiep Complex is as follows.



Source: JICA study team

Figure6-5 Sampling Location Plan Environmental Status

KK_1: Along Thay Cai canal – about 1km away from Landfill No. 3 in the Southeast;
KK_2: Along canal 16 – about 500m away from Landfill No. 3 in the Northwest;
KK_3: Along canal 15 – about 500m away from Landfill No. 3 in the Northeast;
KK_4: Along Thay Cai – about 1km away from Landfill No. 3 in the West;
KK_5: Along canal 17 – about 1.5km away from Landfill No. 3 in the Northwest;
KK_6: Along canal 15 – about 500m away from Landfill No. 3 in the East;
KK_7: In the Project area – Landfill No. 3;
KK_8: At the boundary of Lanfill No. 2;
KK_9: At the Phuoc Hiep WWTP of CITENCO;
KK_{10}: In the operation room of CITENCO.

NM_1: On canal 15, about 1km upstream away from the point of receiving storm water of Lanfill No. 3
NM_2: On canal 15, at the point of receiving storm water of Lanfill No. 3
NM_3: On canal 15, at the point of receiving treated wastewater from Phuoc Hiep WWTP of CITENCO
NM_4: On canal 16, at the point of receiving storm water of Lanfill No. 3
NM_5: On canal 16, at the point of receiving wastewater from car washing of CITENCO
NM_6: On Thay Cai canal, at the confluence of canal 15 and Thay Cai canal
NM_7: On Thay Cai canal, at the confluence of canal 16 and Thay Cai canal
NM_8: On Thay Cai canal, about 1km downstream away from the confluence of canal 15 and Thay Cai canal
NM_9: On Thay Cai canal, about 1km upstream away from the confluence of canal 16 and Thay Cai canal

1) Microclimate

The microclimate monitoring is as follows. In the Complex, there is a temperature of about 29.3 -30.10C, a moisture of about 75 - 81% and wind speed of about 0.8 - 3.0 m/s. In general, the environmental condition in the Complex is rather stable with lightly wind and sun.

Table6-5 The Microclimate Monitoring Result

Measurement position	Temperature (^oC)	Humidity (%)	Wind speed (m/s)
Position KK_1	29.3	78	2.3 ÷ 2.8
Position KK_2	29.5	75	0.8 ÷ 1.3
Position KK_3	29.5	77	1.1 ÷ 2.4
Position KK_4	30.1	80	1.6 ÷ 1.8
Position KK_5	30.0	75	1.2 ÷ 2.2
Position KK_6	29.7	78	1.5 ÷ 2.8
Position KK_7	30.0	81	2.4 ÷ 3.0
Position KK_8	29.0	80	2.3 ÷ 2.8
Position KK_9	29.7	78	2.2 ÷ 2.9
Position KK_{10}	29.3	78	1.2 ÷ 1.7

Source: Result of re-commissioned investigation

2) Noise

The noise monitoring results is as follows. It is lower than an allowable value in QCVN 26:2010/BTNMT-National Technical Regulation on Noise.

Table6-6 The Noise Monitoring Result

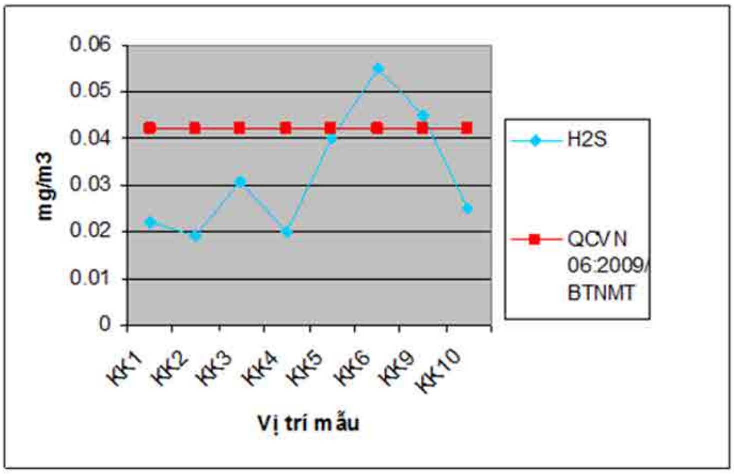
Measurement position	Noise (dBA)	Measurement position	Noise (dBA)
Position KK_1	51.6 ÷ 59.8	Position KK_6	49.1 ÷ 51.2
Position KK_2	49.3 ÷ 56.6	Position KK_7	56.7 ÷ 62.7
Position KK_3	52.2 ÷ 54.5	Position KK_8	55.8 ÷ 61.3
Position KK_4	55.7 ÷ 60.3	Position KK_9	46.3 ÷ 50.9
Position KK_5	48.8 ÷ 52.6	Position KK_{10}	49.2 ÷ 53.8
QCVN 26:2010/BTNMT	**70**	**QCVN 26:2010/BTNMT**	**70**

Source: Result of re-commissioned investigation

3) Atmosphere

The result of atmosphere measurement is described below. Odor was found near the final disposal site of CITENCO. High hydrogen sulfide and ammonium values were actually measured.

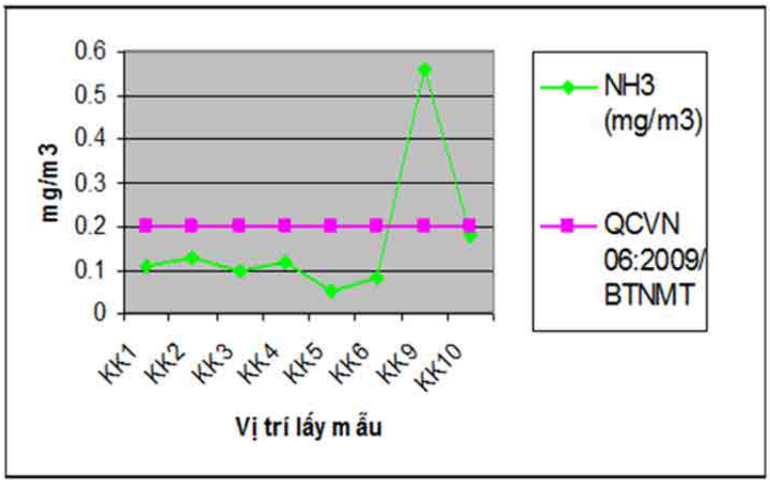
Values of hydrogen sulfide exceeded the value designated by National Technical Regulation on some toxic substances in ambient air (QCVN 06:2009/BTNMT) at four locations. The value at the measurement point of KK7 (landfill site 3 of CIETNCO's final disposal site that is now in operation) was especially high. Yet, all values satisfied the value designated by Promulgation of 21 sanitation standards, 05 principles and 07 parameters of labor sanitation (Decision No. 3733/2002/QD-BYT).



Source: Result of re-commissioned investigation

Figure6-6 Result of Atmospheric Measurement (Hydrogen sulfide)

Values of ammonium exceeded the value designated by National Technical Regulation on some toxic substances in ambient air (QCVN 06:2009/BTNMT) at three locations. As in hydrogen sulfide, the value at the measurement point of KK7 was high. Yet, the values satisfied the value designated by Promulgation of 21 sanitation standards, 05 principles and 07 parameters of labor sanitation (Decision No. 3733/2002/QD-BYT) in this category as well.



Source: Result of re-commissioned investigation

Figure6-7 Result of Atmospheric Measurement (Ammonium)

Table6-7 Result of Atmospheric Measurement

Position	Dust (mg/m^3)	SO_2 (mg/m^3)	NO_2 (mg/m^3)	CO (mg/m^3)	H_2S (mg/m^3)	NH_3 (mg/m^3)	CH_4 (mg/m^3)
KK_1	0.07	0.15	0.02	0.14	0.022	0.11	3.05
KK_2	0.03	0.12	0.03	0.22	0.019	0.13	4.15
KK_3	0.04	0.08	0.04	0.33	0.031	0.10	5.05
KK_4	0.02	0.04	0.01	0.22	0.020	0.12	3.56
KK_5	0.02	0.07	0.02	0.23	0.04	0.05	3.33
KK_6	0.05	0.05	0.03	0.25	**0.055**	0.08	4.23
KK_7	0.03	0.05	0.05	0.25	**0.16**	**0.82**	9.20
KK_8	0.02	0.08	0.02	0.31	**0.062**	**0.33**	18.15
KK_9	0.05	0.13	0.04	0.12	**0.045**	**0.56**	10.12
KK_{10}	0.02	0.04	0.01	0.18	0.025	0.18	13.43
QCVN 05:2013/BTNMT	**0.3**	**0.35**	**0.2**	**30**	-	-	-
QCVN 06:2009/BTNMT	-	-	-	-	**0.042**	**0.2**	-
TCVSLĐ 3733/2002/QĐ-BYT	**8**	**5**	**5**	**20**	**10**	**17**	-

Source: Result of re-commissioned investigation

4) Surface water

The result of surface water measurement is described below. The values of nitrite nitrogen exceeded the standard of National Technical Regulation on surface water quality (QCVN 08:2008/BTNMT) at two locations. Also, the value of Fe exceeded the standard of National Technical Regulation on surface water quality (QCVN 08:2008/BTNMT) at all measurement points. The dissolved iron content in the wastewater discharge standard in Japan is 10 mg/l. Values measured at all locations were well below this value.

Table6-8 Result of Surface Water Measurement

Parameter	**Unit**	**NM1**	**NM2**	**NM3**	**NM4**	**NM5**	**NM6**	**NM7**	**NM8**	**NM9**	**QCVN 08:2008/ BTNMT, Level B1**
pH	-	6.1	6.5	6.3	6.5	6.52	6.23	6.1	6.3	6.98	5.5 ÷ 9
COD	mgO_2/l	20	27	29	22	26	29	29	27	25	30
BOD	mgO_2/l	8	11	14	11	12	12	11	10	10	15
SS	mg/l	8	12	32	28	32	22	34	10	20	50
DO	mgO_2/l	4.0	4.2	4.4	4.0	4.7	4.4	4.9	4.2	4.6	≥4
$N\text{-}NH_3$	mg/l	0.08	0.11	0.44	0.35	0.21	0.4	0.12	0.22	0.09	0.5
$N\text{-}NO_3^-$	mg/l	1.43	1.63	3.4	2.45	2.55	3.82	1.63	1.78	0.98	10
$N\text{-}NO_2^-$	mg/l	0.018	0.035	**0.06**	0.04	0.04	**0.05**	0.037	0.038	0.017	0.04
PO_4^{3-}	mg/l	0.101	0.152	0.178	0.148	0.112	0.152	0.108	0.18	0.21	0.3
Oil & Grease	mg/l	0.04	0.05	0.06	0.04	0.08	0.08	0.05	0.03	0.02	0.1
Cu	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	0.5
Cd	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	0.01
Pb	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	0.05
Fe	mg/l	**2,13**	**2,85**	**3,22**	**2,35**	**3,34**	**3,16**	**3,55**	**4,59**	**4,11**	1.5
Coliform	MPN/ 100ml	1.100	3.500	5.300	1.200	1.500	4.000	1.200	2.400	1.500	7,500

Source: Result of re-commissioned investigation

5) Groundwater

The result of groundwater measurement is described below. Groundwater was measured at three CITENCO landfill sites and 500 meters to the east from the landfill sites. The groundwater was collected by digging 80 meters into the ground.

Table6-9 Result of Groundwater Measurement

Parameter	**Unit**	**NN1**	**NN2**	**QCVN 09:2008/BTNMT**
pH	-	6.84	6.79	5.5 – 8.5
TDS	mg/l	181	533	1500
Cl^-	mg/l	40.6	31.5	250
F^-	mg/l	0.02	0.01	1
$N\text{-}NO_3^-$	mg/l	1.12	1.83	15
SO_4^{2-}	mg/l	0.13	0.11	400
Cu	mg/l	0.022	0.019	1.0
Mn	mg/l	KPH	0.45	0.5
Cd	mg/l	KPH	KPH	0.005
Pb	mg/l	KPH	KPH	0.01
Fe	mg/l	KPH	KPH	5
As	mg/l	KPH	KPH	0.05
Coliform	MPN/100ml	**3,6**	**3**	3

Source: Result of re-commissioned investigation

(3) ECOSYSTEM

1) Aquatic ecosystem

a. Phytoplankton

The analytical results show that there are 5 branches under 5 layers namely Cyanophyta, Chrysophyta, Chlorophyta, Euglenophyta, Dinophyta with a total of 48 species. The abundance and diversity is observed in terms of phytoplankton composition and species.

b. Zooplankton

The analytical results show that the zooplankton is observed with a little number and species. There are 22 species that are divided into some main branches namely Rotatoria, Cladocera, Ostracoda, Copepoda and Larva. Copepoda nauplius species has medium nutrient, this species is well adapted to the river sections contaminated seriously with organic matters. However, they are observed with a little number, it means that the canal has not been polluted.

2) Terrestrial ecosystem

a. Flora

According to field survey, it shows that vegetation inside and around the Complex is mainly melaleuca, Annona reticulata, longan, shrubs, etc.

b. Terrestrial fauna

According to field survey, it shows that there are actually no both rare aquatic and terrestrial animals in local area. Terrestrial animals in the area are usually wild animals such as birds, storks, hamsters, etc.

c. Fishery

Aquatic animals in the Project area are rather little in terms of both type and quantity. There are mainly fish types namely catfish, shark catfish, striped flying barbs, etc.

6.2 INVESTIGATION OF ENVIRONMENTAL EFFECTS

(1) PROCEDURES CONCERNING THE INVESTIGATION OF ENVIRONMENTAL EFFECTS

Investigation of environmental effects needs to be conducted based on the following procedures in Vietnam.

1) Step 1 Gather necessary references and select places to visit.
Collect samples to determine the baseline of environmental quality at a project site and nearby areas and gather data concerning project activities and natural and socioeconomic conditions of a project site.

2) Step 2 Preparation of report (summary) of the investigation of environmental effects
After preparing a draft, summarize the report and submit it to competent local authorities. Matters requested by the competent authorities need to be reflected in the report.
3) Step 3 Submission of a report to an organization to give licenses and permits
Submit a report of the investigation of environmental effects to an organization which gives licenses and permits. The organization which gives licenses and permits is determined depending on characteristics and scale of a project.
4) Step 4 Give a presentation at the organization to give licenses and permits.
5) Step 5 Revise the report of the investigation of environmental effects based on comments of the organization to give licenses and permits.

Regular environmental monitoring is required during the plant construction phase and when starting the operation even after completing the initial investigation of environmental effects.

(2) DIFFERENCES BETWEEN GUIDELINES IN VIETNAM AND JICA GUIDELINE

Differences between guidelines in Vietnam (No. 26/2011/TT-BTNMT) and JICA guideline (OP4.01 Annex B) concerning the investigation of environmental effects are described below.

Table6-10 Comparison between Guidelines in Vietnam (No. 26/2011/TT-BTNMT) and JICA Guideline (OP4.01 Annex B)

World Bank (OP4.01, Annex B) (JICA Guideline on Environmental and Social Consideration)	**Circular No.26/2011(Guideline for Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitments)**
Executive Summary: Concisely discusses significant findings and recommended actions.	**Summary of the EIA report**
Policy, legal, and administrative framework: Discusses the policy, legal, and administrative framework within which the EIA is carried out. Explains the environmental requirements of any cofinanciers. Identifies relevant international environmental agreements to which the country is a party.	**PREFACE** 1. Origin of the project - *Investment necessity* - *Appropriate authority for investment project approval* 2. Legal And technical basis for preparing the EIA report - *Basis of the EIA report* - *Legal basis of the Project* - *Available data sources from the investor* 3. Method of preparing the EIA report 4. Organization for EIA preparation - *Organization for EIA preparation* - *Organizations and members*
Project Description: Concisely describe the proposed project and its geographic, ecological, social, and temporal context, including any offsite investments that may be required (e.g., dedicated pipelines, access roads, power plants, water supply, housing, and raw material and product storage facilities). Indicates the need for any resettlement plan or indigenous	**CHAPTER 1: BRIEF DESCRIPTION OF PROJECT** 1.1. Project's name 1.2. Project's owner 1.3. Project's location - *Geographic location* - *The relationship between the project's area and adjacent objects*

World Bank (OP4.01, Annex B) (JICA Guideline on Environmental and Social Consideration)	**Circular No.26/2011(Guideline for Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitments)**
peoples development plan. Normally includes a map showing the project site and the project's area of influence.	- *The relationship between the project's area with local traffic system* 1.4. Project's main contents *1.4.1. Project's objective* *1.4.2. Number and scale of construction works of the Project* *1.4.3. Construction method for Project's construction work items* *1.4.4. Technology of production* *1.4.5. List of machine and equipment* *1.4.6. Demand for raw materials, fuel and Project's product* *1.4.7. The project's implementation progress* *1.4.8. Investment capital* *1.4.9. Project management and performance*
Baseline Data: Assesses the dimensions of the study area and describes relevant physical, biological, and socioeconomic conditions, including any changes anticipated before the project commences. Also takes into account current and proposed development activities within the project area but not directly connected to the project. Data should be relevant to decisions about project location, design, operation, or mitigatory measures. The section indicates the accuracy, reliability, and sources of the data.	**CHAPTER 2 BASELINE NATURAL, ENVIRONMENTAL AND SOCIO-ECONOMIC CONDITIONS** 2.1. Geography location *2.1.1. Geographic, topographic, geological conditions* *2.1.2. Meteorological condition* *2.1.3. Hydrological condition* *2.1.3. Baseline natural environmental status* *2.1.4. Status of biological resources* 2.2. Socio-economic conditions *2.2.1. Economic condition* *2.2.2. Social condition*
Environmental Impacts: Predicts and assesses the project's likely positive and negative impacts, in quantitative terms to the extent possible. Identifies mitigation measures and any residual negative impacts that cannot be mitigated. Explores opportunities for environmental enhancement. Identifies and estimates the extent and quality of available data, key data gaps, and uncertainties associated with predictions, and specifies topics that do not require further attention.	**CHAPTER 3: ENVIRONMENTAL IMPACT ASSESSMENT** 3.1. Impact assessment *3.1.1. Preparation phase* *3.1.2. Construction and equipment installation phase* *3.1.3. Operation phase* *3.1.4. Other phases* *3.1.5. Impacts from risk and breakdown* 3.2. Comments on detailed contents and reliability of assessment *3.2.1. Assessment of impacts involved in waste* *3.2.2. Assessment of impacts uninvolved in waste* *3.2.3. Assessment of environmental risk and breakdown*
Analysis of Alternatives: Systematically compares feasible alternatives to the proposed project site, technology, design, and operation--including the "without project" situation--in terms of their potential environmental impacts; the feasibility of mitigating these impacts; their capital and recurrent costs; their suitability under local conditions; and their institutional, training, and monitoring requirements. For each of the alternatives, quantifies the environmental impacts to the extent possible, and attaches economic values where feasible. States the basis for selecting the particular project design proposed and justifies recommended emission levels and approaches to pollution prevention and abatement.	**CHAPTER 4: MITIGATION MEASURE FOR NEGATIVE IMPACTS, ENVIRONMENTAL BREAKDOWN PREVENTION AND RESPONSE PROCEDURE** 4.1 Mitigation measure for negative impacts, *4.1.1. Preparation phase* *4.1.2. Construction and equipment installation phase* *4.1.3. Operation phase* *4.1.4. Other phase* 4.2. Prevention and response measures for risk and breakdown *4.2.1. Preparation phase* *4.2.2. Construction and equipment installation phase* *4.2.3. Operation phase*

World Bank (OP4.01, Annex B) (JICA Guideline on Environmental and Social Consideration)	**Circular No.26/2011(Guideline for Strategic Environmental Assessment, Environmental Impact Assessment and Environmental Protection Commitments)**
Environmental Management Plan: Covers mitigation measures, monitoring, and institutional strengthening; see outline in OP 4.01, Annex C.	**CHAPTER 5: ENVIRONMENTAL MANAGEMENT AND MONITORING** 5.1. Environmental management program 5.2. Environmental monitoring program *5.2.1. Construction phase* *5.2.2. Operation phase*
N/A	**CHAPTER 6: COMMUNITY CONSULTATION** 6.1. Reviews Commune-level People's Committees. 6.2. Opinion Community Representatives (if any). 6.3. Reviews Institution Directly Affected By the project (if any). 6.4. Review Reporting Agency Approval Of environmental impact assessment construction projects in infrastructure production, business, and service focus (if any). 6.5. Feedback And commitment to the project owner for suggestions, recommendations and requests for the agencies and organizations were consulted.
N/A	**CHAPTER 7: CONCLUSION, RECOMMENDATION AND COMMITMENT**
Appendix (i) List of EA report preparers – individuals and organizations. (ii)References - written materials both published and unpublished, used in study preparation. (iii) Record of interagency and consultation meetings, including consultations for obtaining the informed views of the affected people and local nongovernmental organizations (NGOs). The record specifies any means other than consultations (e.g., surveys) that were used to obtain the views of affected groups and local NGOs. (iv)Tables presenting the relevant data referred to or summarized in the main text. (v)List of associated reports (e.g., resettlement plan orindigenous peoples development plan).	Appendix - Copies of legal documents relevant to project. - Diagrams (drawings, maps) relevant to project but not yet be presented in EIA report. - Analysis result papers of environmental parameters (air, noise, water, soil, sediment, bio-resources...) with signature, name, title of Head of analysis agency and stamps. - Copies of documents relating to community consultation and sociology questionnaires (if any). - Pictures of project site (if any). - Other relevant documents (if any).

(3) SCOPING PROPOSAL

Scoping is implemented as follows based on the JICA guideline.

[Scoping proposal]

Category		Category of effects	Evaluation		Ground for evaluation
			Before construction During construction	During shared uses	
Pollution prevention measures	1	Air pollution	B-	A-	**During construction:** A temporary exacerbation of the atmospheric quality is expected due to exhaust gases from construction vehicles and particles generated by construction works. **During shared uses:** Air pollutants are emitted from incinerators.
	2	Water pollution	B-	C+	**During construction:** There is a possibility that the water may become turbid due to the construction work and affect the water quality of nearby areas. **During shared uses:** - There is a possibility that the waste water is generated due to the operation of facilities and affect the water quality of nearby areas. - Burying wastes after going through intermediate processing (incineration + MBT) is expected to reduce sources of pollution in landfill sites and improve the quality of leachate.
	3	Wastes	D	Ba	**During construction:** Residual soil of construction and waste materials are expected to be generated. Yet, the emission of toxic wastes is not expected. The generated wastes are landfilled within the currently available sanitary landfill site (using the residual soil for covering). Thus, there is no possibility of affecting the nearby environment. **During shared uses:** - The volume of wastes to be landfilled can be drastically reduced by processing wastes which used to be directly landfilled in intermediate treatment (incineration + MBT). - Wastes containing some harmful substances such as fly ash are expected to be generated.
	4	Soil pollution	B-	C+	**During construction:** There is a possibility that the water may become turbid due to the construction work, which may also negatively affect the soil. **During shared uses:** - There is a possibility that the wastewater may be discharged by operating facilities, which may also negatively affect the soil.

Category		Category of effects	Evaluation		Ground for evaluation
			Before construction During construction	During shared uses	
	5	Noise and vibration	B-	B+	**During construction:** Noise and vibration are expected to be generated during the transportation of construction materials and construction work. **During shared uses:** Noise and vibration are expected to be generated due to the operation of facilities.
	6	Odor	D	B+	**During construction:** No odor-causing operation is expected to take place. **During shared uses:** The odor would not become worse than the current level due to operating facilities within the premise of the current disposal site where wastes are directly landfilled. Instead, the heat treatment and aerobic fermentation stabilize organic wastes which become causes of odor in early phases. Thus, there is a possibility that the facility will reduce the odor that is being generated from the current disposal site.
Natural environment	7	Conservation area	D	D	No national park or conservation area is located at the targeted project site or nearby areas.
	8	Ecosystem	D	D	No old-growth forest, natural tropical forest, or ecologically important habitat (e.g. coral reef, mangrove swamp, and tidal flat) is located at the project site and nearby areas. No rare species has been found at the project site.
	9	Site management after the project	D	D	No site management after completing the project is necessary, since this project does not involve waste disposal site, and the project is expected to be implemented under the BOT scheme.
Social environment	10	Relocation of residents	D	D	Relocation of residents is not necessary.
	11	Lifestyle	D	D	* The noise and vibration level is expected to increase during the construction, and odor needs to be controlled during shared uses. Yet, details are described in the category of "pollution prevention measures" and omitted in this section.
	12	Livelihood	B+	B+	**During construction:** The construction produce employment opportunities. **During shared uses:** The operation and management of new facilities produce employment opportunities to local residents. Waste pickers are employed for manual sorting of wastes and for other tasks. Thus, they can earn stable income.
	13	Cultural asset	D	D	Valuable archaeological, historical, cultural, and religious assets and remains which require special attention are not found in nearby areas.
	14	Landscape	D	C-	There is no landscape which becomes a tourism resource. Yet, chimney stacks and other parts of incineration facilities may degrade the landscape.

Category		Category of effects	Evaluation		Ground for evaluation
			Before construction During construction	During shared uses	
	15	Ethnic minorities and indigenous people	D	D	No ethnic minorities or indigenous people is living in nearby areas.
	16	Working environment	D	Bo	**During construction:** The work occurs within Phuoc Hiep disposal site where no ordinary citizen is found; thus, there is no possibility of harming the citizens. Infrastructures have also been developed, and there is no possibility that workers of the disposal site face risks. **During shared uses:** The working environment becomes improved in comparison to landfilling work. Yet, workers assigned to the operation of incinerators may face risks without proper safety measures.
Others	17	Effects during construction	D	D	*The noise and vibration level is expected to increase during the construction. Yet, details are described in the category of "pollution prevention measures" and omitted in this section.
	18	Monitoring	D	B+	**During construction:** No monitoring is conducted during the construction. **During shared uses:** Monitoring of the amount of CO2 reduction is required for a certain period if the application submitted to JCM subsidy program is accepted.

A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (A further examination is needed, and the impact could be clarified as the study progresses)
D: No impact is expected.

CHAPTER 7 ISSUES ON REALIZATION OF THE PROJECT

(1) Aspects concerning fund

The processing cost and the unit price of electricity sales are low in Vietnam; thus, subsidy is required in addition to loans. Submitting an application to "Subsidy Fund for Leapfrog Type Development" is now being considered. Yet, it is unclear whether expected amount of subsidy can be received for the following two concerns: (i) the subsidy covers half the cost of carbon-reducing equipment; and (ii) the project size is larger than the budget scale of the program. There are a variety of concepts concerning carbon-reducing equipment. Thus, it is important to keep contacting Ministry of the Environment, secretariat, and relevant organizations.

Moreover, it is thought to be necessary loans from JICA based on a relationship of trust with Vietnam government at ODA until now, long-term and stable loans to keep the business in addition to accepting subsidy.

(2) Business partners

Kobelco Eco-Solutions and its subsidiary, Kobelco Eco-Solutions Vietnam have abundant experiences in running water business in Vietnam. However, they have no experience in running waste treatment business. Thus, Japanese and Vietnamese business partners are necessary in order to secure wastes as well.

Multiple negotiation sessions have been held with Hitachi Zosen Corporation to become a Japanese partner. A business commission agreement was agreed on for a part of this FS on December 1, 2014. Negotiation is still being continued to include the conclusion of JV agreement. Hitachi Zosen Corporation submitted a request for an approval in principle to the Ho Chi Minh PC in August 2014 and Kobelco Eco-Solutions in November 2014. Both companies have acquired the approval in principle. Although they are independently operating, we are aiming to work so that the two companies will work on one project at the end as discussed earlier. We are continuing to exchange information and negotiation.

A discussion was held with Viet Star, a waste treatment company. Yet, Viet Star is not considered to be a desirable partner for the following two reasons at this point: (i) Viet Star is demanding an operation under its own licenses (because it takes time to obtain a new license for waste-to-energy power generation); (ii) Viet Star is not willing to make investment. Tam Sinh Ngina that was initially considered as a candidate is focusing on expanding their own composting plant from 1,000 tons/day to 2,000 tons/day. They are not interested in participating our project. Therefore, Tam Sinh Ngina is not considered as a desirable candidate at this point.

(3) Government organizations in Vietnam

A concern is that the response of government organizations is extremely slow, such as that it takes about one year to obtain MD. There is a slight change in their attitude, however, such as that the application for the approval in principle submitted in November 2014 was granted on February 3, 2015, showing that their response was relatively quick. An opposition to Vietnam Waste Solutions, a landfill company, may be affecting this trend. Yet, one of the reason for the faster processing is that the understanding on waste-to-energy projects is being deepened.

Kobelco Eco-Solutions is now mainly negotiating with DONRE. Local staff of Kobelco Eco-Solutions Vietnam is contacting with DONRE. Contacting the Ho Chi Minh PC is also considered necessary in addition to DONRE as the investigation progresses.

(4) Wastes

Wastes are expected to become the largest challenge in the future in this project. All non-industrial wastes are assumed to be under the management of DONRE. A long term agreement with DONRE to warrant the supply of wastes is necessary to ensure stable operation of the project. Concepts concerning individual types of wastes are described below.

1) Sorted waste

Sorted wastes are expected to be 360 tons or 60% of 600 tons. Yet, the volume is not as large at this point. The weight is estimated to be about 300 tons a day in the plan of one zone in Ho Chi Minh City and Binh Thanh district. Wastes need to be sorted in a steady progress for stable operation of the project.

2) Compost residue

Viet Star alone is generating 600 tons of compost residue in a day, meaning the weight is not a problem. Although the compost residue is being generated from a private company, it is categorized as non-industrial waste and placed under the management of DONRE. Thus, the compost residue is expected to be received if designated by DONRE. Even when DONRE gives a designation, it is necessary to maintain a positive relationship with generators of compost residue, since we cannot receive the compost residue if they construct their own incinerators and reduce the amount of compost residue.

3) Dug-up waste

If dug-up waste is included as the target to be processed, additional cost becomes necessary for digging up wastes from landfill sites. Therefore, it is necessary to avoid causing financial burden on the business operator by negotiating with DONRE in regards to the cost.

(5) Land

The land is expected be loaned without charge assuming that utility supply network for electricity and water is in place. Yet, opposition from local residents may be possible due to the nature of a waste treatment facility. The power of the Ho Chi Minh PC and DONRE is expected to be effective in these processes.

Designation of land by DONRE is probably necessary upon staring a business. A designation for Phuoc Hiep disposal site is desirable, since it is already operating as a final disposal site, and composting companies such as Viet Star and Tam Sinh Nghia are already operating in this site, and electricity and water supply are available.

(6) Tipping fee and sales rate of electricity

Negotiation on tipping fee with DONRE and the sales rate of electricity with EVN will start after receiving an official waste land designation from the Ho Chi Minh PC.

The expected tipping fee in this process is 26 USD/ton. Yet, the kick-off meeting with DONRE mentioned 25 to 30 USD/ton. A request for adding the fee is planned to ensure profitability.

The Ordinance of Prime Minister also designated the sales rate of electricity at 10.05 UScent/kWh, which requires an agreement with EVN. A negotiation is required for this process as well.

(7) Overseas rivals

Companies in Korea and Finland are also interested in waste-to-energy project of Ho Chi Minh City. There is an information that they submitted proposals to Ho Chi Minh City.

The profitability of this project may be lowered if competition occurs against lower-price incinerators of overseas rivals.

(8) New PPP law

The new PPP law was enacted starting in April 2015. The conventional Decree No. 108/2009/ND-CP that designated BOT and BOO clearly became inapplicable. The enactment of this law increased the possibility of adopting international competitive bidding for projects which could have been operated based on special orders. This may further reduce the profitability of the project and make running businesses in Vietnam even more difficult. This law was not initially expected and became a great concern which may be an obstacle to this project.

Detailed procedures under the new PPP law are yet to be released, and detailed procedures are still unclear. Future movements need to be carefully observed.

(9) Environment impact assessment

It is necessary to do environment impact assessment because we have not finished it yet.

PART 4

CHAPTER 8 PLAN ON INDUSTRIAL WASTE TREATMENT PROJECT

8.1 BACKGROUND AND NECESSITY OF THE PROJECT

(1) BACKGROUND OF THE PROJECT

In 2010, 2,350 tons/day (non-hazardous industrial waste: 2,000tons/day, hazardous industrial waste: 350tons/day) of industrial waste is generated in Ho Chi Minh City, the biggest city in South Vietnam. 1,140 tons/day (non-hazardous industrial waste: 937tons/day, hazardous industrial waste: 204tons/day, in 2013) of industrial waste is generated in Long An Province, which is one of the provinces composed the Southern Key Economic Zone. 1,052tons/day (non-hazardous industrial waste: 883tons/day, hazardous industrial waste: 169tons/day in 2010) from Binh Duong Province, 1,331tons/day (non-hazardous industrial waste: 1,206tons/day, hazardous industrial waste: 125tons/day, in 2012) from Dong Nai Province, 934.7tons/day (non-hazardous industrial waste: 726.3tons/day, hazardous industrial waste: 208.4tons/day, in 2013) from Ba Ria-Vung Tau Province are generated.

On the other hand, treatment facilities to treat properly these industrial wastes are not developed in Ho Chi Minh City, Long An Province and surrounding provinces, therefore, industrial waste treatment business is promoted by Long An Province, which aims to become environmental-friendliness city.

(2) NECESSITY OF THE PROJECT FOR INTEGRATED THE WASTE MANAGEMENT SYSTEM

This project encompasses an establishment of an integrated system for waste incineration and power generation treating industrial solid waste, which is generated in Ho Chi Minh City, Long An Province and surrounding provinces.

(1) Solid waste generated from Ho Chi Minh City, Long An Province and surrounding provinces will be safely and hygienically treated by incinerator of Japanese advanced technologies to reduce the effects on the environment in the open-dumping site and surrounding area.

(2) High-end incineration treatment system will help to drastically reduce the amount of final disposal waste, it would be the way of solving social problems of life expansion of landfill sites in the future.

(3) Power generation by waste as fuel will contribute to power shortages in Vietnam, as people use electricity more than before, because of increasing population and living standards. And it also contributes to reduce environmental burdens by establishment of “Waste to energy” society using recyclable energies.

(4) Waste treatment companies, which treat unlawfully, have been widespread in Vietnam. In this situation, this project will create a framework under which Japanese companies feel secure to leave waste treatment operations without a risk of being fined. As a result, it will induce

Japanese companies such as plating, molding and casting to move in industrial park in Vietnam, consequently, giving a huge boost to Vietnam's economic competitiveness.

(5) To infuse the concept of "Project finance" into institutions, strong support from the Central Bank and the Ministry of Finance of Vietnam and a proper guidance given to financial institutions will be required.

8.2 OBJECTIVE OF THE PROJECT

Expertise and experiences enriched in establishing waste management system in Japan as well as capitals will be introduced to build systems for incineration of industrial solid waste which is enable a supply of electricity generated by waste incineration. The objective of the project is to contribute to solution of pollution issues, life expansion of for landfill site, and reduction of environmental burden in Vietnam, in addition, to contribute to Vietnam's economic development including attraction of Japanese companies through the development of recycling industries.

8.3 DEMAND PREDICTION OF THE PROJECT

8.3.1 FACT-FINDING SURVEY ON WASTE GENERATION AND TREATMENT

(1) PURPOSE OF SURVEY

Fact-finding survey related to industrial waste, which is generated by company in South Vietnam, was carried out to clarify about treatment amount, method, composition/kinds, treatment cost and waste collection.

(2) SURVEY AREA

The survey areas are Ho Chi Minh City, Long An Province, Dong Nai Province, Ba Ria-Vung Tau Province, Binh Duong Province.

(3) SURVEY CONTENTS

The survey contents is shown below,

1) Treatment amount

100 companies and 15 medical institutions in 1 city and 5 provinces (Ho Chi Minh City, Long An Province, Dong Nai Province, Ba Ria-Vung Tau Province, Binh Duong Province) were chosen as target agencies for fact-finding survey on industrial waste and medical waste.

2) Treatment/disposal methods

The methods of treatment and disposal such as dumping, compost, incineration and recycling were studied.

3) Composition/kinds

The composition/kinds of waste generated from 100 target agencies in 1city and 4 provinces were studied.

4) Waste collection/transportation companies

20 waste collection/transportation companies in 1city and 4 provinces were studied including treatment units.

100 companies were chosen as target agencies. To secure capacity of waste collection, 150 tons/day, 20 companies were selected, which company has possibility to become a business partner.

The data of 100 companies in each type are shown below.

Table8-1 List of Target Companies

No	Type	Dong Nai Province	Ba Ria-Vung Tau Province	Binh Duong Province	Ho Chi Minh City	Long An Province	Total number
1	Packer	1	2	2	2	1	8
2	Leather product	2	2	2	8	4	18
3	Paper product	1	1	4	1	0	7
4	Apparel	5	8	6	6	10	35
5	Sugar industry	0	0	0	0	0	0
6	Wood	5	2	4	2	1	14
7	Accessory (bag, wallet)	2	0	1	0	1	4
8	Tobacco	2	0	0	0	0	2
9	Bedclothes	0	0	1	0	0	1
10	Tire	1	0	0	0	0	1
11	Food	1	5	0	1	3	10
	Total	20	20	20	20	20	100

Source: JICA study team

8.3.2 RESULT OF SURVEY ON WASTE GENERATION AND TREATMENT

(1) CURRENT SITUATION OF WASTE GENERATION

1) Current situation of waste generation and collection/treatment in Long An province

Currently, the total amount of solid waste generation in Long An province is 2,241.1 tons/day, in which municipal solid waste is 1,099.0 tons/day, industrial waste is 1,141.0 tons/day (non-hazardous waste is 937.9 tons/day, hazardous waste is 204.0 tons/day), medical waste is 1.1 tons/day (non-hazardous waste is 0.6 tons/day, hazardous waste is 0.5 tons/day).

Regarding municipal solid waste, 802.3 tons/day of municipal solid waste, which is equivalent to 73.0%, is collected, and all of that is disposed of at landfill site. As for industrial waste, most of non-hazardous industrial waste is recyclable. As for medical waste, collection ratios of non-hazardous medical waste and hazardous medical waste are 100% and 0.5 tons/day of hazardous medical waste is incinerated.

The total amount of solid waste generation in Long An province is shown in the table below.

Table8-2 Amount of Solid Waste Generation in Long An Province (2013)

Unit: tons/day

Type	Non-hazardous wastes				Hazardous wastes			Total
	Domestic	Industrial	Medical	*Total*	Industrial	Medical	*Total*	
Generation	**1,099.0**	**937.0**	**0.6**	***2,036.6***	**204.0**	**0.5**	***204.5***	**2,241.1**
Combustible	329.7	359.0	0.1	*688.9*	170.3	0.46	*170.8*	859.6
Incombustible	769.3	367.3	0.4	*1,137.0*	33.7	0.07	*33.8*	1,170.8
Collection + Treatment	**802.3**	**625.7**	**0.6**	***1,428.5***	**204.0**	**0.5**	***204.5***	**1,633.0**
Landfill	802.3		0.6	*802.8*		0.1	*0.1*	**802.9**
Incineration				-		0.5	*0.5*	**0.5**

Source: JICA study team

2) Current situation of waste generation and collection/treatment in Ho Chi Minh city

Currently, the total amount of solid waste generation in Ho Chi Minh city is 8,000 tons/day, in which municipal solid waste is 5,694.4 tons/day, industrial waste is 2,292.0 tons/day (non-hazardous waste is 1,976.0 tons/day, hazardous waste is 316.0 tons/day), medical waste is 13.6 tons/day (non-hazardous waste is 10.2 tons/day, hazardous waste is 3.4 tons/day).

Regarding municipal solid waste, 5,549.6 tons/day of municipal solid waste, which is equivalent to 97.5%, is collected. In which, 4,717.2 tons/day is disposed of at landfill site and 832.4 tons/day is treated in compost plant. As for industrial waste, most of non-hazardous industrial waste is recyclable or is disposed of at landfill site. On the other hand, 56.9 tons/day of hazardous industrial waste, which account for 18.0%, is incinerated. As for medical waste, collection ratios of non-hazardous medical waste and hazardous medical waste are 100% and 3.4 tons/day of hazardous medical waste, which account for 100%, is incinerated.

The total amount of solid waste generation in Ho Chi Minh city is shown in the table below.

Table8-3 Amount of Solid Waste Generation in Ho Chi Minh City (2010)

Unit: tons/day

Type	Non-hazardous wastes				Hazardous wastes			Total
	Domestic	Industrial	Medical	*Total*	Industrial	Medical	*Total*	
Generation	**5,694.4**	**1,976.0**	**10.2**	***7,680.6***	**316.0**	**3.4**	***319.4***	**8,000.0**
Combustible	740.3	1,247.3	6.8	*1,994.3*	83.4	2.3	*85.7*	2,080.0
Incombustible	4,954.1	728.7	3.4	*5,686.3*	232.6	1.1	*233.7*	5,920.0
Collection + Treatment	**5,549.6**	**592.8**	**10.2**	***6,152.6***	**316.0**	**3.4**	***319.4***	**6,472.0**
Landfill	*4,717.2*	*503.9*	*8.7*	*5,229.7*			-	***5,229.7***
Composting	*832.4*	*88.9*	*1.5*	*922.9*			-	***922.9***

Type	Non-hazardous wastes				Hazardous wastes			Total
	Domestic	Industrial	Medical	*Total*	Industrial	Medical	*Total*	
Incineration				-	*56.9*	*3.4*	*60.3*	***60.3***
Solidification				-	*25.3*		*25.3*	***25.3***
Wastewater treatment system				-	*15.8*		*15.8*	***15.8***
Recycle				-	*218.0*		*218.0*	***218.0***
Sell of valuable		**1,383.2**		**1,383.2**			-	**1,383.2**

Source: JICA study team

3) Current situation of waste generation and collection/treatment in Binh Duong province

Currently, the total amount of solid waste generation in Binh Duong province is 2,009.9 tons/day, in which municipal solid waste is 947.0 tons/day, industrial waste is 1,052.0 tons/day (non-hazardous waste is 883.0 tons/day, hazardous waste is 169.0 tons/day), medical waste is 5.9 tons/day (non-hazardous waste is 4.7 tons/day, hazardous waste is 1.2 tons/day).

Regarding municipal solid waste, 710.0 tons/day of municipal solid waste, which is equivalent to 75.0%, is collected. In which, 568 tons/day is disposed of at landfill site, 71 tons/day is treated in compost plant and 71 tons/day is treated in incineration plant. As for industrial waste, most of non-hazardous industrial waste is recyclable or is disposed of at landfill site. On the other hand, 25.4 tons/day of hazardous industrial waste, which account for 100%, is incinerated. As for medical waste, collection ratios of non-hazardous medical waste and hazardous medical waste are 100% and 1.1 tons/day of hazardous medical waste is incinerated.

The total amount of solid waste generation in Binh Duong province is shown in the table below.

Table8-4 Amount of Solid Waste Generation in Binh Duong Province (2010)

Unit: tons/day

Type	Non-hazardous wastes				Hazardous wastes			Total
	Domestic	Industrial	Medical	*Total*	Industrial	Medical	*Total*	
Generation	**947.0**	**883.0**	**4.7**	***1,834.7***	**169.0**	**1.2**	***170.2***	**2,004.9**
Combustible	284.1	510.6	1.3	*796.0*	141.1	1.0	*142.1*	938.1
Incombustible	662.9	372.4	3.5	*1,038.7*	27.9	0.2	*28.1*	1,066.8
Collection + Treatment	**710.0**	**264.9**	**4.3**	***979.2***	**25.4**	**1.1**	***26.4***	**1,005.7**
Landfill	568.0	264.9	4.3	*837.2*			-	**837.2**
Composting	71.0			*71.0*			-	**71.0**
Incineration	71.0			*71.0*	25.4	1.1	*26.4*	**97.4**
Sell of valuable		**618.1**		***618.1***	**143.7**		***143.7***	**761.8**

Source: JICA study team

4) Current situation of waste generation and collection/treatment in Dong Nai province

Currently, the total amount of solid waste generation in Dong Nai province is 2,698.0 tons/day, in which municipal solid waste is 1,361.0 tons/day, industrial waste is 1,331.0 tons/day (non-hazardous waste is 1,206.0

tons/day, hazardous waste is 125.0 tons/day), medical waste is 6.0 tons/day (non-hazardous waste is 4.5 tons/day, hazardous waste is 1.5 tons/day).

Regarding municipal solid waste, 1,176.0 tons/day of municipal solid waste, which is equivalent to 86.4%, is collected. In which, 606 tons/day is disposed of at landfill site. As for industrial waste, most of non-hazardous industrial waste is recyclable or is disposed of at landfill site. As for medical waste, collection ratios of non-hazardous medical waste and hazardous medical waste are 100% and 1.5 tons/day of hazardous medical waste is incinerated.

The total amount of solid waste generation in Dong Nai province is shown in the table below.

Table8-5 Amount of Solid Waste Generation in Dong Nai Province (2012)

Unit: tons/day

Type	Non-hazardous wastes				Hazardous wastes			Total
	Domestic	Industrial	Medical	*Total*	Industrial	Medical	*Total*	
Generation	**1,361.0**	**1,206.0**	**4.5**	***2,571.5***	**125.0**	**1.5**	***126.5***	**2,698.0**
Combustible	408.3	697.4	1.2	*1,106.9*	104.3	1.3	*105.6*	1,212.6
Incombustible	952.7	508.6	3.3	*1,464.6*	20.6	0.2	*20.9*	1,485.4
Collection + Treatment	**1,176.0**	**1,206.0**	**4.5**	***2,386.5***	**106.4**	**1.5**	***107.9***	**2,494.4**
Landfill	606.0	361.8	4.5	*972.3*			-	**972.3**
Incineration				-		1.5	*1.5*	**1.5**
Sell of valuable		**844.2**		***844.2***			-	**844.2**

Source: JICA study team

5) Current situation of waste generation and collection/treatment in Ba Ria-Vung Tau province

Currently, the total amount of solid waste generation in Ba Ria-Vung Tau province is 1,679.1 tons/day, in which municipal solid waste is 742.0 tons/day, industrial waste is 934.7 tons/day (non-hazardous waste is 726.3 tons/day, hazardous waste is 208.4 tons/day), medical waste is 2.4 tons/day (non-hazardous waste is 1.8 tons/day, hazardous waste is 0.6 tons/day).

Regarding municipal solid waste, 571.3 tons/day of municipal solid waste, which is equivalent to 77.0%, is collected. In which, all of that is disposed of at landfill site. As for industrial waste, most of non-hazardous industrial waste is recyclable or is disposed of at landfill site. As for medical waste, collection ratios of non-hazardous medical waste and hazardous medical waste are 100% and 0.6 tons/day of hazardous medical waste is incinerated.

The total amount of solid waste generation in Ba Ria-Vung Tau province is shown in the table below.

Table8-6 Amount of Solid Waste Generation in Ba Ria-Vung Tau Province (2013)

Unit: tons/day

Type	Non-hazardous wastes				Hazardous wastes			Total
	Domestic	Industrial	Medical	*Total*	Industrial	Medical	*Total*	
Generation	**742.0**	**726.3**	**1.8**	***1,470.1***	**208.4**	**0.6**	***209.0***	**1,679.1**
Combustible	222.6	420.0	0.5	*643.1*	174.0	0.5	*174.5*	817.6
Incombustible	519.4	306.3	1.3	*827.0*	34.4	0.1	*34.5*	861.5
Collection + Treatment	**571.3**	**726.3**	**1.4**	***1,299.0***	**208.4**	**0.6**	***209.0***	**1,508.0**
Landfill	571.3	676.0	1.4	*1,248.7*			-	**1,248.7**
Incineration				-		0.6	*0.6*	**0.6**
Sell of valuable		**50.3**		***50.3***			-	**50.3**

Source: JICA study team

6) Summary of amount of waste generation and treatment

Currently, the total amount of solid waste generation in Long An province and surrounding city/province is 16,623.1 tons/day, in which, Long An province is 2,241.1 tons/day, HCMC is 8,000 tons/day, Binh Duong province is 2,004.9 tons/day, Dong Nai province is 2,698.0 tons/day, Ba Ria - Vung Tau province is 1,679.1 tons/day.

The amount of non-hazardous waste is 15,593.5 tons/day, in which municipal solid waste is 9,843.4 tons/day, industrial waste is 5,728.3 tons/day, medical waste is 21.8 tons/day. The amount of hazardous waste is 1,029.6 tons/day, in which industrial waste is 1,022.4 tons/day, medical waste is 7.2 tons/day.

The total amount of solid waste generation in Long An province and neighboring city/provinces is shown in the table below.

Table8-7 Amount of Solid Waste Generation in Long An Province and Neighboring Provinces

Unit: tons/day

City/Province	Non-hazardous waste				Hazardous waste			Total
	Domestic	Industrial	Medical	*Subtotal*	Industrial	Medical	*Subtotal*	
HCM	5,694.4	1,976.0	10.2	7,680.6	316.0	3.4	319.4	**8,000.0**
Binh Duong	947.0	883.0	4.7	1,834.7	169.0	1.2	170.2	**2,004.9**
Dong Nai	1,361.0	1,206.0	4.5	2,571.5	125.0	1.5	126.5	**2,698.0**
Long An	1,099.0	937.0	0.6	2,036.6	204.0	0.5	204.5	**2,241.1**
Ba Ria-Vung Tau	742.0	726.3	1.8	1,470.1	208.4	0.6	209.0	**1,679.1**
Total	***9,843.4***	***5,728.3***	***21.8***	***15,593.5***	***1,022.4***	***7.2***	***1,029.6***	**16,623.1**

Source: JICA study team

Currently, the total amount of solid waste collection/treatment in Long An province and surrounding city/province is 13,113.1 tons/day, in which, Long An province is 1,633.0 tons/day, HCMC is 6,472.0 tons/day, Binh Duong province is 1,005.7 tons/day, Dong Nai province is 2,494.4 tons/day, Ba Ria - Vung Tau province is 1,508.0 tons/day.

The amount of non-hazardous waste is 12,245.8 tons/day, in which municipal solid waste is 8,809.2 tons/day, industrial waste is 2,209.7 tons/day, medical waste is 21.0 tons/day. The amount of hazardous waste is 867.2 tons/day, in which industrial waste is 860.2 tons/day, medical waste is 7.1 tons/day.

The total amount of solid wastes collection/treatment in Long An province and neighboring city/provinces is shown in the table below.

Table8-8 Amount of Solid Waste Collection/Treatment in Long An Province and Neighboring City/Provinces

Unit: tons/day

City/Province	Non-hazardous wastes				Hazardous wastes			Total
	Domestic	Industrial	Medical	*Subtotal*	Industrial	Medical	*Subtotal*	
HCM	5,549.6	592.8	10.2	*6,152.6*	316.0	3.4	*319.4*	6,472.0
Binh Duong	710.0	264.9	4.3	*979.2*	25.4	1.1	*26.4*	1,005.7
Dong Nai	1,176.0	1,206.0	4.5	*2,386.5*	106.4	1.5	*107.9*	2,494.4
Long An	802.3	625.7	0.6	*1,428.5*	204.0	0.5	*204.5*	1,633.0
Ba Ria-Vung Tau	571.3	726.3	1.4	*1,299.0*	208.4	0.6	*209.0*	1,508.0
Total	**8,809.2**	**2,209.7**	**21.0**	***12,245.8***	**860.2**	**7.1**	***867.2***	**13,113.1**

Source: JICA study team

(2) WASTE COMPOSITIN

Based on the composition analysis results of solid industrial waste of Binh Duong Province, the calorific value of waste was calculated and shown in the table below. Currently, there are few reports of survey on industrial waste composition in Vietnam. The report of survey on industrial waste composition in Binh Duong province carried out in the industrial parks and companies in many business sections. Binh Duong province has strongly developed with diverse business sections and is one of the provinces within the scope of the project, so the industrial waste composition of Binh Duong province is selected as typical industrial waste composition of this project.

Table8-9 Waste Composition and Calorific Value

No.	Composition	Percentage (%)	Heat value (kcal/kg)	The calorific value of 1 kg of waste (kcal)
1	Packaging, nylon	5.28	7,835.2	413.7
2	Sludge from waste water treatment system	0.49	500.0	2.4
3	Rubber scrap	0.86	6,051.1	51.9
4	Cardboard, shredded paper	15.40	3,894.0	599.9

No.	Composition	Percentage (%)	Heat value (kcal/kg)	The calorific value of 1 kg of waste (kcal)
5	Leather and leather products disposal	1.38	4,167.5	57.4
6	Wood chips, sawdust, shavings, wood pallets	16.57	2,880.0	477.2
7	Chemical disposal	0.20	12,166.4	24.6
8	Plastic waste	0.12	7,788.0	9.0
9	Defects (Food and Drug)	2.45	2,220.0	54.5
10	Domestic waste	36.71	2,220.0	815.0
11	Grease	0.24	6,135.4	15.0
12	Rags, scrap only	0.45	9,481.9	42.3
13	Gasoline, waste oil	0.07	9,255.0	6.5
14	Foam waste	6.72	6,000.0	403.3
15	Other	13.06	3,500.0	457.1
Total		100.00	-	**3,429.7**

Source: JICA study team

(3) UNIT COST OF WASTE TREATMENT

The costs of collection, treatment and disposal of industrial waste and medical wastes surveyed from the licensed hazardous waste treatment companies are presented in the table below.

Table8-10 Unit Cost of Waste Treatment

No.	**Treatment methods**	**Unit cost (VND/kg)**	**Note**
1	**SONADEZI SERVICE JOINT STOCK COMPANY**		
1.1	**Non-hazardous waste**		
	Burying hygienic	800 – 1,100	Depend on the composition, properties, workability of each type of waste that appropriate treatment before disposing. Since then handle unit price for each type of waste.
1.2.	**Hazardous waste**		
1.2.1.	– Burying safety; – Solidification, safety burying; – Crushing, solidification, burying safe	5,500 – 18,500	Depend on the type of waste, with each different manufacturing process, analyze samples representative of indicators as a basis for calculating the cost of processing.
1.2.2.	Combustion method	5,500 – 18,500	
1.2.3.	Physicochemical - biological methods	7,000 – 21,000	
2	**TIEN TAI CO. LTD.**		
2.1.	**Non-hazardous waste**		
2.1.1.	Burying hygienic	3,500	Receiving waste: non-hazardous sludge

No.	Treatment methods	Unit cost (VND/kg)	Note
2.1.2.	Combustion method	6,000	Receiving waste: combustible waste
2.2	**Hazardous waste**		
2.2.1.	Combustion method	6,500 – 35,000	Unit price for each type of waste depends on the composition and characteristics of each type of waste.
2.2.2.	Turns solid, safety burying	9,000 – 35,000	Unit price for each type of waste depends on the composition and characteristics of each type of waste.
2.2.3.	Rinse drums, metal contaminated hazardous constituent handle	6,000	
2.2.4.	Physicochemical - Microbiological methods	3.000 – 5.000	Unit price for each type of waste depends on the composition and characteristics of each type of waste.
3	**DAI LAM SON CO. LTD.**		
	Oil Waste Recycling	1.000 – 1.500	Unit price for each type of waste depends on the composition and characteristics of each type of waste.
4	**DONG NAI URBAN ENVIRONMENT SERVICES COMPANY LIMITED**		
4.1	Combustion method:		- Only functional group gathering and processing medical waste. - Unit price depends on the distance to the waste generation facility.
4.1.1.	For medical facility focused	12,279 – 13,944	
4.1.2.	For medical facility not focus	30,399 – 32,063	
5	**HOLCIM VIETNAM CO. LTD.**		
5.1.	At the same handled in cement kilns:		Applicative technology depends on the composition and characteristics of each type of waste.
5.1.1.	- Solid waste:	To 6,000	
5.1.2.	- Liquid waste:	To 6,600	
6	**MOI TRUONG XANH VN JOINT STOCK COMPANY**		
6.1.	Combustion method	5,500 – 8,000	Unit price for each type of waste depends on the composition and characteristics of each type of waste.
6.2.	Chemical and physical methods	6,000 – 7,000	
6.3.	Recycling of waste grease	3,000 – 4,000	
6.4.	Turns solid, safety burying	6,000 – 11,000	
7	**THANH LAP ENVIRONMENT PROCESSING TRADE CO., LTD.**		
7.1.	Combustion method	6,000	
7.2.	Solidification method, safety burying	3,000	
7.3.	Rinse drums, metal handle contaminated hazardous constituent	1,500	
7.4.	Recycling of waste grease	1,500	
7.5.	Chemical and physical methods	1,000	
7.6	The other method type	5,000	
8	**SAO VIET ENVIRONMENTAL JOINT-STOCK COMPANY**		
8.1.	Solvent waste	2,000	
8.2.	Oil, oil sludge waste	2,000	

No.	Treatment methods	Unit cost (VND/kg)	Note
8.3.	Battery-lead battery waste	4,000	
8.4.	Wastewater containing hazardous components	4,500	
8.5.	Flammable solid waste	5,000	
8.6.	Sludge	6,000	
8.7.	Fluorescent Lamp	12,000	
9	**TUOI SANG ENVIRONMENTAL COMPANY LIMITED**		
9.1.	Wastewater containing hazardous components	6,000 – 9,000	
9.2.	Electronic Components Waste	7,000 – 9,000	
9.3.	Hazardous sludge	7,000 – 10,000	
9.4.	Absorbents contaminated hazardous ingredients	7,000 – 10,000	
9.5.	Packaging contaminated hazardous waste	8,000 – 10,000	
9.6.	Waste oils	8,000 – 10,000	
9.7.	Paint sludge Waste	8,000 – 10,000	
9.8.	Battery - lead battery waste	8,000 – 12,000	
9.9.	Waste Ink	12,000 – 15,000	
9.10.	Fluorescent Lamp waste	15,000–25,000	
10	**BINH PHUOC XANH ENVIRONMENTAL TECHNOLOGY COMPANY LIMITED**		
10.1.	The packaging contaminated hazardous	5,000	
10.2.	Flammable wastes, high calorific value	6,000	
10.3.	The refractory waste	8,000	
10.4.	The other wastes	6,000 – 30,000	Unit price for each type of waste depends on the composition and characteristics of each type of waste.
11	**QUOC VIET ENVIRONMENTAL SCIENCE AND TECHNOLOGY COMPANY LIMITED**		
11.1.	The waste from the manufacturing process, plating, rinsing and cleaning metal surfaces	1,500 – 2,000	

Source: JICA study team

8.3.3 PREDICTION ON AMOUNT OF INDUSTRIAL WASTE AND MEDICAL WASTE GENERATION

Currently, the amount of industrial waste in Long An province and neighboring city/provinces is 6,750.7 tons/day, in which non-hazardous industrial waste is 5,728.3 tons/day, hazardous industrial waste is 1,022.4 tons/day. The amount of medical waste is 29.0 tons/day, in which non-hazardous waste is 21.8 tons/day, hazardous waste is 7.2 tons/day.

Table8-11 Amount of Industrial Waste and Medical Waste Generation

[Industrial waste]

Unit: tons/day

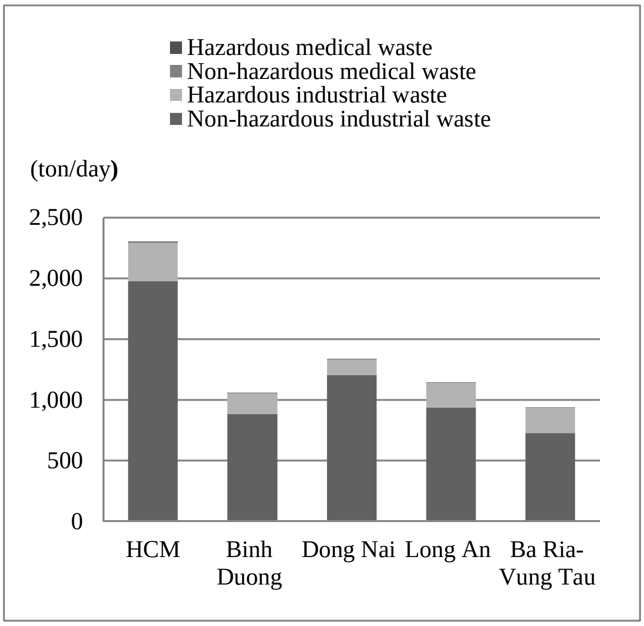
City/Province	Non-hazardous industrial waste	Hazardous industrial waste	Total
HCM	1,976.0	316.0	2,292.0
Binh Duong	883.0	169.0	1,052.0
Dong Nai	1,206.0	125.0	1,331.0
Long An	937.0	204.0	1,141.0
Ba Ria-Vung Tau	726.3	208.4	934.7
Total	**5,728.3**	**1,022.4**	**6,750.7**

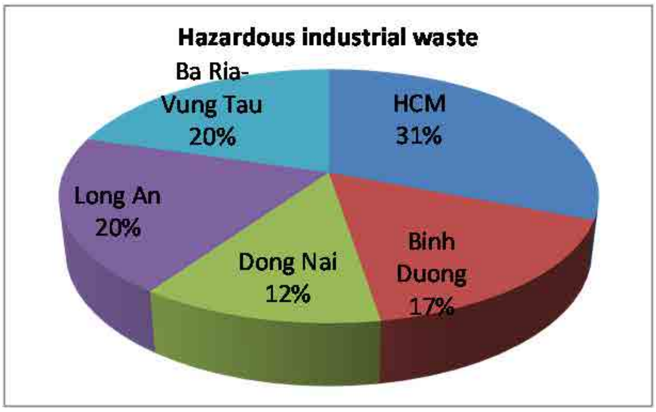
[Medical waste]

Unit: tons/day

City/Province	Non-hazardous medical waste	Hazardous medical waste	Total
HCM	10.2	3.4	13.6
Binh Duong	4.7	1.2	5.9
Dong Nai	4.5	1.5	6.0
Long An	0.6	0.5	1.1
Ba Ria-Vung Tau	1.8	0.6	2.4
Total	**21.8**	**7.2**	**29.0**

Source: JICA study team





Source: JICA study team

Figure8-1 Amount of Industrial Waste and Medical Waste Generation

Each amount of industrial waste and medical waste in Long An province and neighboring city/provinces is predicted in consideration with the economic development of the city/province. The predicted total amount of industrial waste and medical waste in 2020 is 18,532.80 tons/day. The amount of Non-hazardous waste is 15,116.0 tons/day and the amount of hazardous waste is 3,416.8 tons/day.

The amount of industrial waste is 18,434.4 tons/day, in which non-hazardous industrial waste is 15,040.5 tons/day, hazardous industrial waste is 3,393.9 tons/day. The amount of medical waste is 98.4 tons/day, in which non-hazardous waste is 75.5 tons/day, hazardous waste is 22.9 tons/day.

In the prediction, 6,092.0 tons/day, 33% of industrial waste, is generated from Ho Chi Minh City. 1,450.9 tons/day, 43% of hazardous industrial waste, is generated from Ba Ria-Vung Tau province. About half of medical waste, 46.1 tons/day, is generated from Ho Chi Minh City, in which hazardous medical waste is 11.5 tons/day.

< Reference data from the provinces>

- Binh Duong province: *"Report on current status of industrial development in the industrial parks of Binh Duong province"*- Binh Duong province People's Committee,March 2011; *"Report on currrent status of environment in the industrial parks in Vietnam"*- Vietnam Environment Administration (MONRE),2009, Ha Noi City
- Dong Nai province: " Report on plan of socaileconomic development and environmental strategy up to 2020"
- Ho Chi Minh City: "Plan of HCMC People's Committee on solid waste management up to 2020 and vision to 2030"
- Long An province: " Environmental master plan up to 2015 and orientation up to 2020 in Long An province"
- Ba Ria-Vung Tau province: "Plan on solid waste management in Ba Ria-Vung Tau province up to 2025 and vision to 2030"
- Medical waste: According to strategy document of Construction Ministry, emission factor of medical waste per bed in 2010: 2kg/day/bed, in 2015: 2.2 kg/day/bed and in 2020: 2.5kg/day/bed. Hazardous medical waste is about 25% of medical waste generation amount.

Forecast amount of non-hazardous waste and hazardous waste and tabulated industrial waste and medical waste by city/provinces are shown in below.

Table8-12 Forecast Amount of Industrial Waste and Medical Waste Generation in 2020

Unit: tons/day

City/Province	Non-hazardous waste			Hazardous waste			Total
	Industrial	Medical	*Subtotal*	Industrial	Medical	*Subtotal*	
HCM	5,184.00	34.6	*5,218.60*	908	11.5	*919.5*	***6,138.10***
Binh Duong	*2,280.00*	*18.8*	*2,298.80*	*456*	4.7	*460.7*	***2,759.50***
Dong Nai	2,845.90	8.6	*2,854.50*	273	2.7	*275.7*	***3,130.20***
Long An	1,405.50	8.2	*1,413.70*	306	2.7	*308.7*	***1,722.40***
Ba Ria-Vung Tau	3,325.10	5.3	*3,330.40*	1,450.90	1.3	*1452.2*	***4,782.60***
Total	**15,040.50**	***75.5***	***15,116.00***	***3,393.90***	***22.9***	***3,416.80***	***18,532.80***

[Industrial waste]

Unit: tons/day

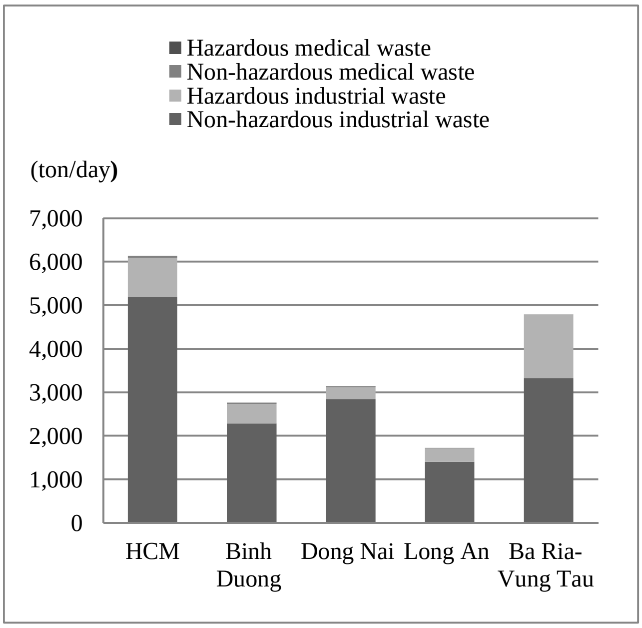
City/Province	Non-hazardous industrial waste	Hazardous industrial waste	Total
HCM	5,184.0	908.0	6,092.0
Binh Duong	2,280.0	456.0	2,736.0
Dong Nai	2,845.9	273.0	3,118.9
Long An	1,405.5	306.0	1,711.5
Ba Ria-Vung Tau	3,325.1	1,450.9	4,776.0
Total	**15,040.5**	**3,393.9**	**18,434.4**

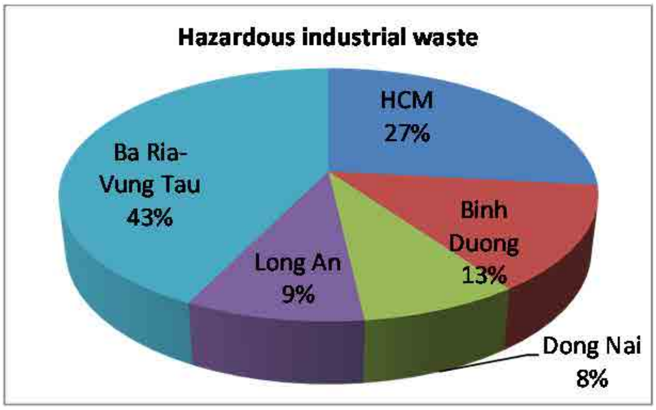
[Medical waste]

Unit: tons/day

City/Province	Non-hazardous medical waste	Hazardous medical waste	Total
HCM	34.6	11.5	46.1
Binh Duong	18.8	4.7	23.5
Dong Nai	8.6	2.7	11.3
Long An	8.2	2.7	10.9
Ba Ria-Vung Tau	5.3	1.3	6.6
Total	**75.5**	**22.9**	**98.4**

Source: JICA study team





Source: JICA study team

Figure8-2 Forecasted Amount of Industrial Waste and Medical Waste Generation

8.4 SCOPE OF THE PROJECT

(1) OUTLINE OF THE PROJECT

Project constructs industrial waste incinerator and it is located in IP of Can Duoc district, Long An province for treating waste from factories, IPs in this province as the neighboring provinces (Ho Chi Minh, Dong Nai…). Besides, after the waste supply source is stable, as expected, it will be constructed a plant for treating ash as the plant in Japan of Tsuneishi Kamtecs for producing artificial sand, construction material and brick from the ignition residue. Power that was generated from the boiler from the increasing power generation efficiency to 27%, it will be sold.

For improving, Thuan Dao IP is aimed to the target of friendly environment IP, it is really effort for attracting the investment to this project.

The overview of this project is showed below.

Table8-13 Outline of the Project (Draft)

Items	Contents
Scope of project	・Industrial waste and medical waste Treatment and Disposol ・Waste power generation
Planned construction site（square）	Thuan Dao Industrial park- Long An（20ha.）
Construction period	About 1 year

Items	Contents
Plan of Receiving waste	・Industrial waste（Hazardous materials, Special Waste such as Reagants and Spray, Waste Plastics, Warehouse of Hazardous Materials） ・Medical waste
Plan of treatment capacity	Industrial waste：150tons/day
Plan of selling power	Estimating based on expected power self-consumption
Facility	【Incineration treatment】First step ・Treatment capacity：150tons/day ・Power generation amount　：4MW 【Ash-baking plant】Second step（Consider after first step） ・Treatment object：Ash (Bottom ash、Flyer） ・Capacity　：Max 50tons/day 【Steam・Power generatior】Installation from first step ・Steam condition：Steam 26t/h, boiler outlet temperature 360℃,　Pressure 30kg/cm2 ・Tubin：4MW 【Landfill site（incineration ash is main）】 ・Usage period：10 years (Ash generation＝50,000ｔ/year ×20％=10,000 t/year）
All facilities	①　First step Incineration plant : waste receiving facility, incinerator, ventilation facility、Boiler、flue gas treatment facilities、stack, landfill site for after incineration ash ②　Second step Ash-baking plant : Ash receiving facilities、ash-baking plant、facility、flue gas treatment facilities、stack Artificial sand is used for civil engineering material utilization ※Second step condition：If the collection of ash emitted by the processing of industrial waste and general waste is determined to be stable it can be secured
Business period	After 2016
Business structure	①　Business partners considered separatel ②　Investment partners: considered separatel ※Assumed that local partners is main

Source: JICA study team

<u>Role and advantage of Long An province</u>

Most of waste treatment units in Vietnam are simple or careless landfill, they are not equipped sanitary treatment system or if be equipped they often make mistake in operating. Besides, there is not the suitable facilities to collect leachate, it issues the trouble in rainny season, when the waste amount increasing, then it influences to the underground water source and pollutes environment seriously. Recent reports showed that industrial and hazardous waste in Vietnam is dumped illegally without any treatment method and more than 60% amount of industrial waste is collected and treated as domestic waste.

In visiting to Long An province for making report for this project, authority of Long An confirmed the problem of waste treatment as the important social matter. Therefore, they are willing to support for doing project with the high-tech from Japan and also gave us the support letter. Be able construct a treatment system that Long An's authority can trust in to give all the industrial waste in this province, it can be a solution for local environmental issue, atract more investment from Japanese and other countries investors, but it is also the important role in the processing of economic development of Vietnam.

<u>Role and advantage of Thuan Dao IP</u>

For making differences to the other IPs, Thuan Dao IP had a target of constructing the IP with the top priority in environmental field. There are many wate treatment companies in Vietnam who violate the legal, it can be absolutely successful and safeful for giving treatment to a Japanese investor as this project. Besides, with this project, it can attract more investment from the supporting industries investors such as metallurgy, steel … as well as improving the ability of competition of this IP.

Mr. Mon – director of IP used to visit the treatment system of Japan appreciates technology there really good. They are very different from the Vietnamese treatment method and very clean in odor or emission gas. Therefore, he acclaims this project and promised try his hard in supporting for taking treatment licence, talking with inhabitant, complete infrastructure and urging the authority in local for doing the project successfully.

<u>Strong point for the waste generators</u>

At present, Japanese investors must face to many issues in environmental regulation such as slow in completing infrastructure which is related to environment, uncompletely environmental law, resident's awareness is weak or the existing of violated waste treatment companies. So, investors have to make plan for handling themselves and face to the risk of cost to treat waste themselves by high-tech methods or cannot treat different kinds of waste with the suitable method. By supplying services as well as giving the preeminent treatment methods from Japanese standard, this project can help the investors feel safe in their operation, for the investors who want to invest in Vietnam in the future, it can be reduced their risk.

(2) COLLECTING AND TRANSPORTATION PLAN

In this stage of this project, expectation capacity is 150 tons of waste. However, because there are some waste collected companies in local, we will buy waste from them as partners.

Below, we show you the potential partners who are waste treatment companies. Accordingly, these companies had their treatment system such as incineration or landfill. However, there are still the requirment for combusting hazardous waste, it can use waste from these intermediary companies (collected or saved).

Collection-Transportation companies	Quantity of vehicles
Sonadezi J/S Service Co.	45
Vietnam Waste Solution Co.Ltd,	80
HCM City Urban Environmental Company (Citenco)	64
Holcim Vietnam Cement Co.	25
Ha Loc Co.Ltd.	31
Vung Tau Urban Environment Service Co.	37

8.5 NECESSITY AND SUITABILITY OF TECHNOLOGY IN THIS PROJECT

Using maximum business and manage ability as well as the experience in supplying service and variety treatment ability by using equipments such as neutralize treatment facilities, solid waste incinerator, liquid waste incinerator, melting furnace … it started from the waste oil from ships treatment activity since 1973 with designed capacity under 170 tons/day. This is the real capacity of our plant in Fukuyama, Japan. It reduces investment, applies good experience for treating industrial waste in Vietnam, even though trainning for staff and reduces the risk in started investment from constructing plant. Moreover, as the financial analysis, with this capacity, the period for getting back the capital will belong 7 years and this project also reaches standard in getting return.

For the standard of necessary average generated heat to the plant of this project, as expected it is 2,500 – 4,000 kcal/kg. This is the calculated number from the standard of Fukuyama and based on the reality experience we are using in Japan. At this level of heat, we are adjusting fuel to control gas and temperature.

8.6 DESIGN CONDITION

(1) CONDITION RELATED TO WASTE

1) Amount of received waste

Amount of received waste: 150 tons/day

Using reality experiences from our plant in Fukuyama, we designed the incinerator with capacity nearly 170 ton/day.

2) Status of waste

As the survey report about the status, quality of waste in Vietnam, currently, it is not much. In Vietnam, Binh Duong province is the place of many Ips and variety in the kinds of factories, plants. Therefore, this report take Binh Duong as the representative object, the datas from Binh Duong will be the representative numbers in the report.

As the result of survey, average generated heat is calculated 3429.7 kcal/kg (as attached in table 8-11)
Average generated heat of the industrial waste for combusting is different, it belongs to the waste's component, waste's structure, generated time or the waste generator. So, together referring from others survey, this project gives the necessary average heat about 2,500-4,000 kcal/kg. This is the number that is calculated from the receiving standard in Fukuyama plant and based on the reality experience we are using in Japan. At this level of heat, it can be managed fuel for controlling gas and temperature.

(2) CONDITION RELATED TO FACILITIES

1) Main facilities

Acceptance Facility, Combustion Facility, Ventilation Facility, Waste Heat Boiler, Flue Gas treatment Facility, Stack

2) Operation time

330day／year

3) Capacity

Kiln 3.5 ton/h + stoker 2.8 ton/h

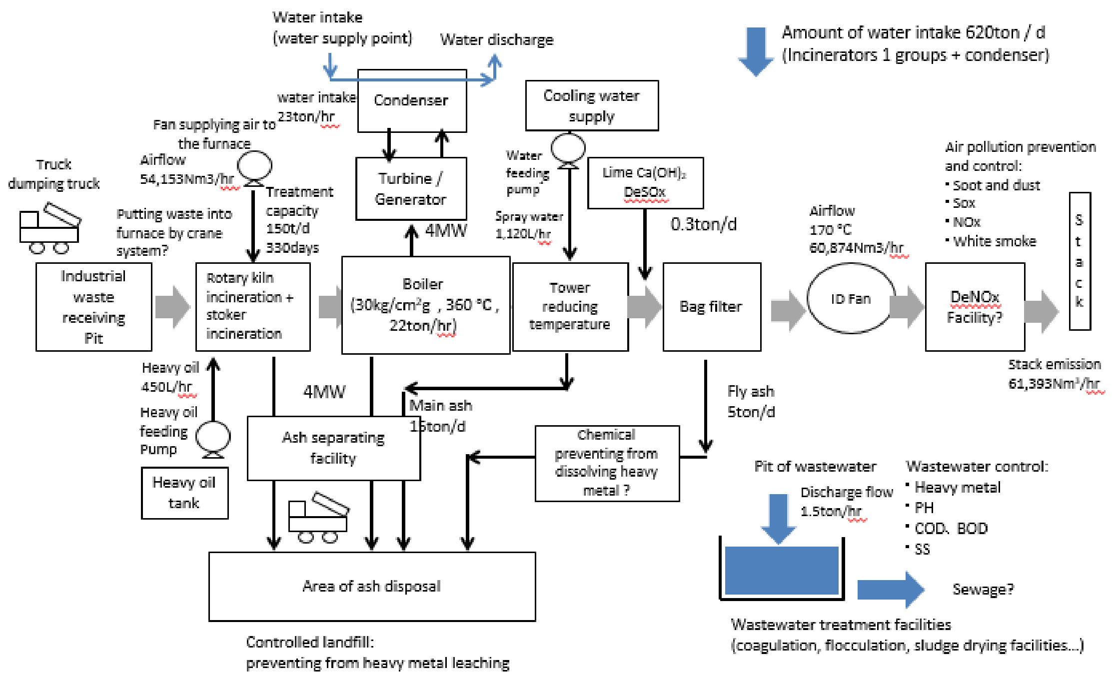
4) Steam-boiler condition

Steam：26 ton/h、Outlet temperature：360℃、pressure：30kg/cm2

5) Basic process of industrial waste incineration

The basic process of industrial waste incineration expected is described as follow.
The industrial wastes (IW) collected delivered to the waste receiving area and temporarily stored is fed to the rotary kiln incinerator by crane system. In the rotary kiln incinerator, the waste is preliminarily combusted at the temperature of 800oC by an external fuel (light oil expected) and the heat generated from industrial waste. The secondary combustion is performed in the stoker incinerator with the temperature of 1000 oC. After absolute combustion in the combined incinerator system, in order to effectively use the heat arising the combustion, the high-temperature emission will be flowed through the waste heat boiler to produce steam with high temperature and pressure (22 ton/h, 360oC). The steam will be taken into the turbine to generate power (4 MW).
The emission reduced the temperature in the boiler is continued to be reduced the temperature by the gas cooler. After lowing the temperature of emission, desulfurizing agent ($Ca(OH)_2$) is added and sulfur components (SOx) in the emission is removed in the form of $CaSO_4$. The emission quality after treatment by emission treatment facility meets the regulation QCVN 30:2012/BTNMT about concentration of SOx, dust, dioxin,…and release into the ambient environment via stack.
Ash after incineration including bottom ash and flyer is recovered and stabilized by heavy metals elution inhibitor, then taken to the ash storage area to store in a period.

Besides, wastewater arising in the company after collected by wastewater treatment facility is treated to meet National Technical Regulations on Industrial Wastewater – QCVN 40:2011/BTNMT for parameters such as COD, BOD, heavy metals before discharging.



Source: JICA study team

Figure8-3 Basic Process of Industrial Waste Incineration

(3) BASIC PROCESS OF INDUSTRIAL WASTE INCINERATION

Basic specification of incinerator is shown below.

Table8-14 Basic Specification of Incinerator (Draft)

Items	Overview
Crude premise estimation	①Industrial waste (enterprises in Ips, healthcare clinics …) Flammable, non-flammable, medical, hazardous waste (as standard in Japan) will use heat from 2,500 to 4,000 kcal/ton (dry) ① Capacity 150 tons/day ② Power generator system Vapor recovery + power generation ③ Ash after burning treatment The main ash after burning will be collected and transported to the disposal site. Transporting to disposal site to avoid leaked situation. In area of 10ha of project, planned land for disposal site is about 500,000 m3.
Waste treatment (estimation)	Assumption after surveying in Hochiminh city and 4 neighboring provinces (Long An, Dong Nai, Binh Duong, Baria – Vung Tau) ① Object Industrial waste (as Japanese GAP) Solid waste (paper wood material, resin, plastic, fiber, contamined soil, sludge), solvent (sludge from waste oil), heavy oil waste

Items	Overview
	Hazardous waste (asbestos, dioxin, strong acid waste, strong alkaline waste) Liquid waste is exempted ② Estimation of power generation (basic dry) 2,500 to 4,000 kcal/ton (considering) ③ Volume for treatment (expected) 150ton x 330days=49.500 ton/year ④ Industrial waste compositions Combustible, non-combustible, crushing, lightweight waste … Classified as sectors (textile, food, chemical, oil …) (considering) ⑤ Chemical's compositions Water, C, H, N, O, Cl, N, ash, heavy metals (Pb, Se, Cr, Hg, As…), ignition residue (considering)

Table 2 - Result of analysing of waste composition Unit: %

Classification of waste		Combustible waste	Non-combustible waste	Other kinds of waste	Crushed waste (specific value)
3 compositions	Water content	42.67	13.38	13.98	20.72
	Ash	6.12	30.68	27.07	9.74
	Combustible compositon	51.20	55.94	58.96	69.54
Analysing of waste composition	Carbon (C)	24.95	43.39	42.94	42.19
	Water (H_2O)	3.60	6.09	6.56	5.56
	Nitrogen (N)	0.29	0.16	0.33	1.97
	Oxygen (O)	22.24	5.16	6.72	15.92
	Combustible Sulfur (S)	0.04	0.53	0.53	2.19
	Volatile HCl	0.10	0.61	1.88	1.71
Heating value	Maximum value kJ/kg	10127	21391	23119	18563
	Minimum value kJ/kg	8242	19676	21285	16785
Specific weight	kg/m^3	130	207	105	127

Items	Overview
Equipment's specification	1. Equipment's specification ① Acceptable and Supply Facilities, Pit yard ③ Supply crane (overhead crane, gribbing amount, cycle time capacity design) ④ Cutting type, Conveyor Facility of Crushed waste ⑤ Removal of abnormal substance (magnetic seperation, incombustible debris, sorting of scrap metal) ⑥ Storage facilities (hazardous materials, special waste such as reagant, spray …, waste plastic, warehouse of hazardous materials) ⑥Cold Storage Warehouse and Pre-treatment Facilities of medical waste (Neutralization and Mixing, Analysis Facilities …) 2. Incinerator Furnace ① Capacity 150tons/day ② Kind of incinerator Suggested by suppliers with cheap price and ensuring the capacity Eg: Stalker furnace, rotary kiln, rotary kiln + stalker furnace Method for the primary and secondary combustion 3. I.D Facilities ① I.D Fan Capacity Generated gas premise ② F.D Fan ③ Power saving control Eg: using inverter

Items	Overview
	４. Steam recovery and power generation Steam recovery (assuming as intermediate pressure steam) ５. Incidental Facilities of Incinerator Furnace ① Electrial facilities (powered equipment, electric room, instrumentation) ② DCS Operation room and DCS ③ Raw Water tank, boiler, pure water manufacturing equipment (Eg: the primary – sand filtration, secondary – membrance treatment, …) ④ Furnace fuel supply equipment (heavy oil tank and transport equipment, drug tank and transport equipment, desulfurization agent tank and supply equipment (Eg: NaOH, hydrated lime) ６. Flue gas cleaning Equipment ① Estimation of combusted gas ② Velocity of dry dust collector (bag filter) ③ Clean gas emission standards Dust concentration, standard of Sox, Nox Vietnamese environmental standard ④ Desulfurization, denitration equipment (Eg: lime type, catalyst type…) ⑤ Dust collection equipment ７. Waste water treatment ① Water treatment facilities, waste water treatment facilities ② Treated water Condition and Waste Water standards Vietnamese environmental standard ③ Managed landfill as planned 500,000m3 Ash after combusting Estimated amount of generated ash Fly ash Estimated amount of fly ash ８. Office, parking Total constructed are 10ha ９. Operating time Operating time 24hours/day, 330days/year １０. In emergency cases Emergency power to prevent equipment damage of power failure or the like emergency, Heat Dissipation Equipment, Instrumentation Power Storage Battery, Preparing of Instrumentation Air,…

8.7 BASIC DESIGN

(1) THE ENTIRE LAYOUT

The entire layout is shown as below.

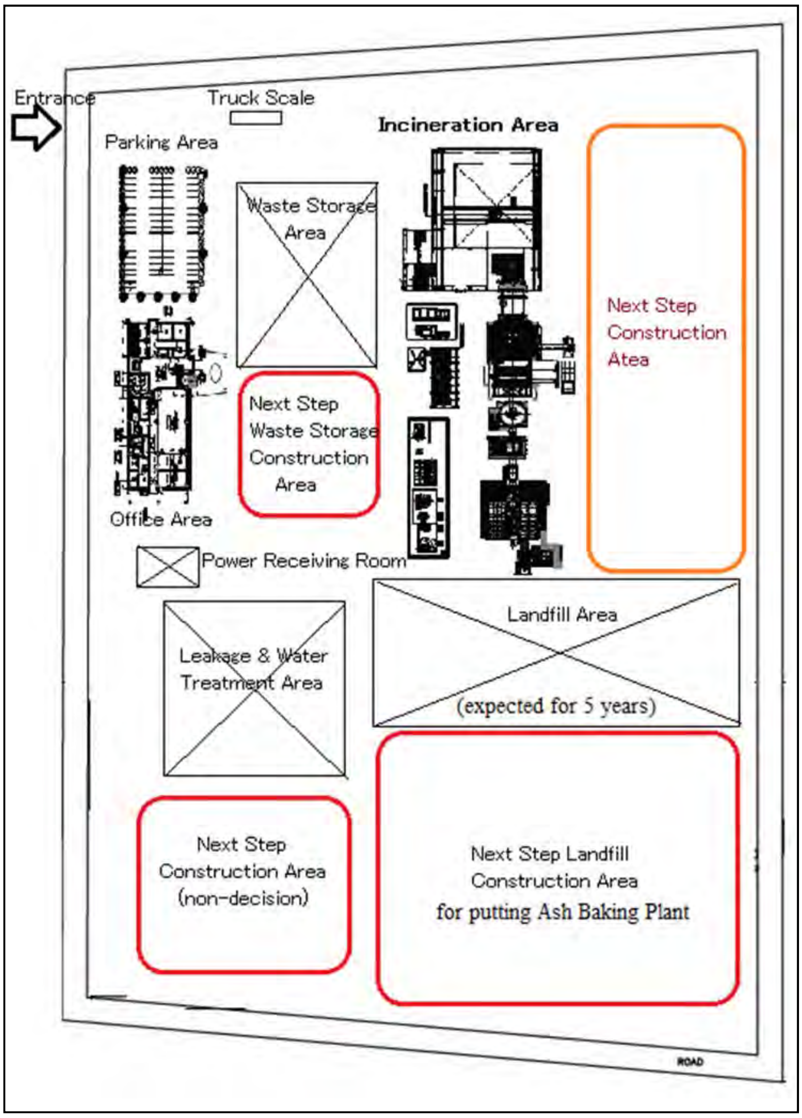


Figure 8-4 Basic Layout of the Incineration Plant in Thuan Dao Industrial Park

(2) FACILITIES LAYOUT

Facilities layout is shown as below.

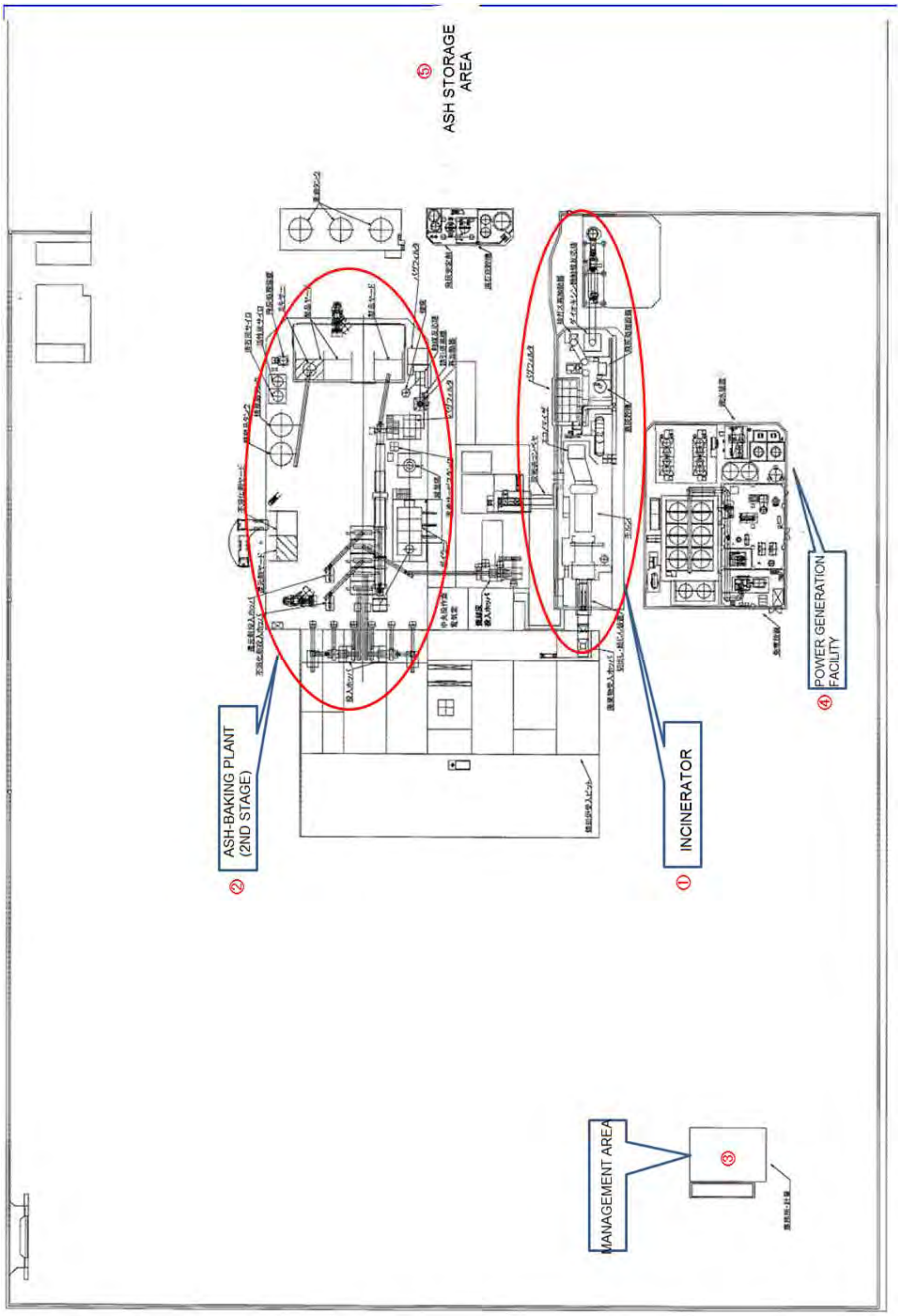


Figure8-5 Layout of Facilities (Draft)

(3) FLOW DIAGRAM INCINERATION PROCESS

Flow diagram incineration process is shown as below.

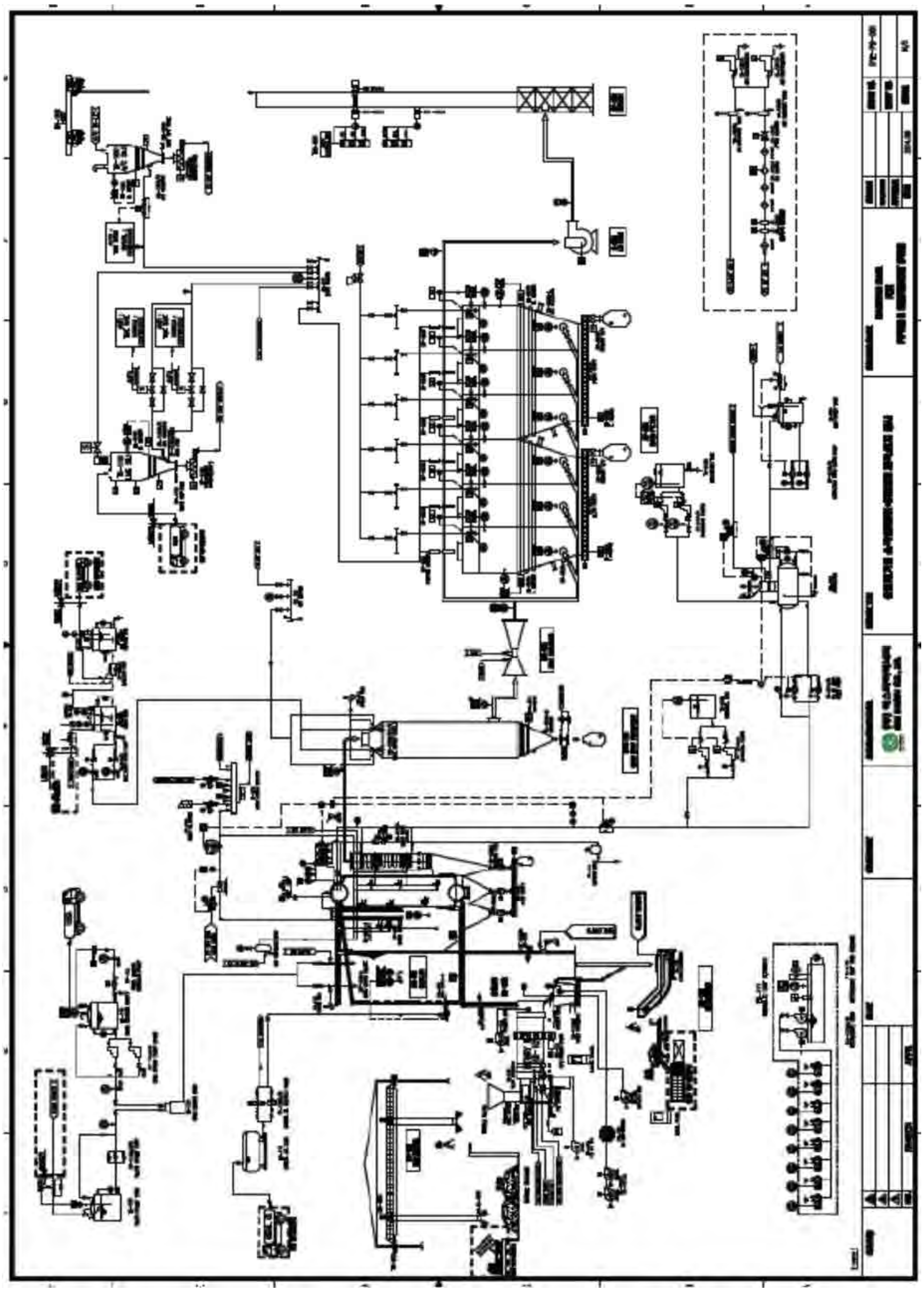


Figure8-6 Flow Diagram Incineration Process (Draft)

(4) STEAM OVER HEATING FACILITY

Flow diagram of Steam Overheating Facility is shown as below.

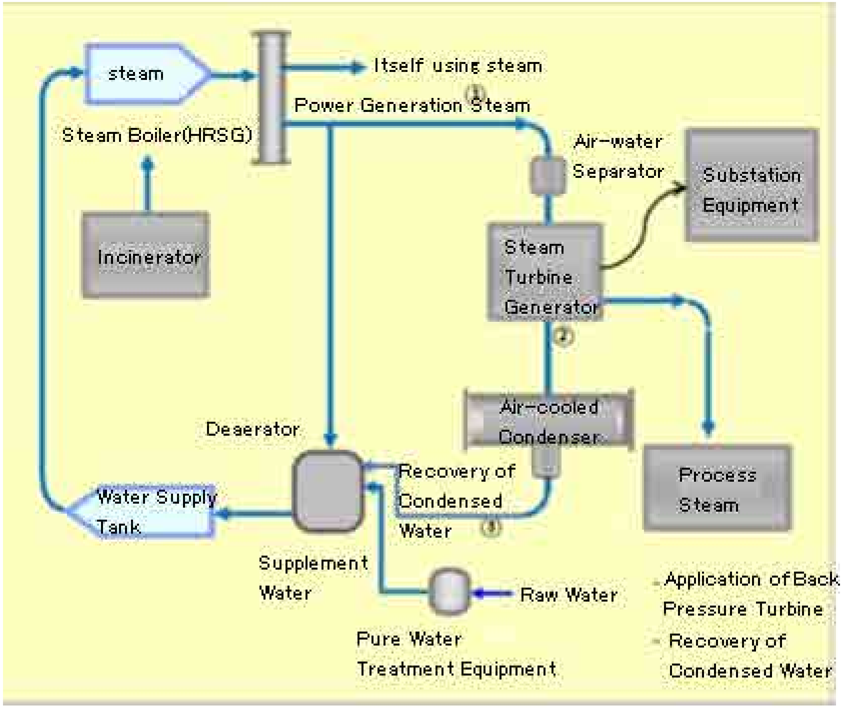


Figure8-7 Flow Diagram of Steam Overheating Facility (Draft)

Table8-15 Basic Specifications of Steam Overheating Facility (Draft)

Item	Spec.	Remarks
Steam Turbine Generator Set		
Steam Turbine	Condensor Type Turbine(4000kW,4500kW)	
Generator	Synchronous Generator,1800rpm, 6.6kV	
Control Panel	GCP, VCB, NGR	
Main Facilities		
Air-cooled Condenser	"A"Frame,1600Mcal	Recovery of Process Steam Condensed Water
	Vacumn Pressure -0.83kg/cm2 g = 0.2ata	Recovery of Process Steam Condensed Water
Water-cooled Condenser	Condenser +Ejector System New Vacumn Pressure -.09kg/cm2g	Recovery of Process Steam Condensed Water

Item	Spec.	Remarks
	Cooling Tower 3500RT	
Pure Water Treatment Facility	R/O(Two Pasa), 5ton/hr	
Substation Facility	High(Low) Pressure Breaker Board, Transformer Board MOF, T/R, CB etc.	
Monitoring and Control Facility	HMI, PLC, PC & Monitor	
Construction		
Elecrical Work	Generator Panel, Secondary Elecrical Facility	
	Line Construction 229kV,100m	
Piping Work	Piping, Insulation, Measuring Facility	
Installation Work	Turbine Generator, Condenser, Substation, Pure Water Treatment Equipment	
Civil Engineering Work	Fondation Structure of Facility	
Building Work	Substation	
Design and Licensing	Engineering, Design Drawings	
	Approval of the Power Generation Project, Pre-check etc.	

(5) FACILITIES

Facilities are shown as below.

Table8-16 Outline of Each Facility（Draft）

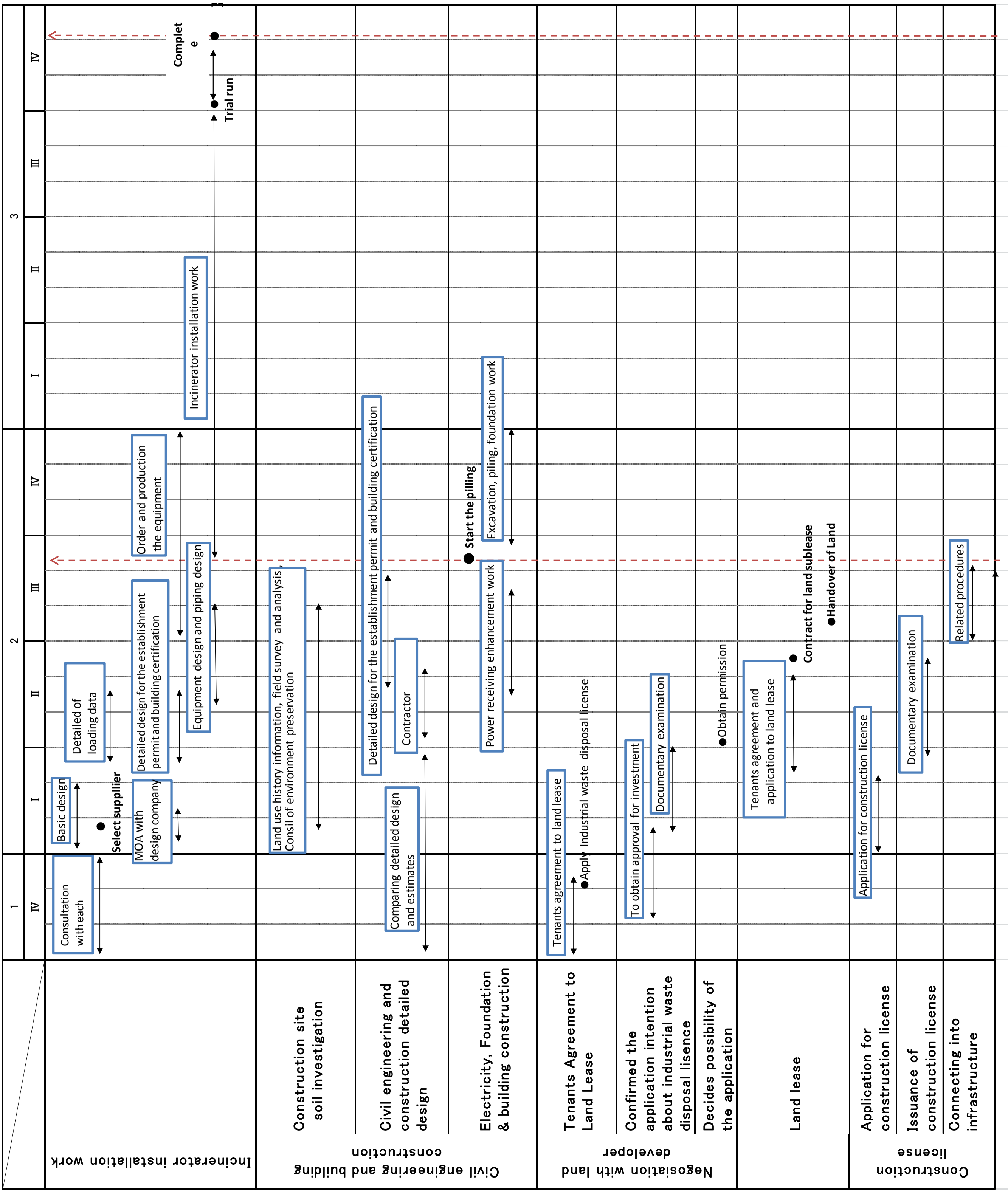
Items	Names	Specification	
		Using Steam	Including Power Generation
Waste Material Feeding Facility	Crusher	Exclude	
	Crane	Overhead Crane, (Bucket: 1.5 ㎥), 1 Lot	
Incinerator	Type	Rotary Kiln + Stocker	
	Capacity	150tons/day (Kiln 3.45 + Stocker 2.8ton/hr)	
	Size	Kiln: Ø3.5Mx10M	
	Lower Calorific value	4,009 kcal/kg	

Items	Names	Specification	
		Using Steam	Including Power Generation
	Gas amount		
	Volume of Combustion Chamber		
	Fire Area		
	Feeding of Waste Liquid to Secondary Combustion Chamber		
	Combustion Burner	1st : 3,000,000 Kcal/h(Kiln) 2nd : 4,500,000 Kcal/h(Stoker)	
	Using Fuel	LNG	
Boiler	Type (Water Tube)	W/T 2-Drum	
	Capacity(Steam)	28 ton/hr	26 ton/hr
	Temperature of Boiler Outlet	230 ℃	360 ℃
	Design Pressure	25 Kg/㎠.	38 Kg/㎠.
	Using Pressure	20 Kg/㎠.	30 Kg/㎠.
	Boiler Efficiency		
	Super Heater		Bid only Notation (360℃)
	Deaerator	2Kg/㎠ (30 ㎥/h)	
	Economizer(Outlet Temperature)	214℃	
	Condenser		
	R/O		
Combustion Gas Facility	SDR	1,813 ㎥/min(Ø5.1Mx16.4M), Nozzle : 4sets	
	Bag Filter	Bag Filter: 1,260EA (6 Chamber)	
	SNCR	Two Fluid Nozzle(4sets)	
	Urea Water Tank	20 ㎥ (FRP)	
	Activated Carbon Tank	5 ㎥	
	Lime Tank (Liquid type)	30 ㎥	
	Wet Scrubber	Dry Venturi Type	
	Process Water Tank	40 ㎥	
	Stack	Ø2Mx30M (SS400+Castable)	
Ash Treatment Facility	Hopper Re-discharge C/V	Wet Apron Con'v (1t/h, 2.2KW)	

Items	Names	Specification	
		Using Steam	Including Power Generation
	Re-discharge C/V	Aperon Type (1t/h, 3.75KW)	
	Re-transfer C/V	Belt type (1t/h, 1.5KW)	
	Magnetic Separator	Electric magnetic	
	Discharge of Fly Ash C/V	Chain Type (5t/h, 2.2KW)	
Fuel Facility	Fuel Tank		
	Feed Pump、Piping		
Ventilation Facility	I.D FAN	2,200A m^3/min x 600mmAq (320KW)	
	F.D FAN(1st)	450A m^3/min x 400mmAq (52.5KW) Kiln	
	F.D FAN(1-1st)	300A m^3/min x 300mmAq (30KW)	
	F.D FAN(2nd)	150A m^3/min x 300mmAq (15KW)	
	F.D FAN(2-2nd)	350A m^3/min x 350mmAq (37.5KW)	
	Return FAN		
	Kiln cooling FAN	150A m^3/min x 500mmAq (22KW)	
Additional Facility	Air compressor	Screw(28.3 m^3/min, 75KW)	
Waste Water Treatment Facility	Waterwater		
	Storage Tank		
Operating	Substation	PLC + HMI	
Generator	Pressure of Inlet and Outlet		Exclude
	Steam Temperature of Inlet and Outlet		
	Generator		
Scope		* Dust collector By-pass poppet damper	
		* Including Secondary Cable work	

8.8 PROJECT IMPLEMENTATION SCHEDULE

Table8-17 Project Implementation Schedule



Civil engineering and consultant company for ash landfill design and construction – recommended by ENTEC

1.CEE (CENTER OF ENVIRONMENTAL ENGINEERING)

1-1. Belonged to SNREC (Southern Natural Resources and Environment Company) of Ministry of Natural Resources and Environment (MONRE)

1-2. Location: Ho Chi Minh

1-3. Actual works: Dong Hoi Quang Binh (11ha), Quang Trach Quang Binh (3ha)

1-4. Business scope: Ground and soil survey, construction, maintenance

2.AIC (Advanced International Joint Stock Company)

1-1 Location: Hanoi

1-2. Actual works: Temporary landfill in Long Thanh Dong Nai (1.5ha), in Long Khanh Dong Nai (5ha)

1-3. Business scope: Ground and soil survey, construction, maintenance

3.KBEC VINA

1-1. Korean own company

1-2. Location: Toc Tien, Ba Ria-Vung Tau

1-3. Actual works: Ba Ria-Vung Tau (38ha) and under expansion of business area (3ha)

1-4. Business scope: Ground and soil survey, construction, maintenance

8.9 BUSINESS COST

(1) FACILITIES COST

Base on the above specification, the received quotations as follows.

Detailed cost for each facility is also supplied in the below table.

Table 8-18 Incinerator Quotation Comparison (Capacity:150tons/day)

Maker	Japan	Korean	China
	A	SGE	C
Head office	Shirakawa city, Ishikawa province	Anyang city	Shanghai
Established year	1971	2009	1977
Capital	98,000,000 Yen	—	2,820,420,000 45 billion Yen (16Yen/Gen)
Staff	50	48	5000
Sales	9.2 billion Yen (2012)	1.5 billion Yen	—

Maker	Japan	Korean	China
	A	SGE	C
Incinerator production achivement	About 100	32	0
Oversea business achivement others information	① Oversea business: No TKAM' back up is necessary ② Be able to conversation in Japannese ③ No kiln production	① Many experiences in oversea business - Vietnam Samsung Briquette 22 MW - Phillipine's incinerator 150 tons/day - Indonesia's incinerator 300 tons/day - Srilanka's incinerator 200 tons/day	① No record of incinerator ② Furnace related to metallurgy, cement Diverse achievements of Kiln
Incinerator type	Stoker furnace 4000kcal/kg	Kiln+Stoker furnace 4000kcal/kg	Kiln+Stoker furnace 3000kcal/kg
Estimation of cost	① Pure vapor recovery：3.6 billion Yen ② Power generate：4 billion Yen(3MW)	① Pure vapor recovery：940 million Yen ② Power generate：9.9+3(in the future) =1.3 billion Yen the cheapest in 3 companies	① Power generate：1.48 billion Yen(3MW)
Estimation of range	① Another cost for transportation of facilities（FOB) ② Another cost for construction in local	① Another cost for transportation of facilities（FOB) ② Cost for installation in local, civil construction	① CIF for main harbor in Vietnam ② Another cost for construction in local
Evaluation	△（Expensive, no oversea experience）	○（Not expensive、many experience in oversea）	△（no experience in incinerator）

Source: JICA study team

Table 8-19 All Facilities Investment Cost

Name of facility	Cost	Note
Incineration plant（inclusive power generator）	1.4 bilions yen	—
Waste water treatment facility	2 milions yen	—
Others plant（Ex: Civil building、Substation equipment）	3 milions yen	—
Landfill site	2 milions yen	1) Average construction price：1,000yen/t 2) Amount of ash after incineration：Amount of treated waste per year50,000t×20%=10,000t/year 3) Construction price： About 2 milions yen =10,000t/yen×20 years×1,000yen/t

Source: JICA study team

(2) MAINTENANCE COST

Following is maintenance cost from experience of Tsuneishi Kamtecs.

Table 8-20 Maintenance-Management Cost

Items	Maintenance-management cost	Basic
Labor cost	1,130,000 yen／year	Estimated local labor unit price is 25% of price in Japan
Fuel cost	70,000,000 yen／year	Estimated 10% of sales
Electric power cost	7,000,000 yen／year	Estimated 1% of sales
Maintenance cost	60,000,000 yen／year	Estimated3% of facilities investment cost
Transportation cost	21,000,000 yen／year	Estimated 3% of sales
Cost related to selling	70,000,000 yen／year	Estimated 10% of sales

Note 1：Number above is assumed that all facilities full operation condition under
Note 2：About labor cost is calculated base on reference of ADB and ILO's report
Source: JICA study team

CHAPTER 9 FEASIBILITY OF PPP INFRASTRUCTURE PROJECT

9.1 RISKS OF THE PROJECT

(1) SUMMARY OF RISK RELATED THE PROJECT

List of expected risk is shown below.

Table9-1 List of Expected Risk

Type of risk		Risk	Countermeasure(draft)
System/Policy	Change of upper level plan	Upper level plan concerning necessary and contents of the project is changed.	Utilization of various official assistance
	Change of laws/tax system	Laws/tax system concerning regulation of environment and currency, foreign remittance are changed.	
	Disapproval and delay of license	License and approval concerning the project implementation is delayed and not permitted.	
Economic	Exchange fluctuations	Income for Japanese company is decreased by exchange fluctuations.	"Reflect to treatment cost", "Increase of borrowings in local currency", "Utilization of trade insurance"
	Price fluctuation	Sales is decreased or cost is increased by price fluctuation.	
	Fund shortage /Interest-rate fluctuation	Fund is not secured. Cost for financial arrangements is increased by interest-rate fluctuation.	
Social/ Natural	Academic discovery /Destruction of nature	Because of Academic discovery /Destruction of nature, the project has to stop.	Consideration of affect to air/soil, site environment and site acquisition.
	Opposition campaign/General strike	Because of opposition campaign/general strike, the project is restricted.	
	Site acquisition	Because of site acquisition, the project is restricted.	
	Natural disaster/ Climate instability/War	Because of natural disaster/ climate instability/war, the project is restricted.	
Customer	Demand fluctuation	The expected demand is not satisfied.	Sufficient survey on Company intention of translation and expansion. Management of project operation cost fluctuation.
	Cost recovery/ payment arrears	Payment is not made properly.	
	Change of requisition	The higher specification/quality level compared with contract is required. Because of unexpected waste, additional treatment cost and facility trouble occur.	
Project Operation	Improper Project Operation	Because of improper study/EPC/management, inauguration delay, poor performance/ defect, facility degradation and worker injuries occur.	Based on consideration of sufficient management and operation, the project makes progress in corporation with local company.
	Procurement shortage	Because of bankruptcy of supplier and subcontract, necessary procurement is not secured.	
	Patent violation/ Protection of intellectual property	Intellectual property of Japanese company is not protected.	

Source: JICA study team

(2) COUNTERMESURE FOR EACH RISK

1) System/Policy

A large scale of factory translation of foreign company is decreasing, but middle scale of factory translation continues and business content is changed from assembly factory to manufacturing with raw material. Solid waste generation is increasing and proper solid waste treatment is one of the important basic policies for Vietnam agency. This becomes more crucial policy following economic development. A dramatic change in policy is one of the risk in Vietnam, so Tsuneishi Kamtecs keeps in touch with JICA Vietnam office, People's committee, MPI and MONRE to deal with change of system and policy through Tsuneishi Kamtecs representative office. Regarding new PPP law, this project does not need in line with this law at this time. But, in new PPP law, solid waste treatment is one of the target business, there is a possibility to apply for government subsidy such as special tax breaks, therefore, Tsuneishi Kamtecs pays attention to operational stipulation for new PPP law continuously.

2) Economic

The situation of Economic change, specially, Consumer Price Index, labor costs, currency exchange and foreign exchange, should be paid attention to.

3) Social/ Natural

It is not easy to secure a site for treatment and disposal of solid waste, especially hazardous waste in the limited national land. The project site should be considered with related agency in Vietnam.

4) Customer

The study on customer has been done already, issue for feasibility of the project is to secure competitive strength by decreasing cost of incineration treatment and gathering lot of customer. It makes many efforts to set proper operation/management cost for incineration plant.

5) Project operation

Technical transfer to Vietnamese local staff related to Japanese experience is one of the key points to make success of the project. To do technical transfer smoothly, it is necessary to consider training in Japan for Vietnamese local staff.

9.2 FINANCIAL ANALYSIS

Based on the calculation, it can take capital (free cash flow) in 7 years. This project reaches the profitability point.

Moreover, for the capital: 70% is borrowed, 30% is invested. Therefore, in the future it can be corporated with partners, this is still in discussing for the matter of investment.

Industrial waste incineration, ash-baking treatment and recycling business in Southern Vietnam project (First estimation

【Proposal】
●Operating rate of facility
・First year 70%
・Thereafter, increase 10% per year from 4th year operation rate: 100%)
●Labor cost
・Estimated the facilities scale from Tsuneishi Kamtecs result value.
・Labor cost unit price of Vietnam is estimated that 25% of unit price in Japan)
●Fuel cost
・10% of sales
・Estimated from our group actual value
●Electric power cost
・1%of sales
・Estimated from our actual value (2.7% of sales) and unit price difference between Japan and Vietnam (30%)
●Transportation cost
・3%of sales
・Estimated from our actual value (10% of sales) and unit price difference between Japan and Vietnam (30%)
●Interest paying
・Loan 1.4 billion yen Local currency-denominated)
・Annual interest rate of 15%
・Loan payment completed in 10 years
●Corporate tax
・Environmental project preferential tax 10%
●Treatment unit price treatment amount
・Estimated from the survey taking in local

【Summary of result】
●Investment recovery period(FCFBase):8years
●IRR(Internal rate of return):4.7%(Business period 10yeras)、10.2%(Business period 15 years)

This plan is temporary result base on research results.
Carefully study through F/S is necessity

【Reason of risk(The matters particularly necessary to delve in the future】
●Initial investment
・Cost-down base on local procurement is possible or not
・Cost -up possiblity.
●Treatment price、Treatment amount(Operating rate of facility)
・Amount of treatment waste is significantly different depend on getting good alliance (collection- transportation company and existing local waste-treatment company) or not。
・Treatment price is significantly different depend on local aurthority and industial waste generator's trend
●Labor cost
・Labor cost is different depend on province (generally upward trend)
・In terms of cost, of course it depends on it can be able to recruite exellent technician (especialy management level) or not
●Transpotation cost
・In terms of cost, treatment price is significantly different depend on getting good alliance (collection- transportation company and

Initial investment			Investment amount	Summary
	Solid waste incinerator and associated equipment		1,430	Treatment amount:150 t per day、50000t/year(334 days operating)
	Waste water treatment facility building		220	
	Power Generator		330	10,000kwh unit price of facility 30,000/kwh
	Landfill site and associated equipment		220	250,000m3 、(controled landfill type)
	Others related cost	Land lease payment 1,100 etc	1,120	
	Total		3,320	

Cash in flow		1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year
Solid waste treatment Sales		700	800	900	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
solid waste treatment unit price(yen/t)		20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000	20,000
Solid waste treatment amount(t)		35,000	40,000	45,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000	50,000
Power selling Sales		28	32	36	40	40	40	40	40	40	40	40	40	40	40	40
power selling unit price(yen/kwh	10.05cent=11yen	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
power selling amount(kwh)	500kwh x 24h x 300 = 3,600,000 kwh/Y	2,520,000	2,880,000	3,240,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000	3,600,000
Recycle materials Sales		–	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Recycling material selling unit price(円/t)																
recycling material selling amount (t)																
Total		728	832	936	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040	1,040
Cash out flow		**1st year**	**2nd year**	**3rd year**	**4th year**	**5th year**	**6th year**	**7th year**	**8th year**	**9th year**	**10th year**	**11th year**	**12th year**	**13th year**	**14th year**	**15th year**
Labor cost		113	113	113	113	113	113	113	113	113	113	113	113	113	113	113
Fuel cost	10% of solid waste treatment sales	70	80	90	100	100	100	100	100	100	100	100	100	100	100	100
Electric power cost	1% of solid waste treatment sales	7	8	9	10	10	10	10	10	10	10	10	10	10	10	10
Maintenance cost	3%of total amount expense in facility and equipment(tax	60	60	60	60	60	60	60	60	60	60	60	60	60	60	60
Land leasing cost	Lump-sum payment when the business started, initial expenses is inclusive															
Others business related cost	3% of sales	21	24	27	30	30	30	30	30	30	30	30	30	30	30	30
Others management cost	10%of sales	70	80	90	100	100	100	100	100	100	100	100	100	100	100	100
Paying interest	15%	210	189	168	147	126	105	84	63	42	21	–	–	–	–	–
Total		551	554	557	560	539	518	497	476	455	434	413	413	413	413	413
Pre-tax income before amortization		177	278	379	480	501	522	543	564	585	606	627	627	627	627	627
Depreciation	Fixed amount (15years)	-221	-221	-221	-221	-221	-221	-221	-221	-221	-221	-221	-221	-221	-221	-221
EBITDA		-45	56	157	258	279	300	321	342	363	384	405	405	405	405	405
Corporation tax	Environmental project preferential tax 10%	0	-6	-16	-26	-28	-30	-32	-34	-36	-38	-41	-41	-41	-41	-41
Free Cash Flow (FCF)		177	272	363	454	473	492	510	529	548	567	586	586	586	586	586
	Balance of borrowings	1400	1260	1120	980	840	700	560	420	280	140					

IRR10 years	4.7%	Automatic calculation
IRR15 years	10.2%	Automatic calculation

Calculation dummy

FCF and Investment		1st year	2nd year	3rd year	4th year	5th year	6th year	7th year	8th year	9th year	10th year	11th year	12th year	13th year	14th year	15th year
FCF and Investment	(3,320)	177	272	363	454	473	492	510	529	548	567	586	586	586	586	586

9.3 ECONOMIC ANALYSIS

(1) ASSUMPTION FOR ECONOMIC ANALYSIS

This Project aims to expand the capacity of incinerator for burning industrial waste generated from factories, plants, manufactories, industrial parks, and so on. Implementation of this Project may result in a definite underlying improvement and preservation in environmental sanitation in the project target area. In addition, this Project is designed to generate electric power using waste heat produced from disposal of industrial waste by incineration, and to deliver for EVN, the Electricity Authority of Viet Nam, the excess of electricity over the on-site use for sale.

(2) ECONOMIC EFFECTS

1) Economic effects on the improvement in environment

The Project covers Ho Chi Minh City (HCM) and four provinces around HCM – such as Long An, Bin Duong, Dong Nai and Ba Ria Bung Tau. These areas are considered strategically important from the economic development point of view in the southern part of the country, as a result of which a remarkable economic development has been achieved these past few years. As a consequence, according to the estimation by the JICA Study Team, a total generation amount of industrial waste in the project target area is estimated to increase to around 15,116 tons per year for non-hazardous industrial waste and 3,417 tons per year for hazardous industrial waste (both including medical waste) in 2020.

In spite of that, both the shortage of companies/agencies with the capability for adequate disposal/processing of industrial waste within the project target area and the distinct lack of incineration facility make it difficult to deal effectively with industrial waste that has continued to increase, thus causing environmental problems – such as illegal dumping, mixed dumping with household waste, etc.

Under these circumstances, introduction of the incinerator for disposal of industrial waste based on the proposal from the Japanese manufacturer involved in the environmental-related plant construction and business, associated with operation of the incinerator in safe and environmentally-responsible manners will have the economic effects on reduction of damage to the environment caused mainly by open-dumping in and around the landfill sites.

2) Economic effects on waste-to-energy (WTE)

In Viet Nam, with a few exceptional projects where methane gas is collected at landfill sites, no full-scale WTE project has been operated. These situations raised a number of important issues for development and promotion of renewable energy.

In the project target area, the supply of electricity could not keep up with the electric power demand that has continuously and rapidly increased with the recent economic growth. To reflect these situations, it is assumed that sales or trade for renewable energy including WTE will be preferentially and specifically advanced in the near future.

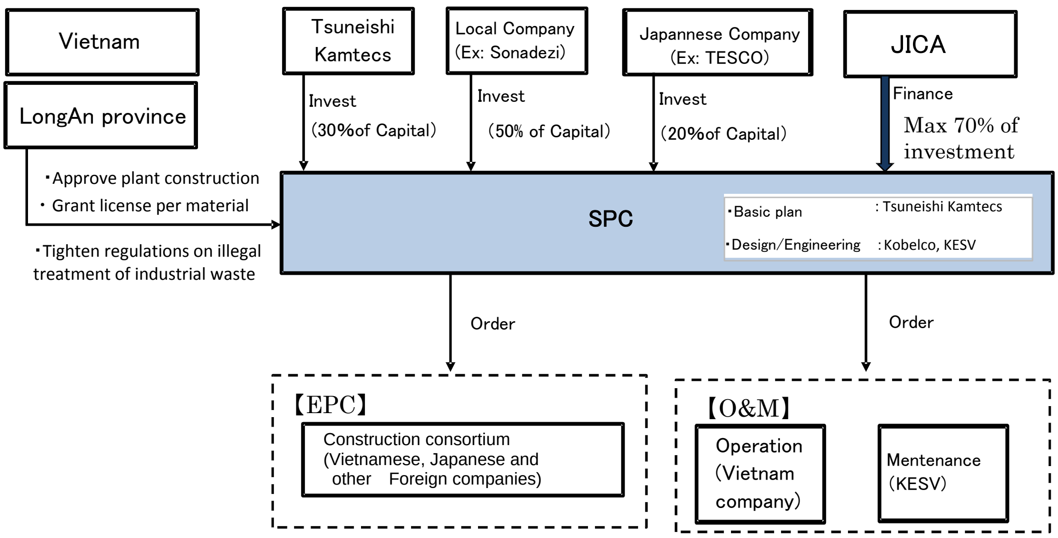
Given these situations as stated above, this WTE project where electric power using waste heat recovered from incinerating the combustible waste with high calories is generated, and sell EVN the surplus electricity in excess of the on-site consumption has the impact of power generation in the project target area, thus economic benefits attributable to the implementation of this Project to be captured as increase and/or saving in terms of scarcity of natural resources.

CHAPTER 10 IMPLEMENTATION PLAN ON THE PROJECT

10.1 PROJECT IMPLEMENTATION STRUCTURE

For local company, companies that as a company can be commissoned of investment, not operation, and maintenance. Now, it has been conducting the business of collection, transport or treatment and disposal of waste. Such as (Sonadezi Joint Stock Comapany), Urban Environment company (HCMC Urban Environment Service Company Limited : CITENCO), VWS (Vietnam Waste Solution : VWS), Holcim Vietnam, Binh Duong Water Supply Sewerage Environment Co., Ltd : BIWASE)

For Japanese companies, companies are doing a general and industrial waste treatment or environment which related to engineering compaines (TESCO, Clean Tech, Idemitsu Engineering)

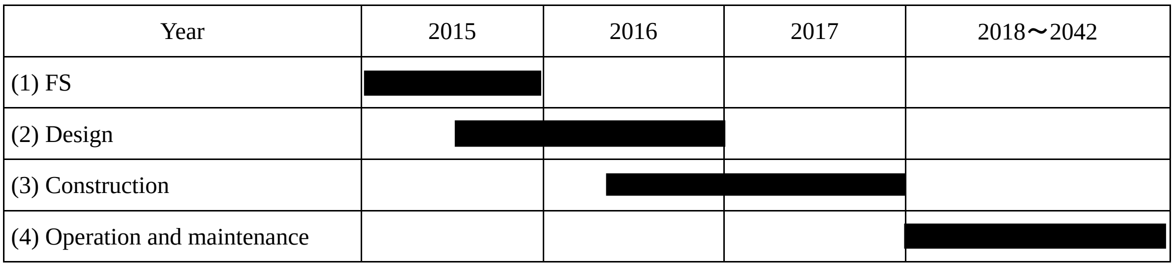


Source: JICA study team

Figure10-1 Business Structure of Waste Treatment Service

10.2 PROJECT IMPLEMENTATION SCHEDULE

This project will be completed to design in 2016. Construction facilities from the 2016 second half, we will plan to start this project from 2018.



Source: JICA study team

Figure10-2 Schedule of Project Execution

10.3 OPERATION AND MAINTENANCE SYSTEM

Operation and maintenance, as a basic to be entrusted to local partners, from the Japanese side, constantly dispatched personnel 2-3 people to support the operation and maintenance.

Table10-1 Outline of Local Partner

【Local partner】

	Company Detail	Degree of interest for project
SONADEZI	Established in 1990 as a state-owned company.SONADEZI has developed and managed eleven out of thirty-one major Industrial Parks in Dong Nai.Environmental business is there part of the diversified businesses.SONADEZI has received a penalty in the drainage outflow	SONADEZI has being operated 10t/d incinerater.Also they planning to start 24t/d new incinerater. They are interested in partner with our project. We need confirm the opinion from person to make a decision. SONADEZI has Hazzardous waste disposal license.
CITENCO	The HCMC Urban Environment Company Limited.They are planning to be private company in the future.CITENCO has strong advantage in collection of general waste.7,000-8.000t/d. Hazzardous waste30t/d (Medical waste 15t).	CITENCO has being operated 28t/d incinerater in HocMon eria. Also new incinerater (35t/d) started work from March 2015. Huge amount of urban waste have filled at CuChi land fill site at Hochimin City.The have high interest to our project.
VIETNAM WASTE SOLUTION	Leading domestic waste treatment company in Hochiminh city. It was established by David Duong - an Vietnamese American. Currently, it is the competitor of HCMC Urban Environment Company Limited - CITENCO.	Currently, it only treats domestic waste. However, it concerns a lot to the waste treatment by incineration method in the future. In the meeting of November 2014, VWS expressed it's concern in TKAM's technology in oil treatment, power generation, combusted waste transportation fields. Especially, it gave many questions about waste to energy for TKAM such as: price, effect...
HOLCIM VIETNAM	Treatment amount is a lot, 30 thousand tons of industrial waste (almost is hazardous waste) per year with the cement furnace factory in Kien Giang province. Waste is collected to Cat Lai harbor and transported to Hon Chong factory by lighter. Waste treatment field is managed by Geocycle center.	As aspect of industrial waste treatment, Holcim is TKAM's competitor. Therefore, it is difficult to corporate in waste collecting only because of waste combusting to make cement was commercialised before. It can corporate in information changing only.
BIWASE	It is a waste treatment and water supply of Binh Duong province. It is also a big company in field of waste treatment in Southern area. It treats either industrial or domestic waste (including hazardous waste).	It had license for hazardous waste treatment already. It is operating incinerator with capacity 100 tons/day and producing 2 incinerators with the same capacity. Currently, this is the biggest incinerator in capacity in Southern area of Vietnam. Collected amount is 1200 tons/day (with 100 tons/day is hazardous waste). In 2012, it had a plan in combusting waste with capacity 500 tons/day (including both of industrial and domestic waste). However, there was trouble in investment, it had stopped at that time. As the meetings with Mr. Lui - Vice director, he showed his concern to TKAM's project.

【Company history-Business content】

	Company detail	Business's fields
SONADEZI	It is the precursor of Sonadezi group. In 1990, it was invested by Dong Nai company and started to develop Bien Hoa Industrial park. It became Company Limited in 2013 and changed it's name to Sonadezi Long Thanh. Currently, it is Sonadezi Joint Stock Company. It is invested by Dong Nai's authority, therefore, it has good relationship with authority. In 2005, it established Sonadezi service company (waste treatment company) and became 1 in 22 belong to Sonadezi.	It develops Industrial park, industrial and domestic waste water treatment, waste treatment, collecting and transporting. It consults environmental resource, office management service, marketing and advertisement service, restaurant and hotel. Travel and tourist car for rent. Office for rent. Experiment analysis.
BIWASE	Before 1975, it is the urban environment and water supply. Since 1997, it changed to Binh Duong water supply company. In 2005, it participated in environmental field and became Binh Duong water supply and environment company limited - BIWASE. It is the largest company in Binh Duong province.	Constructing, designing, consulting issues related to environment. Selling the recycled materials from waste. Products related to water supply. Treating, constructing water pipes. Treating, collecting, transporting waste (hazardous, industrial and domestic waste) Managing water supply works, infrastructure construction, installation Producing compost
VIETNAM WASTE SOLUTION	It was established since July 15 1998. Investment capital is 100% of California Waste Solution - American. It is the first domestic wate treatment in Vietnam. It has good relationship with Long An province and Vietnamese government.	Treating, collecting, transporting domestic waste. Recycling waste to make compost fertilizer. Transporting, constructing and designing waste treatment area of Da Phuoc Industrial park.

Source: JICA study team

CHAPTER 11 ENVIRONMENTAL AND SOCIAL IMPACTS RELATED TO INDUSTRIAL WASTE TREATMENT PROJECT

11.1 SOCIETY AND NATURAL SITUATION AT CANDIDATE SITE

(1) CLIMATE IN LONG AN PROVINCE

1) Temperature

In Long An province, observation point in Tan An City and Moc Hoa has been installed.

Specific of climate

- 26.34℃（2004 - 2008）The annual average temperature of Tan An City observation point
- 27.27℃（2004 - 2008）- The annual average temperature of Moc Hoa observation point
- 23.96℃ - 28.20℃ The annual average temperature’s change.
- 3.4 - 5.1℃− highest temperature moth and lowest temperature month.
- lowest temperature time: December or January highest temperature time : April or May

Table11-1 The Average Monthly Temperatures (2004 - 2008)

Observation point	(°C) The average mothly temperatures											
	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sep	Oct	Nov	Dec
Tan An City	24.74	24.80	26.36	28.20	27.70	27.18	26.54	26.48	26.42	26.50	26.20	25.04
Moc Hoa	23.96	26.22	27.58	29.02	28.50	27.78	27.22	27.52	27.88	27.84	27.48	26.28

Source: Long An DONRE report (2006-2010)

2) Rainfall

The rainy season begins in May and finishes in November, the total amount of rainfall in this season accounts for 90.8-91.3% of total amount of rainfall in this whole year. The rainfall reduces in the dry season, Water flow and groundwater level is lowered.

Table11-2 Average Monthly Rainfall（2004 - 2008）

Observation point	(mm) Average monthly rainfall											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tan An City	17.02	16.04	11.70	55.34	229.24	164.10	213.36	186.70	259.82	242.74	111.12	43.86
Moc Hoa Dist	11.36	2.66	16.48	56.44	90.86	206.54	209.36	200.82	294.46	349.24	150.40	55.26

Source: Long An DONRE report (2006-2010)

3) Humidity

Humidity is changed because of seasons and rainfall. Long An province average humidity is from 79.4% to 88.5%, The highest average humidity is 92% (in rainy season), lowest average humidity is 73% (dry season). Specific to related to humidity

- （2004 - 2008）：87.85% - The average yearly humidity at Tan An
- （2004 - 2008）：81.00% - The average yearly humidity at Moc Hoa

Table11-3 The Average Monthly Humidity（2004 - 2008）

Observation point	The average monthly humidity											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tan An city	86.4	86.6	83.2	81.2	86.8	89.6	90.2	91.0	91.2	90.0	87.4	86.8
Moc Hoa district	77.6	78.6	77.6	76.8	82.8	84.2	85.4	84.2	83.0	81.4	79.2	77.0

Source: Long An DONRE report (2006-2010)

4) Sunlight

The sunny hours of Long An province is 2,337 -2,515 hours.

Table11-4 The Average Monthly Sunlight（2004 - 2008）

Observation point	- The average monthly sunlight (Hour)											
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Tan An city	213.16	229.52	251.62	232.04	201.34	174.12	149.30	172.86	160.86	174.48	198.24	180.06
Moc Hoa district	234.60	239.60	251.36	231.10	222.40	192.16	145.28	181.06	177.34	205.04	215.74	219.24

Source: Long An DONRE report (2006-2010)

(2) SOCIAL ENVIRONMENT IN LONG AN PROVINCE

1) Agriculture

Cultivation: In 2014, the local authority in cooperation with the agricultural encouragement station and the plant protection station of Can Duoc District hold the training courses on rice care technique to the farmers and workshops to introduce the new varieties, care methods and technical science application to increase the agricultural productivity. The total area of agricultural production in the commune in 2014 was 1,066 ha with a total productivity of 4,797 tons, of which the area is 42 ha of Chukrasia Tabularis with the productivity of 420 tons, and 10 ha of crops mainly including cucurbits, cucumber, melon, etc.

Livestock: In 2014, the situation of livestock in the commune is relatively stable without diseases. At the same time, the local authority combined with the local inhabitants to seriously perform the control and held the vaccination against H5N1 disease in poultry and conduct the disinfection in cages, propagandize the farm-houses about being always wary of possible diseases.

2) Industry

At present, there is Long Dinh – Long Can industrial cluster in Long Dinh commune, Can Duoc district, Long An province having started to operate. This cluster locates on area of two communes (Long Dinh and Long Cang communes). In which, there are 15 companies under Long Dinh commune including:

- LD Saf – Viet Co., Ltd.;
- Hoang Tuan Trade Production Co., Ltd.;
- Long An Coal Enterprise;
- Thuan An Coal One member Co., Ltd.;
- Phuong Quan Trade Production Co., Ltd.;
- Petro Vietnam Southern Building and Development J.S.Co.;
- ChingChenFu Vietnam Company;
- Thuan Kieu Vai Private Enterprise;
- Five Star fertilizer Factory;
- VINA-PSMC Precast Concrete Limited Company;
- Ha Tien 1 Cement Joint Stock Company – Long An cement grinding station;
- Binh Dien – Long An fertilizer factory;
- Thanh Tai Long An Construction Trade Production Joint Stock Company;
- Stolt Bitumen Vietnam Co., Ltd.;
- An Hoa Export Seafood Processing Joint Stock Company.

Besides, in the commune, there is also expaned Thuan Dao Industrial Park being constructed to attract investment.

3) Trading

In Long Dinh Commune, there are now neither commercial centers nor markets. However, Long Dinh Commune, Can Duoc District borders on Ben Luc Town, Ben Luc District and Long Can Commune, Can Duoc District. So, the trading activities of the inhibitants in Long Dinh Commune were conducted in the markets under Ben Luc Town and Long Cang Commune.

4) Travel services

Currently, tourism services have not been developed in Long Dinh Commune. In the commune, there are no centralized tourist area and entertainment zone.

5) Traffic system

Traffic system: the main road in the commune is the Provincial Road No. 16 and Long Dinh – Long Cang Road. In addition, there is a waterway traffic that is the East Vam Co River in the commune. In 2014, the commune invested five rural traffic works including (1) cover macadams on four roads in Tron 1 Village with a length of 1,410m; (2) expand the road from Ba Ru Household to Cong Nghiep Road with a length of 270m; (3) concrete the rural road from sewer of Hai Hoang Household to Cay Diep Village with a length of 200m; (5) cover macadams from Nam Hen Household to sewer of Hamlet 2 with a length of 500m.

6) Power supply system:

Power supply system: the power source that is supplied to the commune is a national grid. At present, the grid has covered the whole commune. In 2014, there were three low-voltage projects installed such as (1) low-voltage work in Hamlet 1 from Hai Ty Household to Bay Ho Household with a total length of 317m; (2) low-voltage work in Hamlet 1 from the Provincial Road No. 830 to Lai Van Ut Household with a total length of 460 m; (3) low-voltage work in Hamlet 2 from under Ba Ve Bridge to Tran Van Hai Household with a total length of 337 m.

7) Water supply system

Water supply system: there is now no the water supply company in the commune, so the inhabitants use mainly the water supply from the Hoang Long Water Supply Company located in Ben Luc District for living, drinking and eating activities.

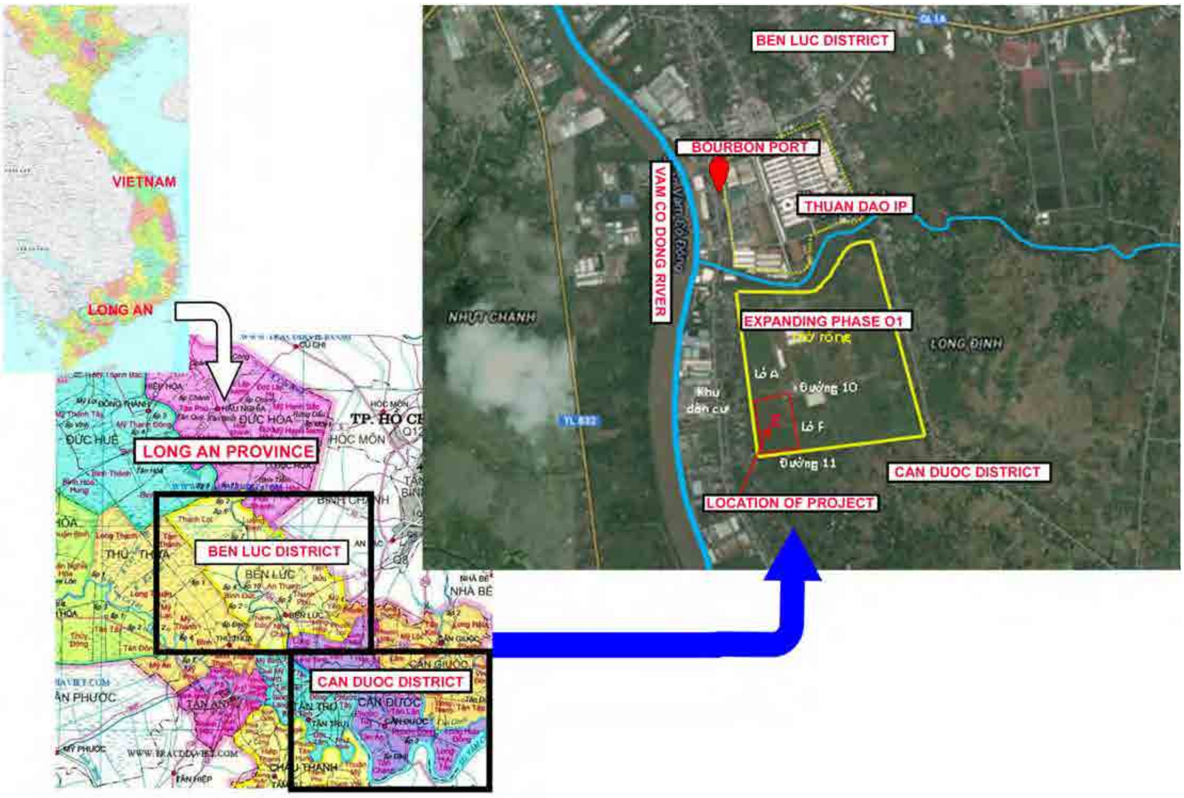
8) Drainage system

Drainage system: there is now no the common drainage system, the drainage system is mainly inland canals. In 2004, two inland irrigation works that were constructed in Long Dinh Commune by Can Duoc District include (1) Dredge and cover macadams in Canal T10 – Dinh Canal – Ngang Canal with a total length of 2,871m, width of 5-6m, depth of 1.5m; (2) Dredge and cover macadams in canal of Hamlet 2 and Ngang Canal of Hamlet 4 with a total length of 2,572 m, width of 5-6m, depth of 1.5m.

(3) SUMMARY OF CANDIDATE SITE

In Southern, Long An province is considering as the intersection of West and East, it is the economical main point of both Southeast area and Mekong delta area. For this feature, the investment from foreign is increasing. Expectation location of this project is Thuan Dao IP, Ben Luc district, Long An province. It is about 25 km from East of Ho chi minh city. Although, Thuan Dao IP is in Ben Luc district, lot E of this IP is in Can Duoc district in administrative site. These 2 districts are isolated by Chanh canal. Thuan Dao IP is far from Vam Co river about 200m.

- In the East: border on Lot F, Thuan Dao expansion Industrial Park (IP)
- In the West: border on residential area of Long Dinh commune;
- In the South: border on road No. 11, Thuan Dao expansion Industrial Park (IP)
- In the North: border on Lot A, Thuan Dao expansion IP



Source: JICA study team

Figure11-1 Location of Thuan Dao IP and Surrounding Area

(4) SCOPING PROPOSAL

This part is about the items in 13 kinds of waste in "environmental checklist", reference for directing the considered items about social of JICA, the items related to environmental (announce in April 2010)

Scoping proposal

Classify		Impact Items	Evaluate		Reason for evaluation
			Construction Stage	Operation Stage	
Repair's measure	(1)	Air pollution	B	D	Construction Stage Reducing the ash and waste gas from transporting vehicles and ash from construction site by spraying water. Operation Stage Flue gas from incinerator after cleaning will go out the stack without any problem.
	(2)	Water pollution	B	D	Construction Stage There is possibility of waste water in the construction stage , however, it can be released after temporary deposit sediment for seperating dust. Operation Stage Waste water which is generated in plant will be collected with the waste water treatment facility and be released to the drain when reached the standard of COD, BOD, heavy metal.
	(3)	Waste	D	D	Construction Stage It will generate waste and spare soil from site. However, it can be buried in current landfill and not affect to the environment. Operation Stage Waste that is saved in ash landfill is detoxified and reduced amount by incineration process. Therefore, the environmental effect will be reduced significantly. Ash and fly ash that is generated in incineration process is treated for preventing heavy metal wash away, it will be saved in ash landfill. This ash will be used for producing artificial sand in the second stage of project.
	(4)	Soil pollution	B	D	Construction Stage There is possibility of waste water in the construction stage. This will influent to the local land. However, waste water can be deposited sediment at temporary saving tank then discharging out. Operatation Stage Plant's ground will be covered concrete for preventing the infiltration of waste water. Waste water will be collected and treated at the waste water system and discharged out.
	(5)	Noise and vibration	B	D	Construction Stage There is possibility of generating noise and vibration in process of constructing and transporting materials. Operation Stage In process of operating, there are facilites make noise and vibration. However, there will be designation for keeping standard of noise and vibration. For example: Silencer facilities attached in boiler.
	(6)	Odour	D	B	Construction Stage As expected, it will not generate odor from any activity. Operation Stage Odourous waste that is detoxified by combusting in high temperature will be better than the current treatment method. However, it still generates odour from the untreated waste in the waste receiving area, so it must prevent odour getting out the area.

Classify		Impact Items	Evaluation		Reason for Evaluation
			Construction Stage	Operation Stage	
Nature	(7)	Reservation	D	D	Outside of scope because Dong Tam's Thuan Dao Ip is only trading.
	(8)	Ecosystem	D	D	At the land of Thuan Dao Ip that was developed by Dong Tam and surrounding areas, there is not forest, tropical forest or important ecological habitats (coral reefs, mangrove wetlands, tidal flats, …) This is not any rare species of animals.
	(9)	Site management after the project	Outside of scope	Outside of scope	Outside of scope because Dong Tam's Thuan Dao Ip is only trading
Social	(10)	Resettlement	Outside of scope	Outside of scope	Outside of scope because Dong Tam's Thuan Dao Ip is only trading
	(11)	Living activities	Outside of scope	Outside of scope	Outside of scope because Dong Tam's Thuan Dao Ip is only trading
	(12)	Livelihood	D	D	Construction Stage: Giving opportunities for recruiting local employees in constructing. Operation Stage: Giving opportunities for provinces by the requirement of recruiting employees to manage plant.
	(13)	Cultural heritage	Outside of scope	Outside of scope	Surrounding areas of this location, there is not important cultural heritage in religious, culture, social or archaeology that need to be preserved.
	(14)	Sight seeing	Outside of scope	Outside of scope	There is not any landscape for tourism.
	(15)	Ethnic minority people	Outside of scope	Outside of scope	There is not the area where ethnic minority people is living surrounding this plant.
	(169	Labor	D	D	Construction Stage: Try to maintain the labor environment with the best quality as the general regulation of safety in hygienic and labor of construction team. Operation Stage: Maintain safety labor environment for employees, keep the general regulation of safety labor of the plant.

Notes:
A+/-: Absolutely correct/ Can be negative effect
B+/-: Fairly correct/ Can be negative effect
C+/-: Level of effect is not clearly
D: Cannot be effective in the project

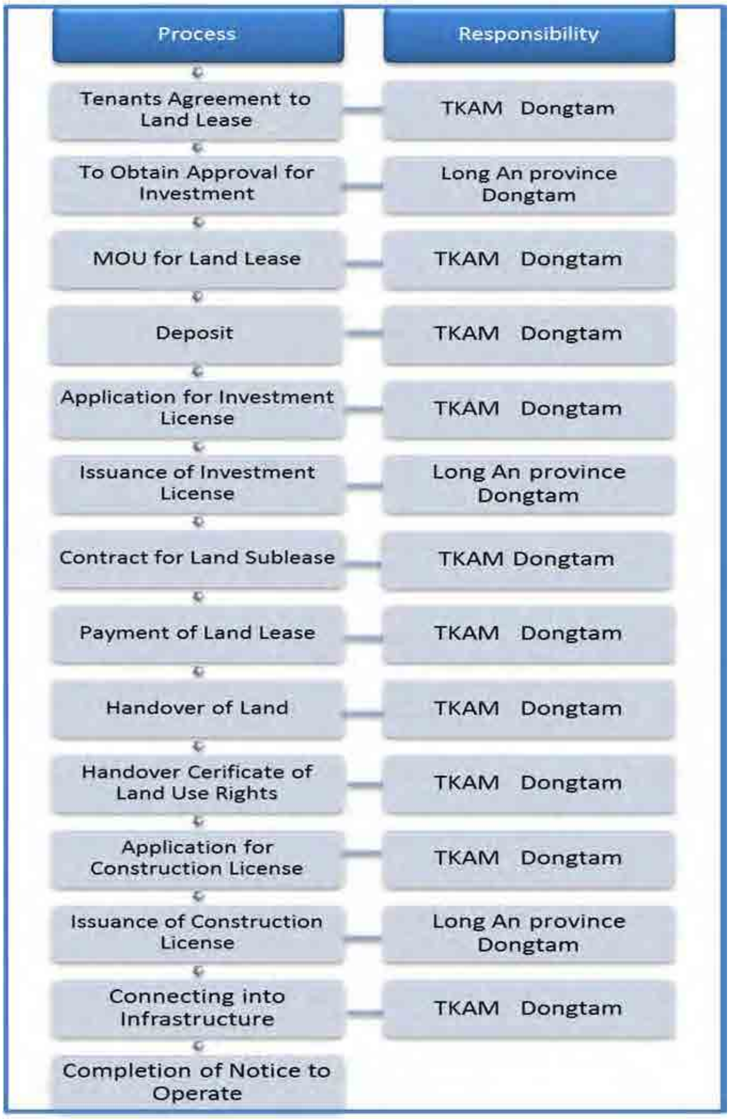
CHAPTER 12 ISSUES ON REALIZATION OF THE PROJECT

(1) Financial

Finding partners for industrial waste treatment in local is important. Although it had 70% investment for project, the last amount is still burden for local companies. Risk also increases because of fluctuation of exchange rate. This shows the requirement of supporting from government.

(2) Candidate for constructing incinerator

Questioning to Dong Tam – a development company of Thuan Dao Ip, Ben Luc district, Long An province for getting license to construct industrial waste incinerator. Currently, it must attract the supporting of the partners. Processing of doing project as following:



(3) Potential partners

As the survey of financial, license for treatment, relationship with government, there are some potential partners: Sonadezi, Citenco, Vietnam waste solution. In the future, it must more conversation with detailed information with them to choose the last partner for project.

(4) Construction of the final disposal site

Authority of Long An province showed us the passive attitude with the project when they heard about landfill, however, this is only for burying ash after combusting, it is not problem. On October 4th, 2012, TKAM received support-letter from Long An but only the commercial purpose only, as MOA that TKAM signed with Dong Tam, it must apply for the license of hazardous waste treatment with the confirmation from Long An also.

(5) License on hazardous waste disposal

In April 8th, Thuan Dao Ip applied document for taking license of hazardous waste treatment to DONRE. Mr. Mon, director of Dong Tam, in July 4th, he met People’s Committee of province and DONRE for clarifying the project. As expected, formal permission will be approved after signing MOA between Dong Tam and TKAM.

(6) Briefing of project concept for public hearing

Companies that have factories in Thuan Dao Ip must conversation with resident’s representatives in this area. Besides, if the location of project is decided, it must have confirmation from Dong Tam about this conversation for People’s Committee of province, it was talk in the meeting with TKAM in January 2015. Mr. Mon, director of Dong Tam said that, waste treatment units of Japanese which he know are very clean (odor, generated gas …), they are not the same as the waste burying company of Vietnam. Therefore, he sures that the corporation with TKAM can completely be accepted by the residential people there. By the way, TKAM would like to invite some representative to visit Fukuyama factory in Japan.

(7) Investment and construction license

Application for getting investment and construction license to Vietnam Investment Committee will be done after the agreement to lease land with Dong Tam. This will be done by Dong Tam’s business marketing department.

(8) Connecting into infrastructure (water and electric power)

In contract with Dong Tam, it includes the water supplying for plant. The maximum water supply is about 60,000 tons/day. Besides, there is also the plan for buying water from water purification plant – Phu An Thanh company. The investigation about the water source had been done. There are also discuss meetings with EVN (Vietnamese electricity company) about the selling power: volume or price.

(9) Increase accuracy of the construction costs

It is considering many constructed companies such as SEG, CEE, some Vietnameses companies, some Japanese companies to give out the final estimation for construction. Currently, it must compare the quotations from these companies' designs for the last decision.

(10) Development and maintenance of human resources

Related to O&M, experience and technology from Japanese will be transferred for local staff from the Japanese engineer and this will be continued until they know absolutely how to operate incinerator. Besides, the staffs who are suitable for operating incinerator will be considered as well as they can be trainned in Japan.

In Vietnam, legislation for waste management and treatment or awareness of the waste generators are in trouble and need solution for detailed treatment. From that fact, Vietnamese authority has recognized the need for waste treatment, Japanese companies knew the appeal in this field in Vietnam. Currently, Vietnamese companies have not the high-tech and security method for waste treatment, cheap price and basic method that give Japanese companies the advanced in competition with high-tech, reasonable price as the important item. In the future, with high-tech of treatment and recycling, Japanese can push up economy and protect environmental for Vietnam, good relationship between 2 countries is also important. Therefore, it is very important if we can do this project as one of the effort for these above purposes.

Appendix

1-1 Summary of Decision 155/1999/QDD-TTg: Regulation on Hazardous Waste Management

1-1 Summary of Decision 155/1999/QDD-TTg: Regulation on Hazardous Waste Management

Article 17: Registration of hazardous waste management practice

1. An organization or individual that registers to practice hazardous waste management shall compile a dossier for registration of hazardous waste management practice according to a set of form shown in Appendix 2 (A and B) to this Circular, and submit 2 (two) sets of the dossier directly or by post to the competent licensing agency under Article 4 of this Circular for examination and first-time grant of a hazardous waste management practice license.

2. Receipt of hazardous waste management practice registration dossiers

(a) Within 10 (ten) days after receiving a hazardous waste management practice registration dossier, the licensing agency shall examine its completeness and validity. In case the dossier is incomplete or invalid, it shall notify such to the practice-registering organization or individual for dossier modification and supplementation.

(b) Within 5 (five) days after receiving a hazardous waste management practice registration dossier already modified and supplemented as requested, the licensing agency shall examine its completeness and validity and may request further modification and supplementation of the dossier if necessary. Such notification shall be made no more than thrice, except times at which the practice-registering organization or individual does not satisfy or fully satisfy requirements of the licensing agency.

(c) If the registration dossier is complete or valid, the licensing agency is not required to make notification and this dossier shall automatically be accepted upon the expiration of the examination time limit.

3. Trial operation of hazardous waste treatment facilities.

(a) A practice-registering organization or individual shall make a plan on trial operation of hazardous waste treatment facilities according to a set of form shown in Appendix 2 (C) to this Circular and submit 2 (two) copies of the plan to the licensing agency concurrently with the practice registration dossier or at a later time.

(b) The time limit for examining a trial operation plan submitted for the first time is 10 (ten) days after the dossier is received, and 5 (five) days for a plan modified and supplemented according to the notification of the licensing agency. The notification shall be made no more than twice, except times at which the practice-registering organization or individual does not satisfy or fully satisfy requirements of the licensing agency.

(c) Within 10 (ten) days after completing the examination of a trial operation plan, the licensing agency shall issue a written approval of such plan, made according to a set of form shown in Appendix 2 (D) to this Circular. This approval shall be enclosed with 1 (one) copy of the plan appended with a certification seal by the licensing agency.

(d) After obtaining a written approval from the licensing agency, the practice-registering organization or individual may temporarily transport hazardous wastes and operate on a trial basis the hazardous waste treatment facility. The licensing agency may extraordinarily inspect the facility and take control samples in the course of its trial operation.

(e) After completing the trial operation, the practice-registering organization or individual shall make a report on results of trial operation of the hazardous waste treatment facility according to a set of form shown in Appendix 2 (E) to this Circular and submit 2 (two) copies of the report to the licensing agency for examination. In case a report is submitted more than 6 (six) months after the issuance of the written approval, the trial operation shall be reregistered.

(f) In case a report on results of trial operation of the hazardous waste treatment facility shows an unsatisfactory or incomplete item, within 10 (ten) days after receiving the report, the licensing agency shall notify such to the practice-registering organization or individual for adjustment or completion of the facility.

Article 18: Grant of hazardous waste management practice licenses

1. In case the licensing agency is the Vietnam Environment Administration, it shall collect written comments of provincial-level Natural Resources and Environment Departments of localities in which hazardous waste treatment facilities of practice-registering organizations or individuals are located on their agreement or disagreement with the grant of hazardous waste management practice licenses; reason(s) for disagreement or matters to be considered before the grant of hazardous waste management practice licenses.Written requests for comments of provincial-level Natural Resources and Environment Departments must be sent not later than the written approval of trial operation plans. Provincial-level Natural Resources and Environment Departments shall reply in writing within 25 (twenty-five) days after receiving a written request of the Vietnam Environment Administration.

2. Within 25 (twenty-five) days after receiving a report on satisfactory results of trial operation, the licensing agency shall evaluate the practice conditions and grant for the first time a hazardous waste management practice license, made according to a set of form shown in Appendix 2 (E) to this Circular. A hazardous waste management practice license is valid for 3 (three) years from the date of grant. A hazardous waste management practice license bears 1 (one) hazardous waste management identification number specified in Appendix 6 to this Circular.

3. In case of necessity, within 25 (twenty-five) days for evaluation of the practice conditions specified in Clause 2 of this Article, the licensing agency shall choose to carry out the following assistance activities.

(a) Forming a technical consultancy team which is composed of environmental, waste management and treatment experts to provide advice on the grant of hazardous waste management practice licenses. The technical consultancy team is tasked to advise and assist the licensing agency in examining the registration dossier, evaluating the practice conditions, processing technologies, results of trial operation, implementation of contents of the environmental impact assessment report and requirements to be included in the decision approving the report and other related matters.

(b) Inspecting hazardous waste treatment facilities and transportation agents for no more than 2 (two) days at each facility or agent, in combination with activities specified at Point c of this Clause.

(c) Holding meetings of the technical consultancy team with the participation of the practice-registering organization or individual and related agencies, organizations and individuals to reach agreement on requests and recommendations regarding the grant of a hazardous waste management license and to discuss and clarify unclear or unsatisfactory matters if any.

(d) Collecting written comments of related agencies, organizations and individuals in case no technical consultancy team is formed.

4. In case the practice-registering organization or individual fails to fully satisfy the practice conditions or to fulfill requirements of the technical consultancy team and related agencies, organizations and individuals, the licensing agency shall notify such conditions or requirements to the practice-registering organization or individual for satisfaction or fulfillment. Within 20 (twenty) days after receiving a report of a practice-registering organization or individual on its/his/her fulfillment of requirements stated in the notice of the licensing agency, enclosed with the appropriately modified or supplemented registration dossier, the licensing agency shall consider and grant a hazardous waste management practice license.

Article 19: Extension of hazardous waste management practice licenses

1. A hazardous waste management practice license may be renewed in multiple times for validity extension, with each extension of 3 (three) years from the date of expiration of the original or previously renewed license. Registration for extension of hazardous waste management practice licenses must be made at least 3 (three) months before the expiration.

2. The sequence and procedures for compilation and receipt of dossiers for registration of extension of hazardous waste management practice licenses comply with Clauses 1 and 2, Article 17 of this Circular.

3. Within 20 (twenty) days after completing the examination of the completeness and validity of a registration dossier, the licensing agency shall consider and renew the hazardous waste management practice license according to a set of form shown in Appendix 2 (E) to this Circular. The hazardous waste management identification number shall remain unchanged. The number of times of renewal includes the first-time grant and subsequent times of renewal.

4. In case of necessity, within 20 (twenty) days for consideration and renewal of a hazardous waste management practice license under Clause 3 of this Article, the licensing agency shall choose to carry out the following assistance activities:

(a) Inspecting hazardous waste treatment facilities and transportation agents for no more than 2 (two) days at each facility or agent, in combination with activities specified at Point b of this Clause;

(b) Holding meetings with the hazardous waste management practitioner and related agencies, organizations and individuals to directly discuss and clarify unclear or unsatisfactory matters if any;

(c) Collecting written comments of the provincial-level Natural Resources and Environment Department (in case the licensing agency is the Vietnam Environment Administration) and related agencies, organizations and individuals.

5. In case a hazardous waste management practitioner encounters problems, thus failing to fully satisfy the practice conditions specified in Chapter II, or fails to discharge the responsibilities specified in Article 26 of this

Circular or fails to fulfill requirements presented by the provincial-level Natural Resources and Environment Department and related agencies, organizations and individuals at meetings or in written comments collected under Clause 4 of this Article, the licensing agency shall notify such conditions or requirements to the hazardous waste management practitioner for satisfaction or fulfillment. Within 15 (fifteen) days after receiving a report of a hazardous waste management practitioner on its fulfillment of requirements stated in the notice of the licensing agency, enclosed with the appropriately modified or supplemented registration dossier, the licensing agency shall consider and extend the hazardous waste management practice license.

Article 20: Modification of hazardous waste management practice licenses

1. A hazardous waste management practice license shall be modified in any of the following cases:
(a) Change or addition of type, technology, size, designed capacity, area or quantity of special-use vehicles and equipment for hazardous waste management practice;
(b) Change or addition of type of, or increase in, the hazardous waste volume to be managed;
(c) Relocation or expansion of the operation area (applicable to hazardous waste management practice licenses with an operation area covering two or more provinces);
(d) Change of the hazardous waste management practitioner without relocation of the hazardous waste treatment facility or relocation of the hazardous waste treatment facility without change of the hazardous waste management practitioner and all special-use vehicles and equipment;
(e) Addition of a hazardous waste treatment facility;
(f) Change or addition of a hazardous waste transportation agent.
2. The sequence and procedures for registration and grant of a modified hazardous waste management practice license are the same as those for the first-time grant of a license specified in Articles 17 and 18 of this Circular. Upon completion of all procedures, the licensing agency shall grant a modified hazardous waste management practice license, made according to a set form provided in Appendix 2 (E) to this Circular, with a validity duration of 3 (three) years from the date of grant. The hazardous waste management identification number shall be changed in case of relocation or expansion of the operation area under Appendix 6 to this Circular. The number of times of grant of the license includes the first-time grant and subsequent re-grants.
3. Trial operation under Clause 3, Article 17 of this Circular is not required in the following cases:
(a) The cases specified at Points c, d and f, Clause 1 of this Article;
(b) Addition of special-use vehicles and equipment for hazardous waste transportation, including also those for packaging, preservation, temporary storage and preliminary processing of hazardous wastes;
(c) Addition of hazardous wastes with characteristics and treatment plans similar to hazardous wastes and groups of hazardous wastes with which treatment facilities have been put into trial operation and been licensed;
(d) Increase in the volume of hazardous wastes with which treatment facilities have been put into trial operation and been licensed.
4. In case the licensing agency is the Vietnam Environment Administration, it shall consider whether the

collection of written comments of the provincial-level Natural Resources and Environment Department is necessary.

5. A hazardous waste management license cannot be modified but must be re-registered for first-time grant under Articles 17 and 18 of this Circular in the following cases:

(a) It has an operation area within a province and was granted by a local licensing agency and is now converted into one granted by the Vietnam Environment Administration for expansion of the operation area;

(b) It has an operation area covering two or more provinces and was granted by the Vietnam Environment Administration and is now converted into one granted by a local licensing agency for narrowing the operation area to a province

Article 22: Revocation of hazardous waste management licenses

1. A hazardous waste management license shall be revoked in any of the following cases:

(a) A competent person defined in Articles 40, 41 and 42 of the Government's Decree No. 117/2009/ND-CP sends to the licensing agency a written request for revocation of the license, enclosed with documents serving as grounds for revocation, including a written record of examination, inspection or investigation; examination, inspection or investigation results; a decision on sanctioning of an administrative violation in environmental protection, or a prosecution dossier or court judgment;

(b) The hazardous waste management practitioner fails to operate 1 (one) year after being granted for the first time the hazardous waste management practice license;

(c) The hazardous waste carrier has all hazardous waste receipt and treatment contracts with the hazardous waste treatment facility owner or the hazardous waste management practitioner terminated and fails to sign a new contract or report such to the licensing agency within 1 (one) month, except the case in which the hazardous waste carrier is concurrently the hazardous waste treatment facility owner and was granted the license under Circular No. 12/ 2006/TT-BTNMT;

(d) The hazardous waste carrier fails to satisfy the practice conditions according to the roadmaps specified in Clauses 2 and 3, Article II of this Circular or fails to notify in writing the licensing agency of the satisfaction 2 (two) months after the date set for satisfaction of those conditions;

(f) The hazardous waste management practitioner, carrier or treatment facility owner terminates the hazardous waste management operation;

(g) The local licensing agency revokes the hazardous waste management license which has an operation area within a province from an organization or individual after it/he/she is granted another hazardous waste management license by the Vietnam Environment Administration for expansion of the operation area under this Circular or Circular No. 12/2006/TT-BTNMT;

(h) The Vietnam Environment Administration revokes the hazardous waste management license which has an operation area covering two or more provinces from a hazardous waste management practitioner after it is granted another hazardous waste management license by the local licensing agency for narrowing of the

operation area to a province under this Circular.
2. The licensing agency shall issue a decision to revoke the hazardous waste management license, clearly stating the grounds and reason for revocation, the hazardous waste management identification number, the date of grant and the name of the organization or individual having the license revoked.
3. Organizations and individuals that have hazardous waste management licenses revoked shall notify the revocation to and terminate all existing hazardous waste management contracts with their customers and partners.

Article 23: Examination and certification of implementation of contents of environmental impact assessment reports and requirements stated in decisions approving these reports for investment projects on hazardous waste treatment facilities evaluated and approved by the Ministry of Natural Resources and Environment
1. In case the licensing agency is the Vietnam Environment Administration.
(a) Procedures for requesting, examining and certifying the implementation of contents of environmental impact assessment reports and requirements stated in decisions approving these reports (including the implementation and trial operation of environmental protection works and solutions) shall not be carried out separately but constitute part of procedures for registering hazardous waste management practice and granting hazardous waste management practice licenses under this Circular.
(b) A hazardous waste management practice license made according to a set form-provided in Appendix 2 (E) to this Circular contains certification of the implementation of contents of the environmental impact assessment report and requirements stated in the decision approving this report (including implementation of environmental protection works and solutions).
2. In case the licensing agency is a local one.
(a) A hazardous waste management practice-registering organization or individual shall concurrently compile a dossier for registration of hazardous waste management practice at the local licensing agency and a dossier to request the Vietnam Environment Administration to certify the implementation of contents of the environmental impact assessment report and requirements stated in the decision approving this report (including implementation of environmental protection works and solutions) under regulations.
(b) A hazardous waste management practice-registering organization or individual shall combine the trial operation of environmental protection works and solutions proposed in its/ his/her environmental impact assessment report with the trial operation of hazardous waste treatment facilities under Clause 3, Article 17 of this Circular.
(c) The local licensing agency and the Vietnam-Environment Administration shall concurrently carry out the two procedures specified in this Clause and separately grant hazardous waste management practice licenses and certificates of implementation of contents of environmental impact assessment reports and requirements stated in decisions approving these reports according to their competence.

1-2 Laws and regulation related to environmental impact

1-2 Laws and regulation related to environmental impact

Category	Laws/Regulations	
General	Law on Environment Protection	No. 52/2005/QH11
	Detail and guidance for implementing some ordinances of the Law on Environmental Protection	Decree No. 80/2006/ND-CP
	Amending and supplementing some ordinances of the Government's decree No. 80/2006/ND-CP	Decree No. 21/2008/ND-CP
	Regulating the sanction of administrative violation in the field of environmental protection	Decree No. 179/2013/ND-CP
	Prescribing the functions, tasks, powers and organizational structure of the Ministry of Natural Resources and Environment	Decree No. 21/2013/ND-CP
	Organization and operation of Vietnam environmental protection fund	Decision No. 02/2014/QD-TTg
	Promulgating the Organization and Operation Charter of Vietnam Environmental Protection Fund, 2008	Decision No. 2031/QD-BTNMT
	Providing for the environmental management and protection of economic zones, hi-tech parks, industrial parks and industrial complexes	Circular No. 08/2009/TT-BTNMT
	Amending and supplementing a number of articles of the Circular No. 08/2009/TT-BTNMT	Circular No. 48/2011/TT-BTNMT
	Establishment of provincial Department of Natural Resources and Environment, 2003	Decision No. 45/QD-TTg
	Specifying mandates, responsibilities, powers and organizational structure of the Department of Water Resources Management, 2008	Decision No. 1035/QD-BTNMT
	Providing for the environmental protection at stages of elaboration, evaluation, approval and implementation of development strategies, planning, plans, programs and projects	Decree No. 140/2006/ND-CP
	Guiding to implement Decree No. 140/2006/ND-CP	Circular No. 06/2007/TT-BKH
	Guiding the functions, tasks, powers and organizations of the natural resources and environment related specialized units under the people's committees at all levels	Circular No. 03/2008/TTLT-BTNMT- BNV
	On the collection, management, exploitation and use of natural resources and environmental data	Circular No. 102/2008/ND-CP
	Egulation on setting-up, assessment, approval, inspection and certification of the implemetation of detailed environmental protection project;	Circular No. 01/2012/TT-BTNMT

Category	Laws/Regulations	
	setting-up and registration of simple environmental protection project	
	On function, tasks, responsibilities, and organizational structure of Vietnam Environmental Protection Administration under MONRE	Decision No. 25/2014/QD-TTg
	Promulgation of 21 sanitation standards, 05 principles and 07 parameters of labor sanitation	Decision No. 3733/2002/QD-BYT
	National Technical Regulation on industrial waste incinerator	QCVN 30:2012/BTNMT
Construction	Law on Construction	No. 16/2003/QH11
	Promulgation of National Technical Regulations on Construction Planning - QCXDVN 01:2008/BXD	Decision No. 04/2008/QD-BXD
	Installation of equipment earthing system for industrial projects	TCVN 9358:2012
Fire-fighting	Law on Fire-fighting	No. 27/2001/QH10
	The Law amending and supplementing a number of articles of the Law on Fire Prevention and Fighting	No. 40/2013/QH13
	Guidance for implementing some ordinances of the Fire-fighting Law and the Law amending and supplementing a number of articles of the Law on Fire Prevention and Fighting	Decree No. 79/2014/ND-CP
	Fire prevention and protection for buildings and structures – Design requirements	TCVN 2622:1995
	Fire extinguishing system – General requirements for design, installation and use	TCVN 5760:1993
Investment	Law on Investment	No. 59/2005/QH11
	Detail and guidance for implementing some ordinances of the Law on Investment	Decree No. 108/2006/ND-CP
	Guiding the import, export, processing and liquidation of imported goods and consumption of products of foreign-invested enterprises	Circular No. 04/2007/TT-BTM
Technology Transfer	Law on Technology Transfer	No. 80/2006/QH11
	Detail and guidance for implementing some ordinances of the Law on Technology Transfer	Decree No. 133/2008/ND-CP
Air quality	National Technical Regulation on some toxic substances in ambient air	QCVN 06:2009/BTNMT
	National Technical Regulation on industrial emission of inorganic substances and dusts	QCVN 19:2009/BTNMT
	National Technical Regulation on industrial emission of organic substances	QCVN 20:2009/BTNMT

Category	Laws/Regulations	
	National Technical Regulation on ambient air quality	QCVN 05:2013/BTNMT
Water quality	Law on Water Resource	No. 17/2012/QH13
	Detailing the implementation a number of articles of the Law on Water Resources	Decree No. 201/2013/ND-CP
	Environmental protection charges for wastewater	Decree No. 25/2013/ND-CP
	Guiding Decree No. 25/2013/ND-CP	Joint circular No. 63/2013/TTLT-BTC-BTNMT
	Promulgating list of fields and sectors in production and processing having wastewater containing heavy metal in serve of the calculating the environmental protection charges for wastewater	Circular No.06/2013/TT-BTNMT
	Urban and industrial-park water drainage	Decree No. 88/2007/ND-CP
	The registration for groundwater exploitation, form of dossier for issue, extension, modification, reissue of water resource permit	Circular No. 27/2014/BTNMT
	National Technical Regulation on surface water quality	QCVN 08:2008/BTNMT
	National Technical Regulation on groundwater quality	QCVN 09:2008/BTNMT
	National Technical Regulation on industrial wastewater	QCVN 40:2011/BTNMT
	National Technical Regulation on Coastal Water Quality	QCVN 10:2008/BTNMT
	National Technical Regulation on Domestic Wastewater	QCVN 14:2008/BTNMT
	National Technical Regulation on Domestic Water Quality	QCVN 02:2009/BTNMT
	Water supply – Pipeline system and Construction works – Design standard	TCXDVN 33:2006
Sodid waste	Ratifying the Strategy For Management of Solid Waste in Vietnamese Cities and Industrial Parks till the Year 2020	Decision No. 152/1999/QD-TTg
	Solid waste management	Decree No. 59/2007/ND-CP
	Guidance of implementing some ordinances of Decree No. 59/2007/ND-CP	Circular No. 13/2007/TT-BXD
	Environmental protection charges for solid waste	Decree No. 174/2007/ND-CP
	Guidance of implementing Decree No. 174/2007/ND-CP regarding environmental protection charges for solid waste	Circular No. 39/2008/TT-BTC
	Approving the planning on construction of solid	Decision No. 1440/QD-TTg

Category	Laws/Regulations	
	waste treatment facilities in three northern, central and southern key economic regions up to 2020	
	National Strategy of Integrated solid waste Management up to 2005, vision to 2050	Decision No. 2149/QD-TTg
	Approving the program for investment in solid waste treatment during 2011-2020	Decision No. 798/QD-TTg
Hazardous Waste	Regarding hazardous waste Management	Circular No. 12/2011/TT-BTNMT
	National Technical Regulation on hazardous waste threshold	QCVN 07:2009/BTNMT
	Hazardous waste – Classification	TCVN 6706:2009
	National Technical Regulations on Hazardous Thresholds for Sludge from Water Treatment Process	QCVN 50:2013/BTNMT
Noise	National Technical Regulation on noise	QCVN 26:2010/BTNMT
Vibration	National Technical Regulation on vibration	QCVN 27:2010/BTNMT
Soil	National Technical Regulation on allowable limit for heavy metals in soil	QCVN 03:2008/BTNMT
Land Use, Resettlement, Compensation	Law on Land	No. 45/2013/QH13
	Providing for Implementation of Law on Land	Decree No. 43/2014/ND-CP
	Regulations on land prices	Decree No. 44/2014/ND-CP
	Collection Of Land Use Levies	Decree No. 45/2014/ND-CP
	Compensation, Support and Resettlement When Land is Recovered by the State	Decree No. 47/2014/ND-CP
	The sanctioning of administrative violations in the land domain	Decree No. 105/2009/ND-CP
	Issuance of regulations on compensation, support and resettlement when the State acquire lands in the territory of HCMC	Decision No. 35/2010/QD-UBND
Forest, biodiversity, natural environment	Law on forest protection and development	No. 29/2004/QH11
	Implementation of the Law on forest protection and development	Decree No.23/2006/ND-CP
	Law on Biodiversity	No. 20/2008/QH12
	Detailing and guiding a number of articles of the Biodiversity Law	Decree No. 65/2010/ND-CP
Climate change	The national strategy for climate change	Decision No. 2139/QD-TTg
	National action plan on climate change period 2012 - 2020	Decision No. 1474/QD-TTg
	The national target program on response to climate change	Decision No. 158/2008/QD-TTg
	The national target program on response to climate change period 2012 - 2015	Decision No. 1183/QĐ-TTg
International environmental	Convention on Biological Diversity (CBD)	Effective dated in Vietnam on Nov 16th, 1994
	Kyoto Protocol on Climate Change	Effective dated in Vietnam on Sep 25th, 2002

Category	Laws/Regulations	
conventions/agre-ements/treaties which Vietnam engaged	Stockholm Convention on Persistent Organic Pollutants (POPs)	Effective dated in Vietnam on Jul 7th, 2002
	UN's International Declaration on Cleaner Production	Effective dated in Vietnam on Sep 22th, 1999
	UN Convention to Combat Desertification	Effective dated in Vietnam on Nov 23th, 1998
	Basel Convention on the Control of Trans boundary Movements of Hazardous Wastes and their Disposal	Effective dated in Vietnam on Mar 13th, 1995
	Agreement on Cooperation for the Sustainable Development of the Mekong River Basin	Effective dated in Vietnam on Apr 5th, 1995
	United Nations Convention on the Law of the Sea (UNCLOS)	Effective dated in Vietnam in 1994
	Vienna convention for the protection of the ozone layer including the Montreal Protocol on Substances that Deplete the Ozone Layer	Effective dated in Vietnam in Jan 26th, 1994
	United Nations framework Convention on Climate Change	Effective dated in Vietnam in 1994
	Cartagena Protocol on Biosafety	Effective dated in Vietnam in 2004
	Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES)	Effective dated in Vietnam on Jan 15th, 1994
	MARPOL International Convention for the Prevention of Pollution from Ships	Effective dated in Vietnam in 1991
	Convention on Wetlands of International Importance especially as Waterfowl Habitat (Ramsar)	Effective dated in Vietnam in 1989
	Convention Concerning the Protection of the World Cultural and Natural Heritage	Effective dated in Vietnam in 1982
	International Commitment on spray and utilize pesticide, FAO	Effective dated in Vietnam in 1985
	Convention on the Conservation Of Migratory Species Of Wild Animals (CMS)	Under discussion
	Agreement on the Network of Aquaculture Centers in Asia and the Pacific	Effective dated in Vietnam in 1989
	Agreement for the Establishment of the Asia-Pacific Fishery Commission	Effective dated in Vietnam in 1995
	Agreement on the Conservation of Nature and Natural Resources	Under discussion

1-3 VIETNAM INVESTMENT PROCEDURES APPLICATBLE FOR SOLID WASTE TREATMENT PROJECT

VIETNAM INVESTMENT PROCEDURES
APPLICATBLE FOR SOLID WASTE TREATMENT PROJECT

PREPARED BY
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JULY 2015

VIETNAM INVESTMENT PROCEDURE
APPLICABLE FOR SOLID WASTE TREAMENT PROJECT

TABLE OF CONTENTS

INTRODUCTION

Investment projects in Viet Nam are separated into several types: Public investment projects, PPP projects, and normal commercial investment projects. Each type of investment projects is governed by different laws and related decrees, circulars and other related regulation.

Types of projects	Major governing laws and regulation
Public investment projects	Law on Public investment, Law on Bidding, Law on Enterprises.
PPP projects	Law on Public investment, Law on Investment, Decree No. 15/2009/NĐ-CP on Public Private Partnership investment form, Law on Bidding, Law on Enterprises.
Commercial projects	Law on Investment, Law on Bidding, Law on Enterprises.

As for commercial projects, procedure for investment registration is different based on business line, amount of capital, incentives requirement of the project. As for PPP projects, procedure for investment registration is different based on projects type A, B, C and whether proposed by investors or by the State authorities.

The structure of this report comprises two parts: Part 1 is the investment registration procedure for commercial projects and Part 2 is the investment registration procedure for PPP projects. In this report, we mainly focus on describing procedure for investment registration of projects that we think applicable for Tunesihi case; specifically, commercial projects which the Prime Minister approves investment registration and PPP projects of type A & type B and proposed by investors.

In addition, considering specific character of the project as solid waste treatment project, after receipt of the investment registration license, the project may need to register for license or certification for waste treatment based on the type of wastes treated (i.e, hazardous waste, ordinary solid industrial waste, or municipal solid waste). Types of authorization in these cases are also presented in this report.

PART 1 - INVESTMENT PROCEDURES FOR COMMERCIAL WASTE TREAMENT PROJECTS

	Procedure	Responsible parties	Results	Timeline	Regulation references
STEP 1 -	**Project Preparation**	The investor			
1,1	**Market research**	The investor			
1,2	**Legal framework research**	The investor			
1,3	**Discussion & negotiation with Vietnamese partner**	The investor			
1,4	**Make a joint venture agreement/ a project cooperation contract**	The investor			
STEP 2 -	**Application for Decision on Investment Policy**	The investor, the State authorities (the National Assembly/ the Prime Minister/ the Provincial People's Committee)	Decision on Investment Policy		Article 30, 31, 32, 33, 34, 35 of Law on Investment 2014
2,1	**Preparation & submit of documents to the local registry office** *(for projects that are subjects to issuance of a decision on investment policies)*	The investor			
2,2	Issuance of Decision on Investment Policy	The State authorities		Within 35 days from date of receipt of documents, investors shall receive notification of result from the registry office (for projects authorized by the Provincial People's Committee)	
	Please see Appendix 1.1 for more detail on subject of application and document requirement of this step.				
STEP 3 -	**Selection of investors via auction (if necessary)**	The investor, the soliciting entity, the authorized bodies, the State authorities			
STEP 4-	**Investment Registration**	The investor	Investment Registration Certificate		Article 36, 37, 38, 39 of Law on Investment 2014

	Procedure	Responsible parties	Results	Timeline	Regulation references
4,1	**Preparation & submit of documents** *(for projects that are not subjects to issuance of a Decision on investment policies)*	The investor			
4,2	Issuance of Investment Registration Certificate	The State authorities		- Within 05 working days from the receipt of the decision on investment policies (for projects that are subjects to issuance of a decision on investment policies; - Within 15 days from the receipt of sufficient documents (for projects that are not subjects	
	Please see Appendix 1.2 for more detail on subject of application document requirement , and contents of the Investment Registration Certificate				
STEP 5-	**Application for license/ certification for waste treatment**	The investor, the State authorities (MONRE, the provincial People's Committee)	License of hazardous waste treatment/ Certification of meeting environmental protection requirements		Article 9,10,11, 31,32 of Decree 38/2015/NĐ-CP
5,1	**Preparation & submit of documents**	The investor			
5,2	Issuance of Investment Registration Certificate	The State authorities			
	Please see Appendix 1.3 for more detail on subject of application and authority to issue license/ certification for waste treatment				

Appendix 1.1. Subject of application and document requirement for application for Decision on Investment Policy (details of Step 2.1)

1. Subjects of application

1.1. Project belong to the authority of the National Assembly

Except for the projects subject to issuance of decisions on investment policies by the National Assembly according to regulations of law on public investment, the National Assembly shall issue decisions on investment policies of the following projects:

1. Projects that have significant effects on the environment or potentially have seriously affect the environment, including:

a) Nuclear power plants;

b) Projects that change purposes of land in national parks, wildlife sanctuaries, landscape sanctuaries, experimental forests of 50 hectares or larger; headwaters protective forests of 50 hectares or larger; protection forests meant for protection against wind, sand, waves, land reclamation, environmental protection of 500 hectares or larger, production forests of 1,000 hectares or above;

2. Projects that change purposes of land meant for rice cultivation with two or more crops of 500 hectares or larger;

3. Projects that require relocation of 20,000 people or more in highlands; 50,000 people or more in other areas;

4. Projects that require special policies decided by the National Assembly.

1.2. Project belong to the authority of the Prime Minister

Except for the projects subject to issuance of decisions on investment policies by the Prime Minister according to regulations of law on public investment and the projects which are of the authority of the National Assembly, the Prime Minister shall issue decisions on investment policies of the following projects:

1. The following projects regardless of capital sources:

a) Projects that require relocation of 10,000 people or more in highlands; 20,000 people or more in other areas;

b) Construction and operation of airports; air transport;

c) Construction and operation of national seaports;

d) Petroleum exploration, extraction, and refinery;

dd) Betting and casino services;

e) Cigarette production;

g) Development of infrastructure of industrial parks, export-processing zones, and specialized sectors in economic zone;

h) Construction and operation of golf courses;

2. Projects not mentioned in Clause 1 of this Article in which investment is VND 5 billion or above;

3. Projects of investment of foreign investors in sea transport, provision of telecommunications services with network infrastructure; afforestation, publishing, journalism, establishment of wholly foreign-invested science and technology organizations or science and technology companies;

4. Other projects subject to issuance of decisions on investment policies by the Prime Minister as prescribed by law.

1.3. Project belong to the authority of the Provincial People's Committee

1. Except for the projects subject to issuance of decisions on investment policies by the People's Committee of the provinces according to regulations of law on public investment and the projects which are of the authority of the National Assembly/ the Prime Minister, the People's Committees of provinces shall issue decisions on investment policies of the following projects:

a) Projects that use land allocated or leased out by the State without auction or bidding or transfer; projects that require changes of land purposes;

b) Projects that use technologies on the List of technologies restricted from transfer prescribed by regulations of law on technology transfers.

2. The investment policies of investment projects mentioned above executed at industrial parks, export-processing zones, hi-tech zones, and economic zones in conformity with planning approved by competent authorities are not subject to approval of the People's Committees of provinces.

2. Document requirement

2.1. For projects authorized by the Provincial People's Committee

The document consists of:

a) A written request for permission for execution of the investment project;

b) A copy of the ID card or passport (if the investor is an individual); a copy of the Certificate of establishment or an equivalent paper that certifies the legal status of the investor (if the investor is an organization).
c) An investment proposal that specifies: investor(s) in the project, investment objectives, investment scale, investment capital, method of capital rising, location and duration of investment, labor demand, requests for investment incentives, assessment of socio-economic effects of the project;
d) Copies of any of the following documents: financial statements of the last two years of the investor; commitment of the parent company to provide financial support; commitment of a financial institutions to provide financial support; guarantee for investor’s financial capacity; description of investor’s financial capacity;
e) Demand for land use; if the project does not use land allocated, leased out by the State, or is not permitted by the State to change land purposes, then a copy of the lease agreement or other documents certifying that the investor has the right to use the premises to execute the project shall be submitted;
f) Explanation for application of technologies to the projects that use technologies on the List of technologies restricted from transfer prescribed by regulations of law on technology transfers, which specifies: names of technologies, origins, technology process diagram, primary specifications, conditions of machinery, equipment and primary technological line;
g) The business cooperation contract (if the project is executed under a business cooperation contract).

2.2. For projects authorized by the Prime Minister:

The investor shall submit the project documents to the local registry office. The document consists of:

a) The documents as mentioned for projects authorized by the Provincial People's Committee;
b) Land clearance and relocation plan (if any);
c) Preliminary assessment of environmental impacts and environmental protection measures;
d) Assessment of socio-economic effects of the project.

2.3. For projects authorized by the National Assembly:

The investor shall submit the project documents to the local registry office. The document consists of:

a) The documents as mentioned for projects authorized by the Provincial People's Committee;
b) Land clearance and relocation plan (if any);
c) Preliminary assessment of environmental impacts and environmental protection measures;
d) Assessment of socio-economic effects of the project;
e) Proposed special policies (if any).

Appendix 1.2. Subject of application, document requirement for investment registration, and content of the Investment Registration Certificate (details of Step 4.1)

1. Subjects of application

The Investment Registration Certificate is required in the following cases:

a) Investment projects of foreign investors;

b) Investment projects of the business organizations which are

- 51% of charter capital or more is held by foreign investors, or the majority of the general partners are foreigners if the business organization is a partnership;
- 51% of charter capital or more is held by the business organizations mentioned in Point a;
- 51% of charter capital or more is held foreign investors and the business organizations mentioned in Point a.

2. Document requirement

The investor shall submit the project documents to the local registry office. The document consists of:

a) A written request for permission for execution of the investment project;
b) A copy of the ID card or passport (if the investor is an individual); a copy of the Certificate of establishment or an equivalent paper that certifies the legal status of the investor (if the investor is an organization).
c) An investment proposal that specifies: investor(s) in the project, investment objectives, investment scale, investment capital, method of capital rising, location and duration of investment, labor demand, requests for investment incentives, assessment of socio-economic effects of the project;
d) Copies of any of the following documents: financial statements of the last two years of the investor; commitment of the parent company to provide financial support; commitment of a financial institutions to provide financial support; guarantee for investor's financial capacity; description of investor's financial capacity;
e) Demand for land use; if the project does not use land allocated, leased out by the State, or is not permitted by the State to change land purposes, then a copy of the lease agreement or other documents certifying that the investor has the right to use the premises to execute the project shall be submitted;
f) Explanation for application of technologies to the project mentioned in Point b Clause 1 Article 32 of this Law, which specifies: names of technologies, origins, technology process diagram, primary specifications, conditions of machinery, equipment and primary technological line;

g) The business cooperation contract (if the project is executed under a business cooperation contract).

Note:

Collection, treatment, recycling of waste is one of business lines that are given investment incentive.

3. Contents of the Investment Registration Certificate

a) Code of the project.
b) Name and address of the investor.
c) Name of the project.
d) Location and area of the project.
e) Objectives and scale of the project.
f) Capital investment in the project (including the investor's capital and raised capital), capital contribution and capital raising schedule.
g) Duration of the project.
h) Project execution schedule: schedule of infrastructural development and inauguration (if any); schedule of achievements of primary targets and items; targets, duration, and operations of each stage (if the project is divided into multiple stages);
i) Investment incentives, support, and conditions (if any).
j) Conditions applied to the investor (if any).

Appendix 1.3. Detail on subject of application and authority to issue license/ certification for waste treatment (details of Step 5)

1. Hazardous waste treatment

a) Hazardous waste treatment project must be given License for hazardous waste treatment.

b) The Ministry of Natural Resources and Environment shall be competent agencies in licensing hazardous wastes treatment on a national scale.

c) A License for hazardous waste treatment content includes:

- operation areas,
- number and types of hazardous waste permitted to treat,
- the vehicles, system, equipment for the transport and treatment of hazardous waste (including pre-processing, recycling, co-treatment, recovery of energy),
- other requirements for hazardous waste treatment.

d) The time-limit for licensing hazardous waste treatment is 3 years from the date of issuance.

e) Procedures for licensing hazardous waste treatment shall replace procedures for: inspection and certification of completion of the environmental protection works according to reports on environmental impact assessment, environmental protection projects (or equivalent records and document); confirmation of meeting environmental protection requirements for treatment facilities of daily-life solid waste and ordinary industrial solid waste (in case hazardous waste treatment facilities combine treatment of daily-life solid waste with ordinary industrial solid waste treatment); Other procedures for environment relevant to the operational stage of hazardous waste treatment facilities as prescribed by law.

f) During the consideration, granting the License for hazardous waste treatment, the Ministry of Natural Resources and Environment shall approve in writing the trial operation of hazardous waste treatment as a temporary base for organizations and individuals to conclude contracts of collection, transportation and treatment of hazardous waste serving the trial operation within 06 (six) months.

2. Ordinary solid industrial waste

a) Ordinary industrial solid waste treatment project must be given certificate of meeting environmental protection requirements prior to official operation.

b) Authority to certify or adjust the certification of meeting environmental protection requirements:

❖ The Ministry of Natural Resources and Environment shall certify or adjust the certification of meeting environmental protection requirements for:

- Ordinary industrial solid waste treatment facilities of which reports on environmental impact assessment are approved by the Ministry of Natural Resources and Environment;
- Ordinary industrial solid waste treatment facilities receive waste for treatment from the waste generation sources in the inter-provincial areas;
- Ordinary industrial solid waste treatment facilities associated with hazardous waste treatment (replaced by the License for hazardous waste treatment).

❖ The provincial People's Committee shall certify or adjust the certification of meeting environmental protection requirements for:

- Ordinary industrial solid waste treatment facilities of which reports on environmental impact assessment is under its competence.
- The facilities only receive waste for treatment from the generators in the provincial areas.

PART 2 - INVESTMENT PROCEDURES FOR SOLID WASTE TREATMENT PPP PROJECTS

(Applied for project belong to Type A, B and proposed by the Investors)

	Procedure	**Responsible parties**	**Results**	**Timeline**	**Regulation references**
I	**PREPARATION**				
STEP 1 -	**Project Preparation**	The investor	- Project proposal - Project FS		
1.1	**Market research**	The investor			
1.2	**Legal framework research**	The investor			
1.3	**Select Vietnamese partner**	The investor			
1.4	**Make a joint venture agreement**	The investor			
STEP 2 -	**Preparation, assessment, approval and announcement of Project Proposals**	The investor, the State authorities	- A written approval of the Project proposal		
2.1	**Preparation & submit of Project Proposals**	The investor			Article 20, 21 of Decree 15
2.2	Project approval	The State authorities		within 30 days from the receipt of full documents	Article 22 of Decree 15
2.3	Project announcement	the State authorities, the investors		within 07 business days from the approval of Project Proposal	Article 23 of Decree 15
	Please see Appendix 2.1 for more detail on document requirement of the project proposal.				
STEP 3 -	**Preparation, assessment, and approval of Feasibility Study Reports**	The investor, the State authorities, the authorized bodies	- A written agreement among the Ministries, Branches, and provincial People's Committees and the Investor(s) on assignation of the Investor(s) to prepare Feasibility Study Report - A written approval of the Feasibility Study Report		

	Procedure	Responsible parties	Results	Timeline	Regulation references
3.1	**Preparation & submit of Feasibility Study Reports**	The investor			Article 24, 25 of Decree 15
3.2	Evaluation of Feasibility Study Reports	The authorized bodies			Article 26 of Decree 15
3.3	Approval of Feasibility Study Reports	The State authorities			Article 27 of Decree 15
	Please see Appendix 2.2 for more detail on the document requirement of this step.				
II	**SELECTION OF INVESTORS**				
STEP 4 -	**Pre-qualification**	The investor, the soliciting entity, the authorized bodies	- Shortlist of investors is published on the national bidding network or Vietnam Public Procurement Review Journal by the soliciting entity; - Notification to every investor that submits the pre-qualification application by the soliciting entity;		Chapter II of Decree 30
4.1	Prepare the pre-qualification				
4.1.1	Make the pre-qualification documents;	The soliciting entity			Article 17 of Decree 30
4.1.2	Appraise, approve the pre-qualification documents	The authorized bodies			Article 17 of Decree 30
4.2	Organize the pre-qualification				
4.2.1	Announce the pre-qualification;	The soliciting entity			Article 18 of Decree 30
4.2.2	Publish, adjust, clarify the pre-qualification documents;	The soliciting entity			Article 18 of Decree 30
4.2.3	**Prepare, submit pre-qualification applications;**	The investor			Article 19 of Decree 30
4.2.4	Receive, manage pre-qualification applications;	The soliciting entity			Article 19 of Decree 30
4.2.5	**Adjust, withdraw pre-qualification applications (if necessary)**	The investor			Article 19 of Decree 30

	Procedure	Responsible parties	Results	Timeline	Regulation references
4.2.6	Bid opening.	The soliciting entity			Article 19 of Decree 30
4.3	Evaluate pre-qualification applications.	The soliciting entity			Article 20 of Decree 30
4.4	**Clarify pre-qualification applications (if necessary)**	The investor			Article 20 of Decree 30
4.5	Submit the pre-qualification results	The soliciting entity			Article 21 of Decree 30
4.6	Appraise, approve the pre-qualification results;	The authorized bodies			Article 21, Clause 2 Article 83 Decree 30
4.7	Publish the short list.	The soliciting entity			Article 21, Point d, clause 1, Article 2 & Point c clause 1/ Point b clause 2 Article 5 of Decree 30
STEP 5 -	**Investor Selection plan**	The soliciting entity, The authorized bodies			
5.1	Making the investor selection plan	The soliciting entity			Article 23 of Decree 30
5.2	Evaluating the investor selection plan	The appointed party			Article 24 of Decree 30
5.3	Approving the investor selection plan	The authorized body			Article 24 of Decree 30
STEP 6 -	**Competitive bidding for selection of investors in PPP projects**	The investor, the soliciting entity, the authorized bodies, the State authorities			
6.1	Preparation for the investor selection				
6.1.1	Make the bidding documents;	The soliciting entity			Article 26 of Decree 30
6.1.2	Evaluate the bidding documents	The soliciting entity			Article 28 of Decree 30
6.1.3	Approve the bidding documents	The State authorities			Article 28 of Decree 30
6.2	Organization of investor selection				

	Procedure	Responsible parties	Results	Timeline	Regulation references
6.2.1	Invite bids;	The soliciting entity			Article 29 of Decree 30
6.2.2	Publish, adjust, clarify the bidding documents	The soliciting entity			Article 30 of Decree 30
6.2.3	**Prepare, submit bid-envelopes**	The investor			Article 31 of Decree 30
6.2.4	Receive, manage bid-envelopes	The soliciting entity			Article 31 of Decree 30
6.2.5	**Adjust, withdraw bid-envelopes (if necessary)**	The investor			Article 31 of Decree 30
6.2.6	Open technical proposals.	The soliciting entity			Article 32 of Decree 30
6.3	Evaluate technical proposals		- A list of investors that satisfy technical requirements is send to all participant investors by the soliciting entity, inviting investors that satisfy technical requirements to attend opening financial - commercial proposals		
6.3.1	Inspect the validity of technical proposals;	The soliciting entity			Article 36 of Decree 30
6.3.2	Evaluate technical proposals in details;	The authorized bodies			Article 37 of Decree 30
6.3.3	Appraise, approve the list of investors that satisfy technical requirements.	The State authorities			Article 37 of Decree 30
6.4	Opening and evaluating financial – commercial proposals				
6.4.1	**Open financial – commercial proposals**	The soliciting entity + The investor	The opening record that bears the signatures of the soliciting entity and investors who attend the opening ceremony is send to investors that satisfy technical requirements;		Article 38 of Decree 30

	Procedure	Responsible parties	Results	Timeline	Regulation references
6.4.2	Inspect the validity of financial – commercial proposals;	The authorized bodies			Article 39 of Decree 30
6.4.3	Evaluate financial – commercial proposals in details and rank investors;	The authorized bodies			Article 39 of Decree 30
6.4.4	**Preliminarily negotiate the contract**	The first ranked investors + The soliciting entity	- Draft Investment Agreement - Draft Contract		Article 40 of Decree 30
6.5	Submit the investor selection result	The soliciting entity			Article 42 of Decree 30
6.6	Appraise, approve the investor selection result	The State authorities			Article 42, Clause 4 Article 83 of Decree 30
6.7	Publish the investor selection results	The soliciting entity	- Investor selection result is published on the national bidding network or Vietnam Public Procurement Review Journal by the soliciting entity; - Written notification of investor selection result is send to every participant investor by post or fax by the soliciting entity;	within 5 working day from the day on which the investor selection result is approved.	Point 6 Article 42, Point 13 Article 6 of Decree 30
STEP 7-	**CONTRACT NEGOTIATION, COMPLETION**				
7.1	**Negotiate and complete the contract**	The investor + the State authorities			Article 43 of Decree 30
7.2	**Sign the investment agreement**	The investor + the State authorities	The investment agreement		Article 30 of Decree 15, Article 44 of Decree 30
7.3	**Sign the contract**	The investor + the State authorities	The contract	After the investment certificate is issued	Article 31 of Decree 15, Article 44 of Decree 30
III	**INVESTMENT REGISTRATION & ESTABLISHMENT OF THE PROJECT ENTERPRISE**				

	Procedure	Responsible parties	Results	Timeline	Regulation references
STEP 8 -	**Investment Registration**	The investor + the State authorities	Investment Registration Certificate	within 25 days from the date of receipt of full legitimate dossiers	Article 39, 40, 41 of Decree 15
	Please see Appendix 2.3 for more detail on the competence to grant the Investment Registration Certificate, document requirement and contents of the Investment Registration Certificate				
STEP 9 -	**Establish the project enterprise**	The investor + the State authorities			Article 42 of Decree 15
IV	**IMPLEMENTATION OF THE PROJECT**				
STEP 10 -	**Select contractors to implement the project**	The investor			Article 44 of Decree 15
STEP 11 -	**Prepare construction site for the Project**	The Provincial People's Committee + other related authorized bodies			Article 45 of Decree 15
STEP 12-	**Prepare technical construction designs**	The Investor/ The Project Enterprise			Article 46 of Decree 15
STEP 13-	**Supervise the project contract performance**	The investor + the State authorities			Article 47 of Decree 15
STEP 14 -	**Supervise the quality of the work**	The State authorities			Article 48 of Decree 15
STEP 15 -	**Management and operation of the work**	The Investor/ The Project Enterprise or in accordance with conditions in the contract			Article 49 of Decree 15
STEP 16 -	**Investment monitoring and evaluation, financial publicity**				Article 52 of Decree 15
V -	**FINALIZATION AND TRANSFER OF THE PROJECT WORK**				
STEP 17 -	**Finalization of the project work**	The investor + the State authorities			Article 53 of Decree 15
STEP 18 -	**Transfer of the project facility**	The investor + the State authorities			Article 54 of Decree 15

Appendix 2.1. Content requirement of the project proposal (details of Step 2.1)

The proposals for project shall have the following contents:

a) A written proposal for project implementation;

b) Project Proposal shall include the following main contents:

i. The necessity of investment; advantage of the PPP investment form compared to others; type of Project Contract;
ii. The consistence of the project with the planning, development scheme and the criteria set out in Article 15.1 of Decree 15;
iii. Proposed object, scale, location of the project; demand for land use and resources;
iv. Preliminary analysis of requirements on technique, standards, project quality, provided products or services;
v. Proposed project implementation schedule; facility construction and exploitation duration; plan for organization of management, commercial operation or service supply;
vi. Proposed plan on compensation, site clearance, and resettlement;
vii. Proposed criteria for implementation of other Projects (with respect to those implemented under BT Contract);
viii. Preliminary analysis of the project financial plan, including: total investment capital, equity structure and mobilization method; State equity invested for project implementation (if any); expenses; income, price, commodity and service fees; payback period, interests;
ix. Preliminary expectation of risks during project implementation and risk separation among competent State bodies and the Investor(s);
x. Proposal of investment incentives and guarantees (if any);
xi. Preliminary expectation of the project's social – economic efficiency; the project's impact on environment, society, national defense and security;
xii. Other necessary contents.
xiii. With respect to any project consisting of construction structure, in addition to such contents mentioned above, the Project Proposal shall include preliminary design as stipulated by the construction law.

c) Documents proving the legal status, capacity, and experience of the Investor(s);

d) Experience in implementing similar projects (if any);

e) Other necessary documents for explanation of the proposal for project (if any).

The Investor(s) shall prepare and submit the proposals for project to the Ministries, Branches, and provincial People's Committees.

Appendix 2.2. Content requirement of the Feasibility Study Report (details of Step 3.1)

In respect of projects proposed by the Investor(s) and approved, the Ministries, Branches, and provincial People's Committees shall assign the Investor(s) to prepare the Feasibility Study Report.

The assignation of the Investor(s) to prepare Feasibility Study Report shall be made by a written agreement among the Ministries, Branches, and provincial People's Committees and the Investor(s). Such agreement must specify the purposes, requirements, Feasibility Study Report preparation fees, independent consultant rental and handling principles in case another Investor is selected for project implementation.

The Feasibility Study Report of a project shall consist of the following contents:

a) Detailed analysis of the necessity of the project implementation investment and advantages compared to other investment forms; type of Project Contract;
b) The consistence of the project with the planning, development scheme and the criteria set out in Article 15.1 of this Decree;
c) Object, scale, components (if any), location of the project; demand for land use and resources;
d) Technical and technological notes for satisfaction of requirements on project quality, provided products or services;
e) Assessment on current status of the project, machinery, equipment, asset value (in respect of O&M Contract); criteria for implementation of other projects;
f) Project implementation schedule; facility construction and exploitation duration; plan for organization of management, commercial operation or service supply;
g) Compensation, site clearance, and resettlement plan;
h) Project financial plan (as set out in Article 16.2.h of this Decree);
i) Capital mobilization ability for project implementation, assessment of market demand and liquidation; study on the interest in the project of the Investor(s) and the lender(s);
j) Analysis of risks and responsibility of each party in risk management during project implementation;
k) Proposal of investment incentives and guarantees (if any);
l) The project's social – economic efficiency and impact on environment, society, national defense and security;
m) Other necessary contents.
n) With respect to any project consisting of construction structure, in addition to such contents mentioned above, the Feasibility Study Report shall include preliminary design as stipulated by the construction law.

Appendix 2.3. Competence to grant the Investment Registration Certificate, document requirement and contents of the Investment Registration Certificate (details of Step 8)

1. Competence to grant, amend and revoke the Investment Registration Certificate

1. The Ministry of Planning and Investment shall issue, amend and revoke the Investment Registration Certificate with respect to the following projects:

a) Projects of national importance;

b) Projects in which Ministries, branches or bodies authorized by the Ministries and bodies are the state authorities having competence to enter into the project contracts;

c) Projects to be implemented in 02 provinces and cities ore more.

2. The provincial People's Committee shall issue, amend and revoke the Investment Registration Certificates with respect to Projects not stipulated in Point 1.

2. Document requirement

The application file for issuance of the Investment Registration Certificate shall comprise:

a) Written request for issuance of an Investment Registration Certificate;
b) Investment agreement and the project contract draft;
c) Feasibility study report and approval decision of the project;
d) Documents approving the use of state investment capital involved in the project implementation (if any);
e) Joint venture contract and draft of the project enterprise charter (if any);
f) Decision on selection of the investor.

The investor shall submit 05 sets of application files, of which at least 01 set of original documents must be submitted to the authorized State body.

3. Contents of the Investment Registration Certificate

An Investment Registration Certificate shall contain the following main contents:

a) Name and address of the investor;
b) Name of the project;
c) Objectives, scale, requirements, conditions for implementation of the project;
d) Project implementation location and land use area;
e) Total investment capital of the project;
f) Project term and implementation schedule; and the capital source structure;
g) Duration and progress of the project;

h) Value, proportion, progress, and conditions for disbursement of the State investment capital used for project implementation (if any);
i) Investment incentives (if any).
j) For BT projects, in addition to the contents on the infrastructure construction projects above, the Investment Registration Certificate must provide for conditions for implementation of other projects. For other projects, procedures for issuance of the Investment Registration Certificate shall be conducted in accordance with the law on investment.

LIST OF IMPORTANT REGULATIONS

No.	Document No.	Document Name	Date
I. Investment regulations			
1	Law No. 67/2014/QH13	Law on Investment	Issue date: November 26, 2014 Effective date: July 01, 2015
2	Law No. 49/2014/QH13	Law on Public Investment	Issue date: June 18, 2014 Effective date: January 01, 2015
3	Decree No. 15/2009/NĐ-CP	Decree on public private partnership investment form	Issue date: February 14, 2015 Effective date: April 10, 2015
II. Waste treatment regulations			
4	Decree No. 38/2015/NĐ-CP	Decree on management of waste and discarded material	Issue date: April 24, 2015 Effective date: June 15, 2015
III. Bidding regulations			
5	Law No. 43/2013/QH13	Law on Bidding	Issue date: November 26, 2013 Effective date: July 1, 2014
6	Decree No. 30/2015/NĐ-CP	Guidelines for some articles on investor selection of the law on bidding	Issue date: March 17, 2015 Effective date: May 5, 2015
7	Decree No. 63/2014/NĐ-CP	Detailing the implementation of several provisions of Law on Bidding regarding the selection of contractors	Issue date: June 26, 2014 Effective date: August 15, 2014
8	Circular No. 01/2011/TT-BKHĐT	Guidelines for checking of the bidding	Issue date: January 4, 2011 Effective date: March 1, 2011
9	Circular No. 21/2010/TT-BKH	Detailing on appraisal of bidding document	Issue date: October 28, 2010 Effective date: December 15, 2010
10	Circular No. 20/2010/TTLT-BKH-BTC	Guidelines on providing bidding information to publish in Bidding Journal	Issue date: September 21, 2010 Effective date: November 5, 2010
IV. Other regulation			
11	Law No. 68/2014/QH13	Law on Enterprises	Issue date: November 26, 2014 Effective date: July 1, 2015
12	Law No. 45/2013/QH13	Land Law	Issue date: November 29, 2013 Effective date: July 1, 2014

Appendix

2-1 Analysis of Phuoc Hiep Municipal Solid Waste (MSW) Composition

REPORT OF

PHUOC HIEP MUNICIPAL SOLID WASTE RESULTS, JANUARY 2014

January, 2014

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LIST OF ACRONYMS

DW	:	Dry Weight
HCV	:	High Calorific Value
LCV	:	Low Calorific Value
MSW	:	Municipal Solid Waste
VS	:	Volatile Solid
WW	:	Wet Weight

1. GENERAL INFORMATION OF PHUOC HIEP LANDFILL

1.1 Location

Phuoc Hiep landfill locates at the North West Solid Waste Treatment Complex at Tam Tan hamlet, Phuoc Hiep commune, Cu Chi district, Ho Chi Minh city. Phuoc Hiep landfill is about 50 km far from the city center towards the North West, 5 km far from Cu Chi District center towards the South West, which is showed in the picture in Appendix 7. The landfill shares borders with the following positions:

- The region located in the planning areas of the North West Solid Waste Treatment Complex and the existing Indigo forest area in the East and North direction;
- Canal No. 16 in the North West direction;
- Thay Cai Canal in the South West direction;
- Canal No. 15 in the South East direction.

1.2 Capacity and operation status

General information of capacity and operation status in Phuoc Hiep landfill is showed in Table 1.

Table 1. General information of capacity and operation status in Phuoc Hiep landfill

No.	General information	Compartment No.1	Compartment No.1A	Compartment No.2	Compartment No.3
1	Operation duration	2003 - 2007	2007 - now	2008 - now	Both landfill and construction activities
2	Filling area (ha)	18.99	9.75	19.50	60.00
3	Designed capacity (ton/day)	3,000	3,000	3,500	3,000
4	Actual average receiving capacity (ton/day)	3,000	3,000	3,500	-
5	Landfill type	Sanitation	Sanitation	Sanitation	Sanitation
6	Landfill height from ground level (m)	25	15 - 17	-	-
7	Landfill depth from ground level (m)	-7	-7	-7	-7

Source: *Department of Natural Resources and Environment of HCM city (2010, 2013)*

1.3 Disposal technologies

Phuoc Hiep landfill is a sanitation landfill with full items of environmental protection facilities such as

- Area of compartment No. 1 is 18.99 ha and divided into 4 sub-compartments. Each sub-compartment is about 4.74 ha in area. Maximum height of the compartment is 25 m. Municipal solid waste disposal in each compartment is covered in 10 layers. Each layer's thickness is 2.2 m (solid waste has been carefully compacted by landfill bulldozer). Thickness of soil layer between the solid waste layers is 20 cm. On the top, it is betonies layer and then 30 cm topsoil layer covered the compartment.

- Compartments No.1A and No.2 also use similar system of bottom liner and top-covering layer to compartment No. 1. Moreover, in design, pile wall system of compartment No. 1A has been reinforced in order to avoid slip and subsidence incidents surrounding the landfill.

- In compartment No.2, when the solid waste reaches appropriate level, the compartment No.2 will be connected with compartment No.1A in order to take advantage of the strong pile wall system of compartment No.1A. A part of border between compartment No.2 and compartment No.1A will be used for filling the waste in order to increase receiving ability.

- Compartment No.3 of the landfill began to operate in October, 2013 and was continuously constructed other construction items by South Korea contractor.

1.4 Objective of sampling

Sampling purposes at Phuoc Hiep landfill is to analyze physical composition, moisture, volatile solid, ash and gross calorific value of solid wastes in order to evaluate the quality of MSW.

1.5 Implementation schedule

Table 2. Implementation schedule

No.	Articles	Timing plan		
		09/01-10/01	10/01-23/01	11/02-04/03
1	Survey and sampling			
2	Classification of municipal solid waste, bulk density			
3	Analysis of physical composition and moisture			
4	- Analysis of ash, volatile solid (VS) - Analysis of gross calorific value			
5	Data processing			
6	Preparation of report			

2. STATUS OF MSW TRANSPORTATION ACTIVITIES AT PHUOC HIEP LANDFILL

2.1 Process of MSW transportation at Phuoc Hiep landfill

Diagram of solid waste transportation inside Phuoc Hiep landfill is presented in Figure 1.

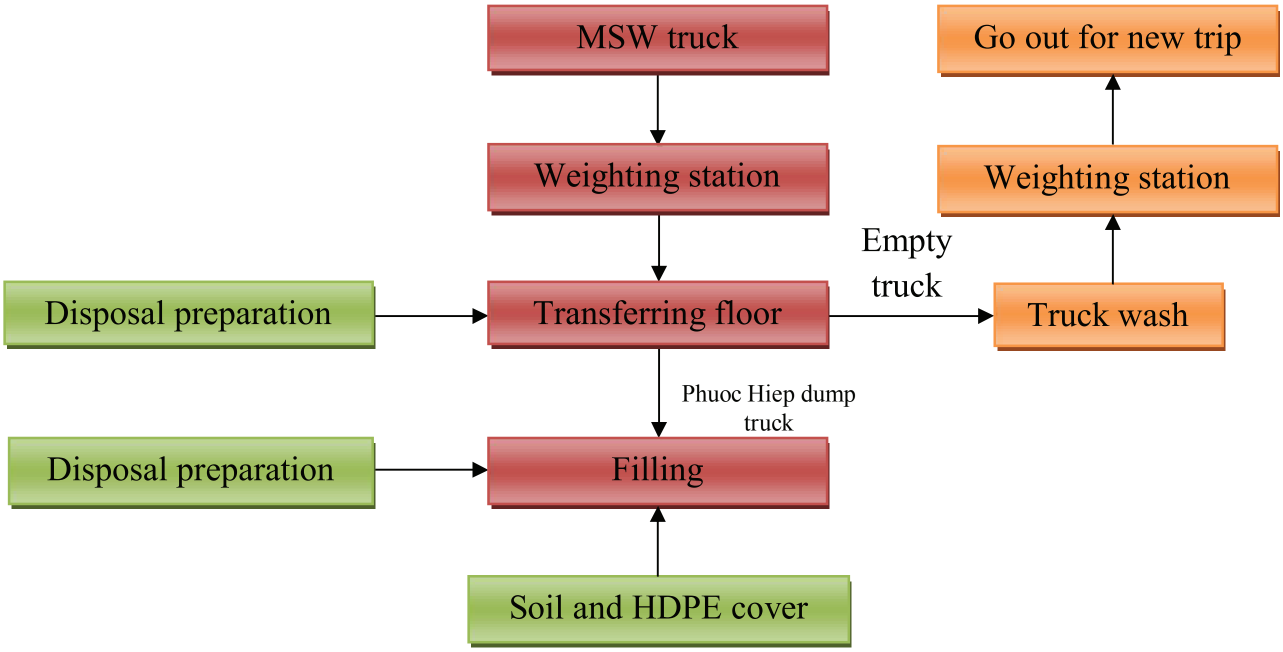


Figure 1 Process of solid waste transportation inside Phuoc Hiep landfill.

2.2 Original of MSW and transporters to Phuoc Hiep landfill

There are two waste sources transported to Phuoc Hiep landfill:

(1) Municipal solid wastes (MSW) from Ho Chi Minh City and Duc Hoa District, Long An Province:

- City Environmental Company (Citenco) collects and transports solid wastes from Binh Chanh, Nha Be, Binh Thanh, Tan Phu; district 2, 7, 9, 10, 11, and 12.
- Industrial agricultural Co-operative transports wastes from District 11.
- Duc Hoa Public Service Company transports wastes from Duc Hoa District, Long An Province.
- 11 public service companies transfer wastes from their own districts.

(2) Residue wastes arising from processes of classifying, recycling and composting from Vietstar Company.

Table 3. Original of solid waste at Phuoc Hiep landfill

No.	Waste transporters	Transfer station	Original of solid wastes
1	Citenco	- Quang Trung- Go Vap - Tong Van Tran- District 11	Binh Thanh, Tan Phu, Binh Chanh, Nha Be, District 2, District 7, District 9, District 10, District 11, District 12
2	Cu Chi public service company	- Tan An Hoi - Tan Phu Trung - Phuoc Thanh - Cu Chi - Tan Thong Hoi - Tan Thanh Tay - Phu Hoa Dong - An Nhon Tay - Lo 6 - Tan Thanh Dong - Quang Viet - Trung An - Pham Van Coi	Cu Chi District
3	Hoc Mon public service company	- Ba Diem - Tan Thoi Nhi - Xuan Thoi Thuong - Thi Tran	Hoc Mon District
4	Industrial agricultural Co-operative	- Tan Hoa	District 11
5	District 12 public service company	- Hiep Thanh - Tan Thoi Hiep	District 12
6	District 2 public service company	- Binh Trung Tay - An Loi Dong	District 2
7	District 9 public service company	- Long Hoa - Phuoc Long A - Ben Do - Vinh Thuan	District 9
8	Binh Thanh public service company	- Phan Van Tri - Thanh Da	Binh Thanh District
9	Go Vap public service company	- Quang Trung	Go Vap District
10	Tan Binh public service company	- Pham Van Bach	Tan Binh District
11	Thu Duc public service company	- Go Dua - So Ga 4 - Linh Xuan 5 - Truong Tho 3 - Tam Than - Hiep Binh Chanh	Thu Duc District

No.	Waste transporters	Transfer station	Original of solid wastes
12	Duc Hoa public service company	- No information	Duc Hoa District - LA
13	Vietstar	- No information	Tan Phu, Phu Nhuan, Tan Binh district, Tranport factory No.1, No.2
14	District 1 public service company	- No information	District 1
15	Phu Nhuan public service company	- Nguyen Kiem	Phu Nhuan District

2.3 The number of waste transporters, trips and total amount of solid wastes at Phuoc Hiep landfill

According to field works in January 2014, there are 15 waste transporters dumping the wastes into Phuoc Hiep landfill. The average is about 273 trips per day. The average total amount of solid waste is about 3,348 tons/day. The details are presented in Table 4.

Table 4. Solid waste mass and number of trips transport into Phuoc Hiep landfill per day

Date	Total waste transporters	Number of trips	Total solid waste mass (ton)
09/01/2014	15	273	3,369
10/01/2014	15	272	3,326
Average	15	273	3,348

There are about 65.1% numbers of trips in the day time (12:00 – 18:00, about 170 trips) and 37.6% numbers of trips in the night-time (18:00 – 6:00, about 103 trips). Therefore, the amount of solid waste transported to the landfill is about 65.7% in the day time and 34.3% at nighttime). (See Table 5 and figure 2).

In the daytime (12:00 – 18:00), the rush hours are from 12:00 to 15:00, covering more than 64.7% trips of day time. In the night-time (18:00 – 6:00), the rush hours are from 18:00 to 21:00, covering about 42.9 % trips of night-time.

Table 5. Frequency of transporter trips and total amount of MSW into landfill during the activity time

Time / Date	From 12:00 – 18:00		From 18:00 – 6:00	
	Number of trips	Solid waste mass (ton)	Number of trips	Solid waste mass (ton)
09/01/2014	162	2,195	111	1,174
10/01/2014	178	2,207	94	1,119

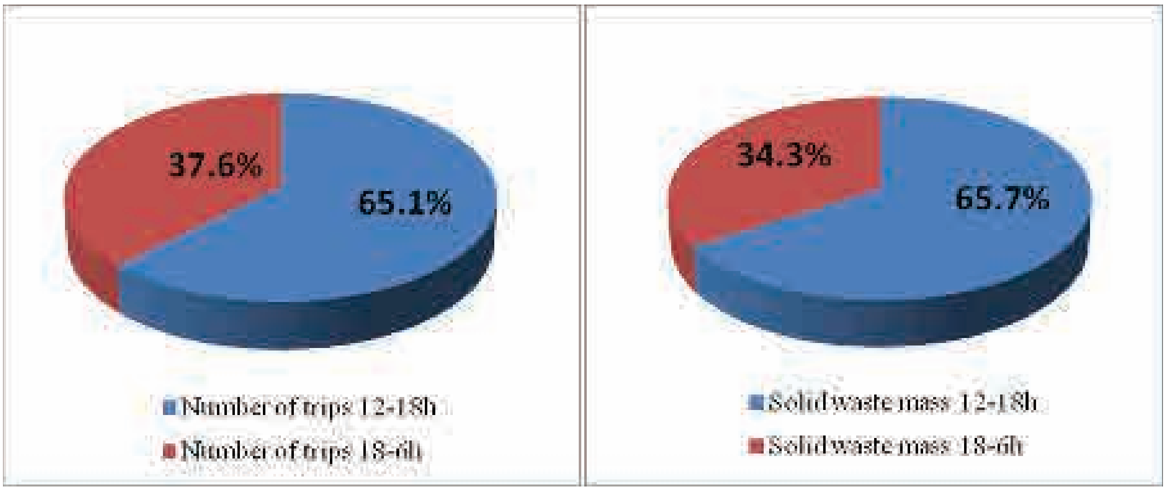


Figure 2 The ratio of numbers of trips and solid waste mass in the day time and the night-time.

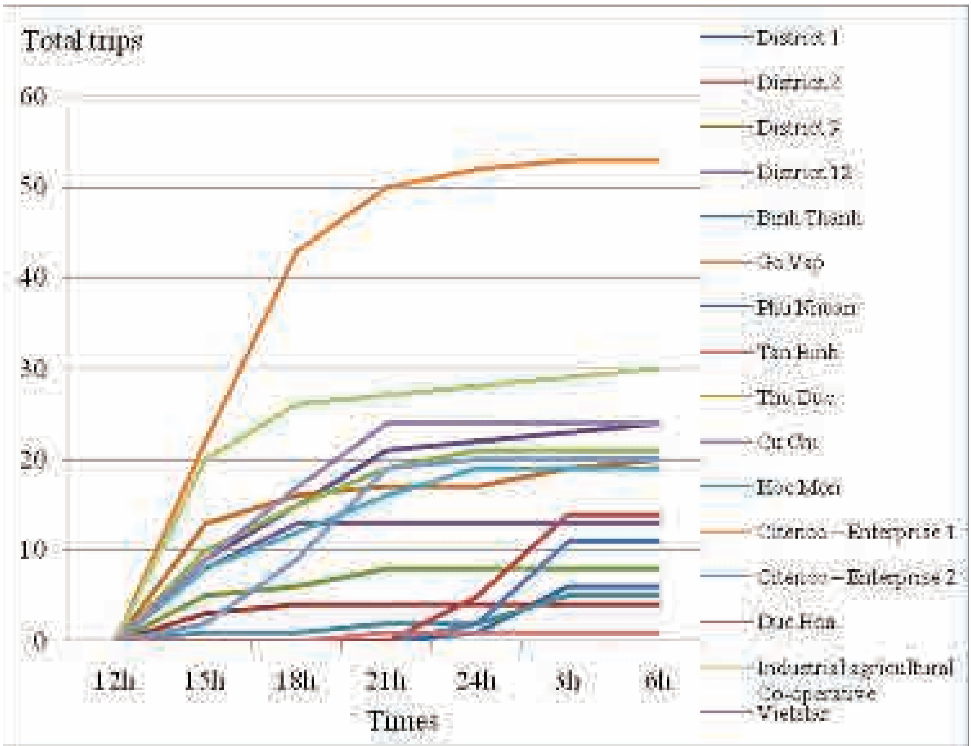


Figure 3 Transport time into Phuoc Hiep landfill of transport units

The study data also shows that there are 26.1% total numbers of trips and 25.8% amount of solid wastes transported by Citenco.

Average time for a truck going in and out Phuoc Hiep landfill is ranging from 10 to 15 minutes. The time passing weighing station is a minute in average.

There are three types of vehicles transporting wastes to Phuoc Hiep landfill: Rear Load Refuse truck, Hook lifting garbage truck, Tarpaulin truck.

Hook lifting garbage truck

Rear Load Refuse Truck

Tarpaulin truck

Figure 4 Types of vehicles transporting garbage to Phuoc Hiep landfill

Most of the wastes are transported into Phuoc Hiep landfill by RLR truck (Rear Load Refuse Truck). Except:

- Vietstar Company transports the waste by tarpaulin truck.

- Citenco transports the waste by hook-lifting garbage truck.

In this survey (in January 2014), the garbage trucks have loading capacity ranging from 4 tons to 18 tons, most of them are ranging from 10 tons to 15 tons, covering 71.2% in total trips (273 total trips). Besides, Citenco is covering 25.8% in total trips ranging from 10 tons to 15 tons.

The detail data of waste transporters, vehicles, trips as well as the total amount MSW of each transporter and transport time into Phuoc Hiep landfill are presented clearly in Table 6 and Figure 5.

Table 6. Activities of waste transporters into Phuoc Hiep landfill

No.	Waste transporters	Number of garbage trucks	Average number of trips in day	Type of vehicle	Note: time	
					From 12:00 to 18:00	From 18:00 to 6:00
1	Citenco	45	72	RLR, HL	Frequently (62%)	Mainly from 18:00 to 21:00 (38%)
2	Cu Chi public service company	5	16	RLR	Frequently (100%)	Not entering
3	Hoc Mon public service company	5	20	RLR	Frequently (64%)	Mainly from 19:00 to 21:30 (36%)
4	Industrial agricultural Co-operative	23	28	RLR	Frequently (86%)	Mainly from 20:00 to 3:00 (14%)
5	District 12 public service company	6	24	RLR	Frequently (64%)	Mainly from 18:00 to 0:00 (36%)
6	District 2 public service company	3	4	RLR	Unusually	Unusually
7	District 9 public service company	5	10	RLR	From 12:00 to 16:00 (75%)	Mainly from 18:30 to 19:00 (25%)
8	Binh Thanh public service company	3	5	RLR	Unusually (22%)	Only from 0:00 to 3:00 (78%)
9	Go Vap public service company	14	20	RLR	From 12:00 to 16:00 (83%)	Only 18:00-19:00 and 2:30-3:30 (17%)
10	Tan Binh public service company	11	15	RLR	Not entering	Mainly from 21:00 to 2:00 (100%)
11	Thu Duc public service company	8	22	RLR	From 12:00 to 17:00 (68%)	Mainly from 19:30 to 23:30 (32%)
12	Duc Hoa public service company	1	1	RLR	Unusually	Unusually
13	Vietstar	4	21	Tarpaulin	Frequently (83%)	Only from 18:00 to 20:00 (17%)
14	District 1 public service company	6	6	RLR	Not entering	Only from 23:30 to 2:30 (100%)
15	Phu Nhuan public service company	7	10	RLR	Not entering	Only from 23:30 to 3:00 (100%)

No.	Waste transporters	Number of garbage trucks	Average number of trips in day	Type of vehicle	Note: time	
					From 12:00 to 18:00	From 18:00 to 6:00
Note: **RLR**: Rear Load Refuse truck; **HL**: Hook lifting garbage truck **Tarpaulin:** Tarpaulin truck						

***Statistics**: 09/01/2014 and 10/01/2014*

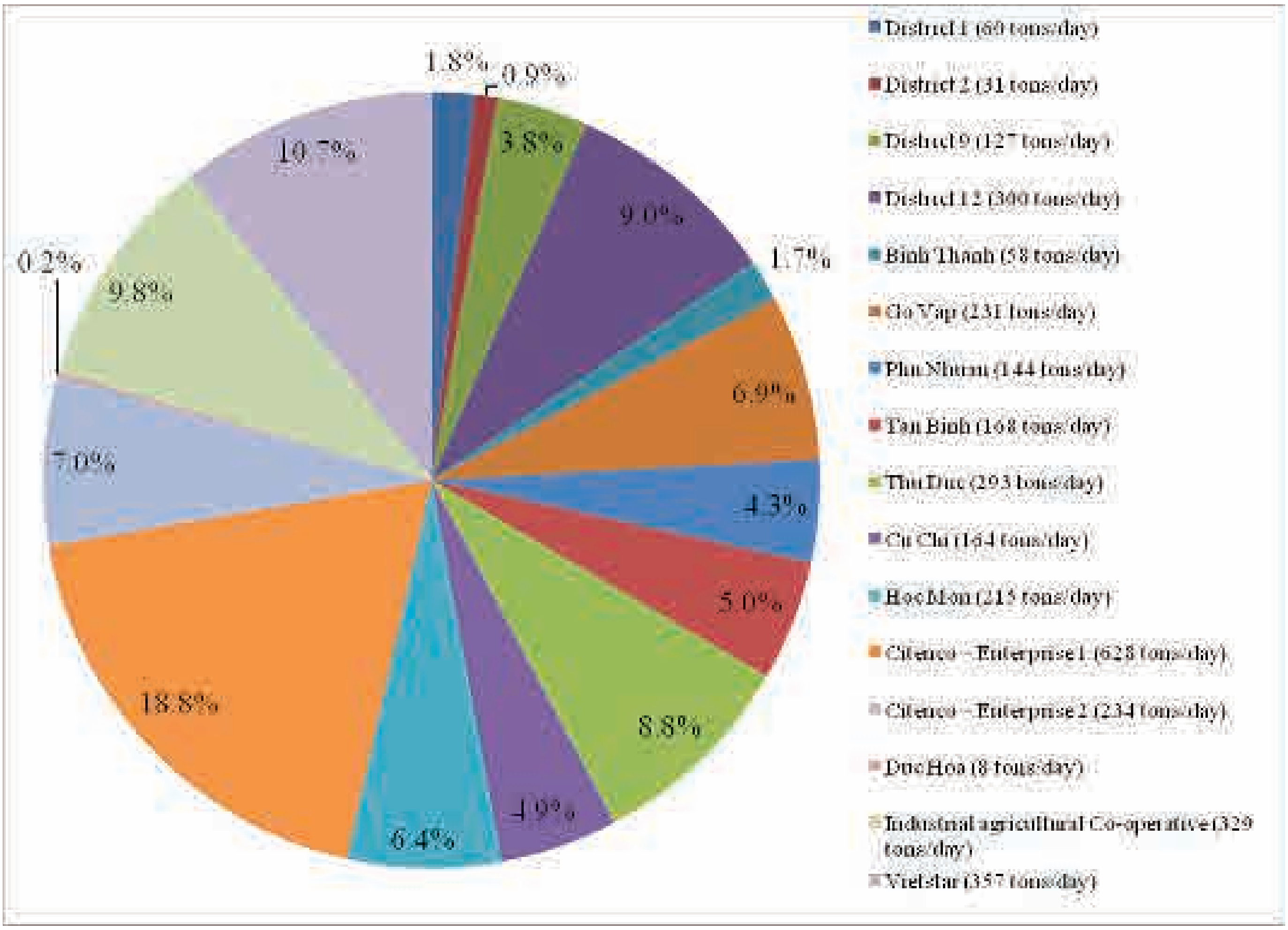


Figure 5. The average solid waste mass (%) of each transporter into Phuoc Hiep landfill

Figure 5 shows that among 15 transporters to Phuoc Hiep landfill, Citenco is the major transporter to Phuoc Hiep landfill, with 25.8% total MSW, 862 tons/day (Enterprise 1: 628 tons/day and Enterprise 2: 234 tons/day).

- After that, Vietstar transports about 10.7% - 357 tons/day, agricultural Co-operative occupies 9.8% - 329 tons/day. From 0.2% to 9.0% (8–300 tons/day) total MSW are: Duc Hoa, District 2 public service Company, Binh Thanh, district 1, district 9, district 12, Phu Nhuan, Tan Binh, Thu Duc, Cu Chi, Hoc Mon public service company, and Go Vap district public service Company.

3. SAMPLING PLAN, SAMPLING METHOD AND ANALYTICAL METHOD

3.1 Sample plan

4 samples are taken at Phuoc Hiep landfill in two days:

Day 1: 2 samples in day time, from 12:00 to 18:00

Day 2: 1 sample in day time and 1 sample in night-time, from 16:30 to 22:00

3.2 Sample method

3.2.1 Collection of sample

a. Sampling location will be decided based on work safety and specific samples.

b. The samples are taken from the MSW collection vehicles and 10^{th} MSW collection vehicle is selected to be sampled in each period. At that time number of truck, date, time, transport units, origin of waste are recorded.

c. MSW is discharged from a collection vehicle into the pile. In the pile, four sampling points are randomly selected, and 20 kg of MSW are collected from each of the four points. In total, 80 kg of samples are collected from one vehicle.

d. Procedure c. is repeated four times. Final weight of samples will be approximately 300 kg.

3.2.2 Preparation of sample

a. Solid wastes after sampling are cut into pieces smaller than 15 cm by shovels and scissors. Bags and their contents should be also cut into smaller pieces. Similarly, bulky wastes such as cardboards and branch of trees are also cut into pieces smaller than 15cm.
Each sample is then mixed manually by shovels. The sample should be mixed as homogeneously as possible.

b. The mixed sample is then divided and taken twice a quarter to obtain a smaller sample. By the way, the final sample, which is one-four of the initial sample, is analyzed. An illustration is presented as follows:

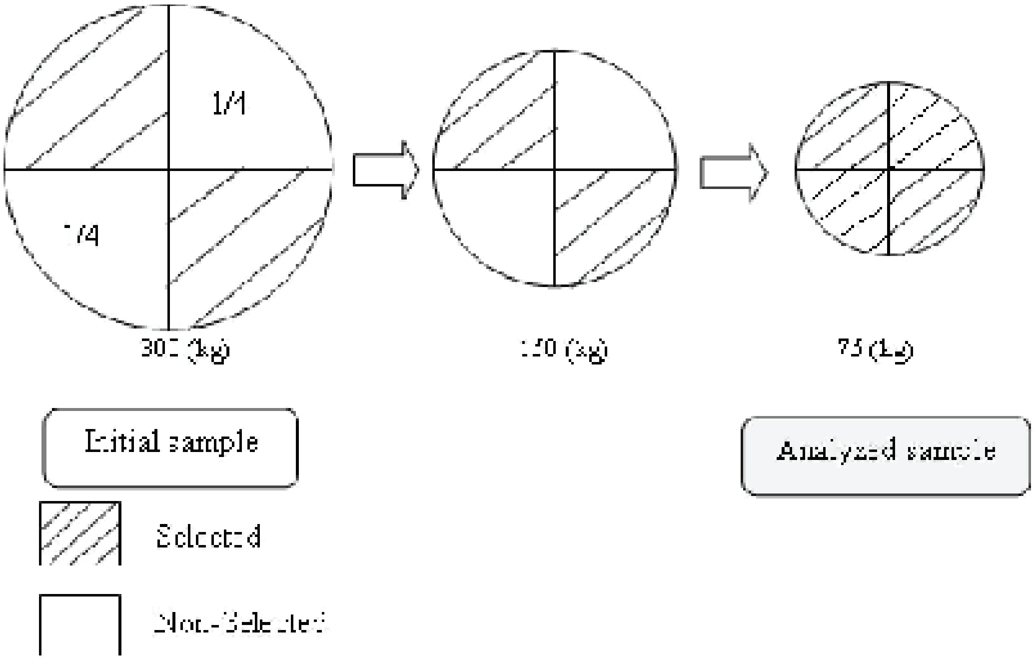


Figure 6. Sampling method

3.3 Analytical method

3.3.1 Measurement of bulk density

a. The prepared sample in 3.2.2 is used.

b. Plastic container with capacity of 80 L is used. The capacity (V_o) and weight (W_o) of the container should be measured beforehand.

c. The sample is then filled into the container. It should be noted that the sample should not be pushed in the container.

d. The container is lifted by hand and dropped in an upright position from the height of about 30 cm. If the volume of the sample in the container decreases as a result, more samples should be added to the container (to reach the same level as in Procedure c.).

e. Procedure d. is repeated three times. Then, weight of the container containing the sample (W_1) is measured.

f. Bulk density is calculated as follows.

$$\text{Bulk density (kg/L = t/m}^3\text{)} = \frac{W_1(kg) - W_0(kg)}{V_0(L)}$$

3.3.2 Composition of samples

a. The raw samples are prepared as described in section 3.2.2

b. The samples are spread on lining at sorting area for separation.

c. The raw samples are physically separated into the following eleven compositions:

1-Food wastes (meat, vegetable, etc.), ***2***-Paper, ***3***-Diaper, ***4***- Plastic, ***5***-Textile, ***6***-Wood, ***7***-Rubber and leather, ***8***-Metal, ***9***-Inorganic waste (coal ash, brick, glass…), ***10***-Shell, ***11***- Others such as very small pieces not being able to be classified by visual observation.

d. Each composition (Xi) is weighted and the total weight (X) of all compositions will be calculated. Each physical composition is calculated according to the following formula:

$$\text{Physical composition } x_i(\%, \text{wet weight basis}) = \frac{X_i(kg, \text{wet weight basis})}{X(kg, \text{wet weight basis})} x\ 100$$

$$\text{Physical composition } y_i(\%, \text{dry weight basis}) = \frac{\text{Dried weight of each component } (kg)}{\text{Total dried weight of components } (kg)} x\ 100$$

3.3.3 Moisture content

a. Moisture content of each composition is determined individually according to APHA 2540 G (2012).

b. Each composition is cut into pieces of 2 to 3 cm and individually spread in metal container with 20 cm diameter (height of wastes should be less than 10cm in the container if possible).

c. After that, the wastes will be dried at 105 degrees Celsius by conductive heating for 4 to 5 days or until the constant weight obtains.

d. Finally, moisture content of each composition will be calculated according to difference between weight of wet sample and that of dried sample.

3.3.4 Volatile solid, ash and gross calorific value

08 combustible samples (food waste, paper, textile, wood, plastic, rubber & leather, diaper and others) are cut into pieces less than 1cm for analysis of volatile solid and ash content. They will be combusted at 550 degrees Celsius according to APHA 2540 G (2012).

08 combustible samples (food waste, paper, textile, wood, plastic, rubber & leather, diaper and others) are cut into pieces less than 1cm and then crushed into pieces smaller than 2mm for analysis of gross calorific value according to TCVN 200-2007 (ISO 1928:1995).

The analytical method of solid waste is presented in Table 7.

Table 7. Analytical method of solid waste

No.	Parameter	Analytical method	Analytical Instrument
1	Moisture	APHA 2540 G	WTB Binder, Germany, Metter Toledo MS204 balance, Switzerland
2	Volatile solid and Ash	APHA 2540 G	Nabertherm oven, Metter Toledo MS204 balance, Switzerland

No.	Parameter	Analytical method	Analytical Instrument
3	Gross calorific value	TCVN 200 -2011 (ISO 1928:2009)	IKA calorimeter C 4000

4. ANALYTICAL RESULTS OF PHUOC HIEP MSW

4.1 Information of Phuoc Hiep MSW samples

The Phuoc Hiep MSW samples were taken in 2 days:

- January 9th, 2014 from 12:50 to 17:10: Dry season-Sample quantity: 2 samples

- January 10th, 2014 from 17:20 to 21:30: Dry season- Sample quantity: 2 samples

Specific information of Phuoc Hiep MSW samples is presented in the following table:

Table 8 Information of Phuoc Hiep MSW samples

Sample No.	Vehicle registration number	Time	MSW transporter	Original of Waste	Vehicle color/ Type	Sampling MSW sample(kg)	Analyzing MSW sample (kg)
09/01/2014							
1	57K- 0963	12h50	Industrial-Agricultural Co-operative	Tan Hoa transfer station	Blue/ Rear load refuse Truck	351	96
	51E-02533	13h10	Thu Duc District public service company	Linh Xuan transfer station	Green/ Rear load refuse Truck		
	51C-21527	13h40	District 9 public service company	Phuoc Long transfer station	Green/ Rear load refuse Truck		
	57K-3837	14h00	Go Vap District public service company	Nguyen Huy Dien transfer station	Blue/ Rear load refuse Truck		
2	51E-01640	14h20	District 12 public service company	Hiep Thanh transfer station	Green/ Rear load refuse Truck	346	80

	51C-09856	15h30	Citenco – Factory No.1	Quang Trung transfer station	Green/ Hook lift Truck		
	51C-05809	16h10	Thu Duc District public service company	Thu Duc District	White/ Rear load refuse Truck		
	51E-02669	17h10	Citenco – Factory No.2	Pham Van Xao transfer station	Green/ Rear load refuse Truck		
10/01/2014							
3	51C-18565	17h20	Hoc Mon District	Ba Diem commune	Green/ Rear load refuse Truck	318	83
	62A-00123	17h40	Duc Hoa Town- Long An Province	Duc Hoa Town- Long An Province	Green/ Hook lift Truck		
	51C-05199	18h10	Citenco – Factory No.2	Tong Van Tran transfer station	Green/ Rear load refuse Truck		
	51C-29835	18h43	Thu Duc District	Thu Duc hospital	Green/ Rear load refuse Truck		
4	51C-18565	19h40	Hoc mon District public service company	Hoc mon District	Red-White/ Rear load refuse Truck	361	82
	51C-08984	20h20	District 2 public service company	Binh Trung Tay transfer station	Orange/ Rear load refuse Truck		
	51E-02190	21h05	Tan Binh Thanh District public service company	Tan Binh District	Green/ Hook lift Truck		
	51C-26161	21h30	Binh Thanh District public service company	Binh Thanh District	Green/ Hook lift Truck		

4.2 Physical composition of Phuoc Hiep MSW

The results of average percent of wet weight and dry weight of MSW at Phuoc Hiep landfill are presented at Figure 7 and Figure 8. The results show that:

High proportional compositions (> 5%) are food waste, plastic and textile by both wet and dry weight. There are 61.3%, 17.3% and 6.4% by wet weight and 44.8%, 25.9% and 8.4% by dry weight, respectively. The remain compositions such as paper, diaper, inorganic, rubber and leather, others, shell-bone, wood, metal occupy low proportion, respectively 4.2%, 4.1%, 2.2%, 1.6%, 1.4%, 0.9%, 0.6% and 0.2% by wet weight, and 5.8 %, 2.6%, 4.8%, 3.2%, 1.3%, 1.8%, 1.1% and 0.5% by dry weight.

Compared with the data in Report of Phuoc Hiep MSW in November, 2013, it shows that food waste, paper, rubber and leather, metal and shell –bone increase by both wet and dry weight, but other compositions such as diaper, textile, wood, inorganic, plastic and others decrease by both wet and dry weight. However, only the physical compositions of food waste and plastic have great change. Particularly:

- The average percentage of food waste is still 61.3% by wet weight, but increases from 40.5 % (Nov, 2013) to 44.8% by dry weight now.

- The average percentage of plastic decreases from 19.6% to 17.3 % by wet weight and from 33.3% to 25.9% by dry weight.

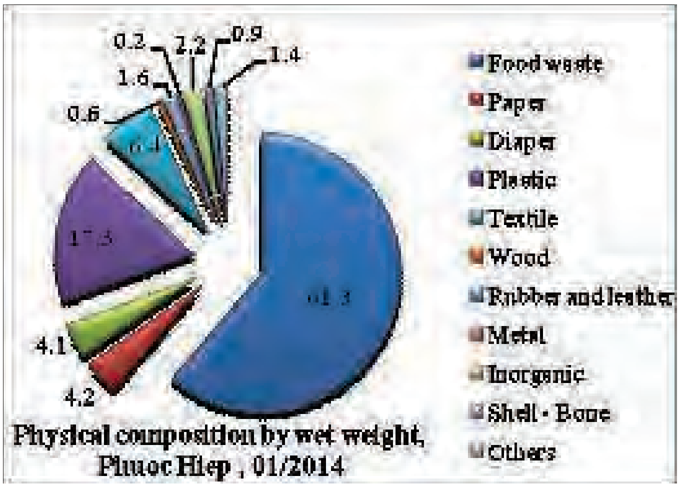


Figure 7. Average physical compositions (% wet weight) of 4 samples in January 2014

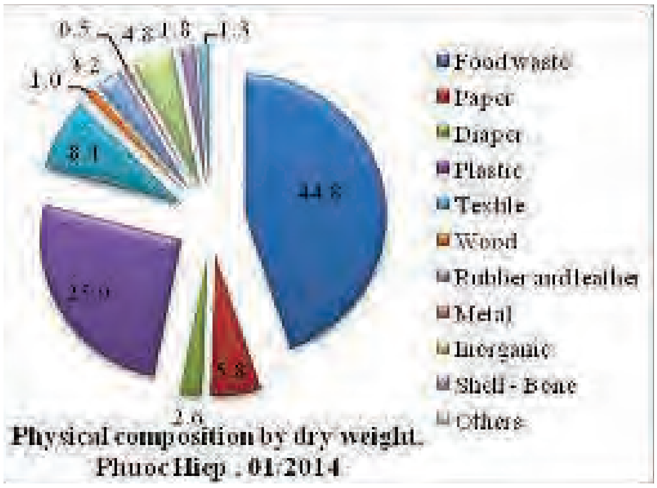


Figure 8. Average physical composition s(% dry weight) of 4 samples in January 2014

Statistic physical composition results of each physical composition (% wet weight) of each sample are presented in Table 9 and Figure 9. The proportion of each composition in each sample hasn't significantly changed among 4 samples.

Table 9. Statistic physical composition of 4 samples (January 2014)

No.	Composition	Physical composition result (% wet weight)			
		Sample 1	Sample 2	Sample 3	Sample 4

1	Food waste	64.7	58.0	60.6	61.7
2	Paper	3.8	4.7	4.7	3.5
3	Diaper	5.0	2.1	4.9	4.4
4	Plastic	16.2	18.2	19.3	15.3
5	Textile	5.0	8.8	3.7	8.1
6	Wood	0.3	0.6	1.2	0.1
7	Rubber and leather	2.5	1.5	1.2	1.0
8	Metal	0.3	0.4	0.1	0.1
9	Inorganic	1.5	1.7	2.1	3.5
10	Shell - Bone	0.4	1.9	1.2	0.1
11	Others	0.3	2.1	1.0	2.2

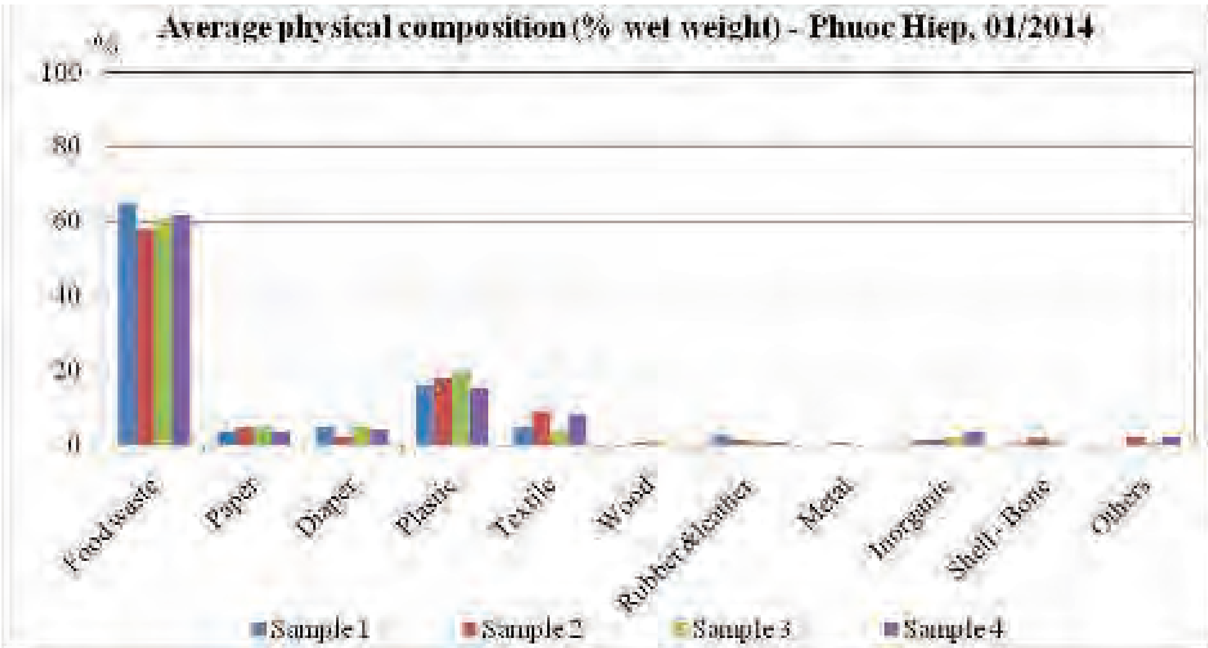


Figure 9. Average physical composition (% wet weight) of 4 samples

4.3 Moisture, volatile solid and ash

4.3.1 Moisture

The moisture content's data of each sample are presented in Table 10, Figure 10 and 11.

Table 10 Statistic moisture of each composition of 4 samples

No.	Composition	Moisture content (%)						
		Sample 1	Sample 2	Sample 3	Sample 4	Average (%)	Min	Max
1	Food waste	69.6	68.0	70.5	62.3	67.6	62.3	70.5
2	Paper	37.1	37.0	36.0	44.5	38.7	36.0	44.5
3	Diaper	52.4	82.5	81.4	83.3	74.9	52.4	83.3
4	Plastic	31.7	27.0	33.2	44.2	34.0	27.0	44.2
5	Textile	23.2	46.5	44.6	46.7	40.3	23.2	46.7
6	Wood	18.3	19.0	13.0	19.2	17.4	13.0	19.2

7	Rubber and leather	3.2	7.2	13.0	20.1	10.9	3.2	20.1
8	Metal	1.5	1.1	1.6	2.2	1.6	1.1	2.2
9	Inorganic	3.7	4.6	4.3	1.3	3.5	1.3	4.6
10	Shell - Bone	8.2	9.9	12.1	8.0	9.6	8.0	12.1
11	Others	24.7	53.2	62.7	62.9	50.9	24.7	62.9

- Moisture of diaper is the highest with the average value 74.9% and ranges from 52.4% to 83.3% because of their capability of water and leachate absorption.
- Moisture of food waste is ranging from 62.3% (sample 4) to 70.5% (sample 3) and average value is 67.6%. It depends on differences among food waste components.
- The average moisture of textile, paper, plastic, wood, rubber and leather, and shell-bone has an insignificant change compared with the previous one (November 2013), with the average value 40.3%, 38.7%, 34.0%, 17.4%, 10.9% and 9.6%, respectively.
- The difference of others in these samples makes the different moisture content. Others' component of sample 1 is almost hair so its moisture is low (24.7%), but others in sample 4 include hair, leaves and small branches, so moisture is higher (62.9%).
- Metal and inorganic (brick, coal ash, broken cups, etc) have low moisture because of their physical characteristics. Moisture of metal and inorganic is from 1.1% to 2.2% and from 1.3% to 4.6%, respectively.

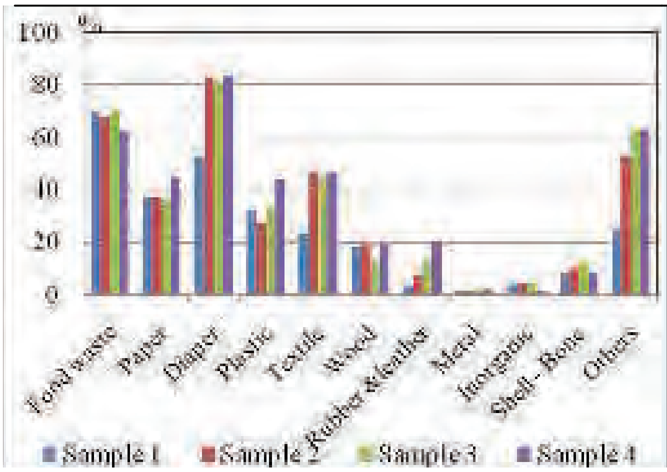


Figure 10. Moisture content (%) of each composition of MSW sample

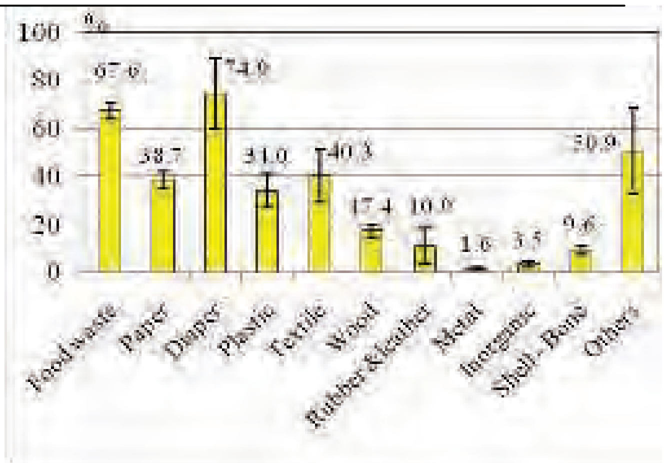


Figure 11. Average moisture content (%) of each composition of MSW sample

4.3.2 VS and Ash

Figures from 12 to 15 show the result of volatile solid and ash of each sample. Ash of metal, inorganic and shell – bone is not analyzed and estimated 100% dry weight.

- Ash of food waste is ranging within from 26.3% (sample 3) to 32.1% (sample 1) by dry weight, and is greater than the value in sampling period in November 2013 which fluctuates from 17.7% to 25.6% by dry weight.

- Ash of rubber and leather is 20.8% (average value) by dry weight, and is ranging from 15.9% to 27.5%.

- Ash of paper accounts for 18.4% (average value) by dry weight.

- Ash of wood, plastic, diaper and textile is 17%, 13.4%, 12.9% and 8.2% respectively.

-Ash of others is ranging from 2.3% (sample 1) to 20.3% (sample 2), and the average is 14.6%. Composition in sample 1 is almost hair, so, the ash is the lowest.

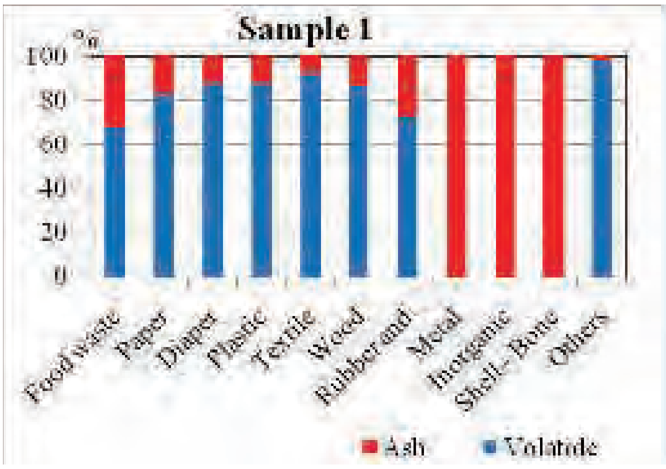


Figure 12. Ash and volatile solid by dry weight (%) of sample 1

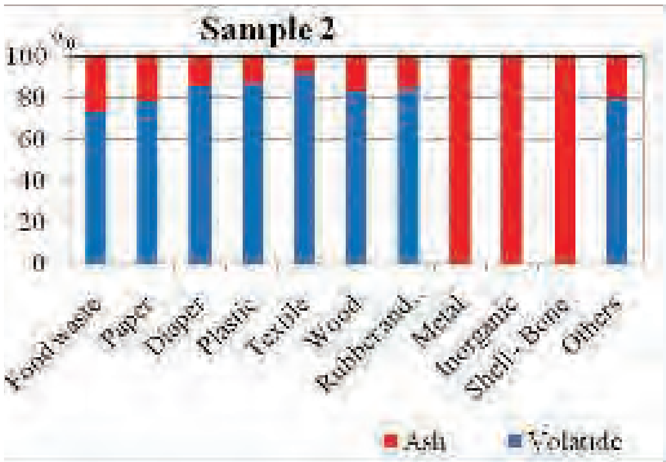


Figure 13. Ash and volatile solid by dry weight (%) of sample 2

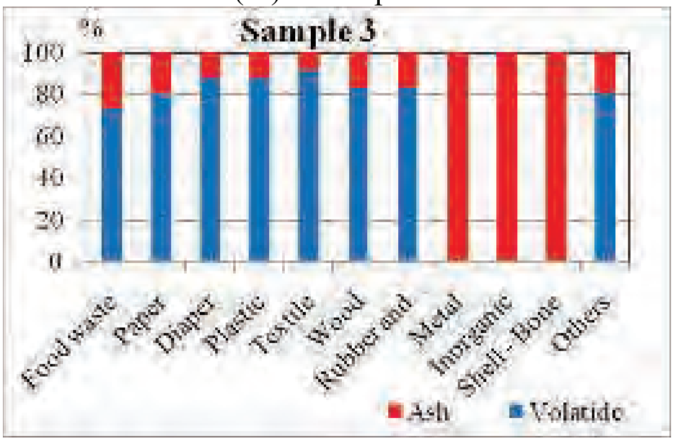


Figure 14. Ash and volatile solid by dry weight (%) of sample 3

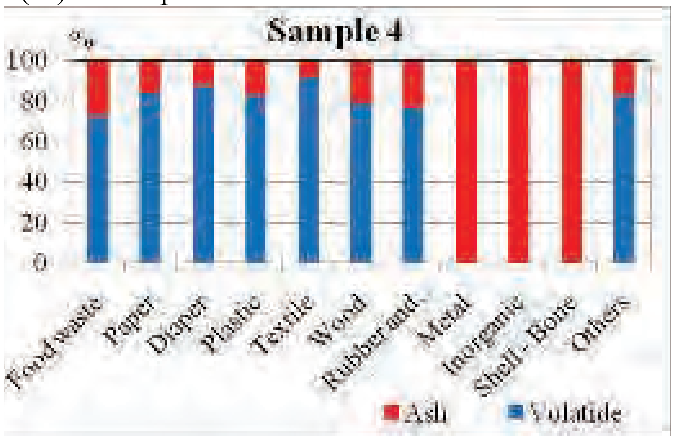


Figure 15. Ash and volatile solid by dry weight (%) of sample 4

The VS and ash values by dry weight and wet weight are presented in Table 11 and 12.

Table 11. Statistic VS value by dry weight of 4 samples (January 2014)

No.	Composition	VS % dry weight		
		Average	Min	Max
1	Food waste	71.9	67.9	73.7
2	Paper	81.7	78.9	84.7
3	Diaper	87.2	85.6	88.4
4	Plastic	86.6	83.5	88.0
5	Textile	91.8	91.4	92.2
6	Wood	83.0	79.4	86.2
7	Rubber and leather	79.2	72.5	84.1
8	Metal	0.0	0.0	0.0

9	Inorganic	0.0	0.0	0.0
10	Shell - Bone	0.0	0.0	0.0
11	Others	85.5	79.7	97.7

"-" is not analyzed

Table 12. Statistic ash value by dry weight of 4 samples (January 2014)

No.	Composition	Ash % dry weight		
		Average	Min	Max
1	Food waste	28.1	26.3	32.1
2	Paper	18.4	15.3	21.1
3	Diaper	12.9	11.6	14.4
4	Plastic	13.4	12	16.5
5	Textile	8.2	7.8	8.6
6	Wood	17.0	13.8	20.6
7	Rubber and leather	20.8	15.9	27.5
8	Metal	100	100	100
9	Inorganic	100	100	100
10	Shell - Bone	100	100	100
11	Others	14.6	2.3	20.3

Average values of ash and VS value by dry weight are presented in figure 16 and figure 17.

- As data recorded in figure 16, the average VS values of 8 of 11 compositions (excluding metal, inorganic waste and shell-bone) are high between 71.9% and 91.8%, and 85.5% for others.

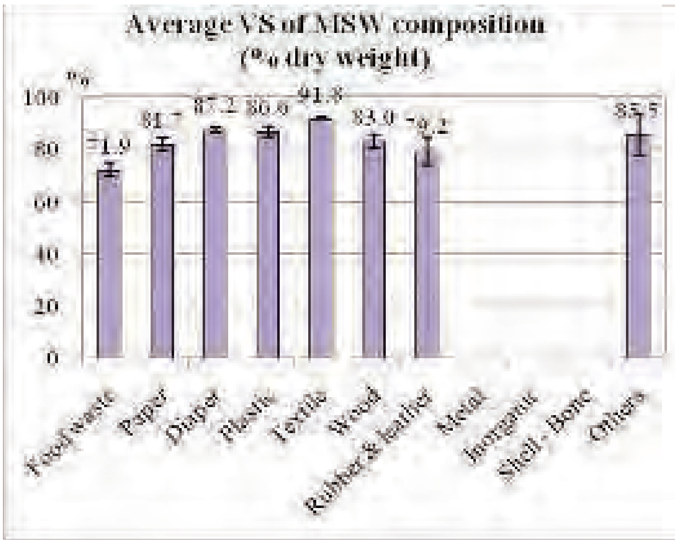


Figure 16. Average value of VS by dry weight of MSW composition.

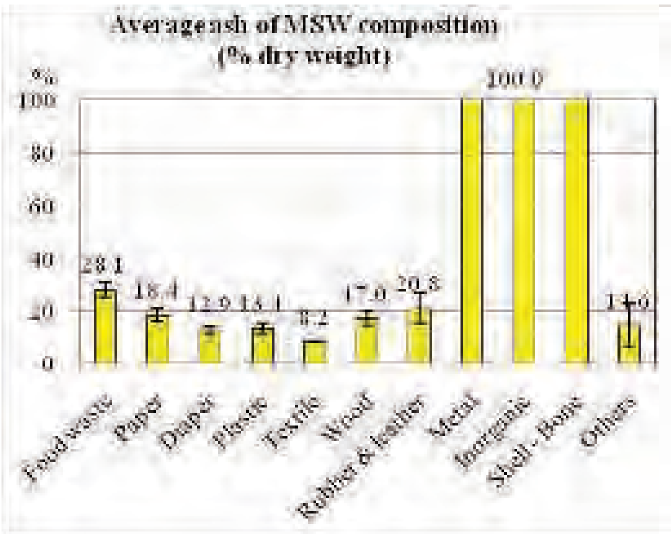


Figure 17. Average value of ash by dry weight of MSW composition.

4.4 Correlation of moisture, VS and ash

4.4.1 Correlation of moisture, VS and ash of each composition by wet weight.

The correlation of moisture, VS and ash of each composition is presented in 4 figures, from figure 18 to figure 21.

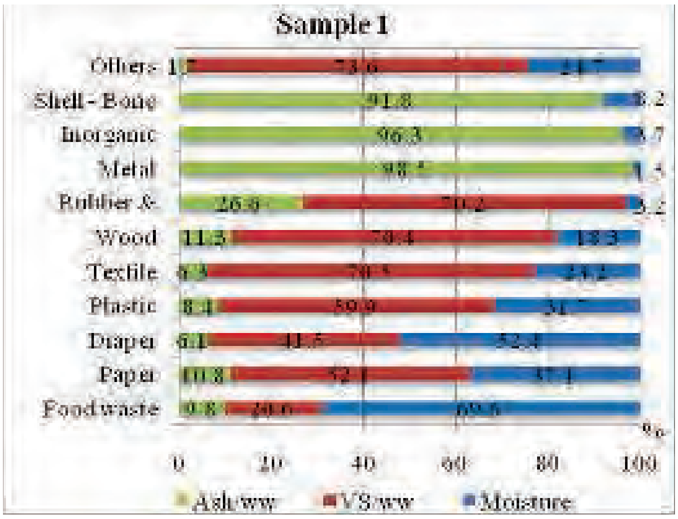


Figure 18. Correlation of moisture, VS and ash of each composition of sample 1

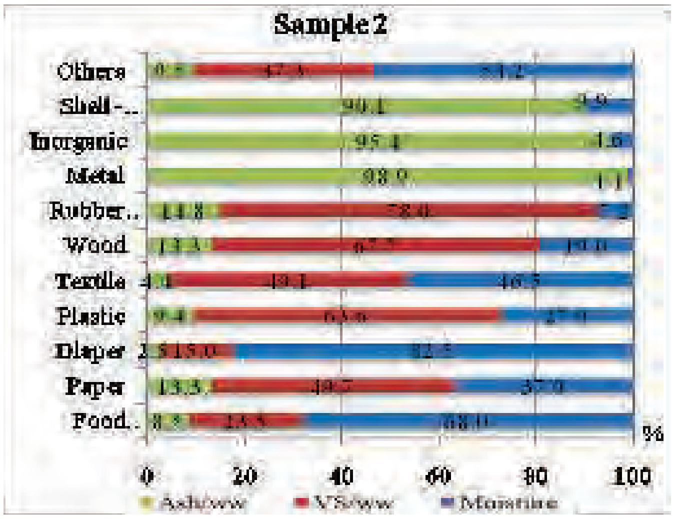


Figure 19. Correlation of moisture, VS and ash of each composition of sample 2

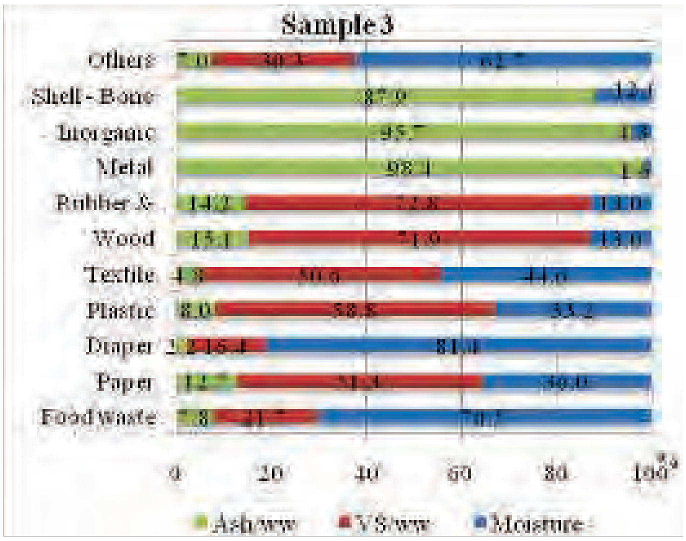


Figure 20. Correlation of moisture, VS and ash of each composition of sample 3

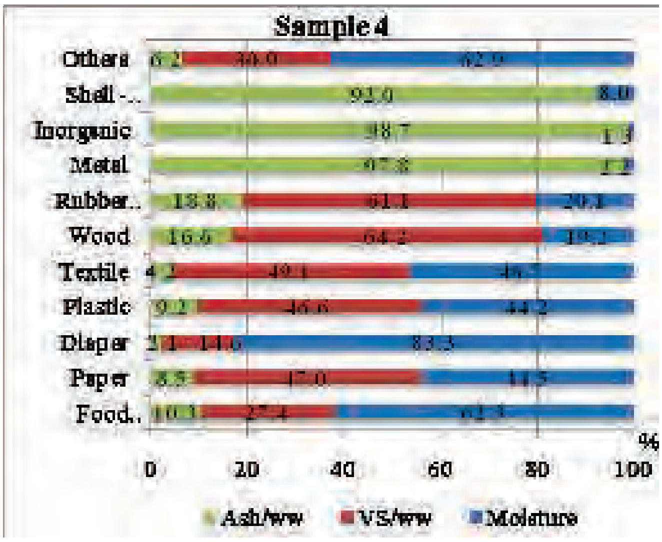


Figure 21. Correlation of moisture, VS and ash of each composition of sample 4

According to these figures, correlation of moisture, VS and ash in each composition is based on natural characteristics.

- Food waste has the highest proportion of physical composition with moisture 62.3% - 70.5%, VS: 20.6%- 27.4% and ash: 7.8% - 10.3% by wet weight.

- The second high proportion of physical composition is plastic with moisture fluctuating 27.0%- 44.2%, VS: 46.6% - 63.6% and ash: 8.0% - 9.4% by wet weight.

- Textile's moisture, VS and ash values are 23.2 % - 46.7%, 49.1% - 70.5% and 4.2% -7.3%, respectively.
- Diaper has the highest moisture 52.4% - 83.3% and the lowest ash 2.1% - 6.1%.

- Other compositions have low percentage of physical composition. Any that, moisture of shell-bone is 8.0% to 12.1%, moisture of metal is 1.1% to 2.2%, and moisture of inorganic is 1.3% - 4.6%. The remaining dryness of these compositions is estimated 100% ash.

4.4.2 Correlation of moisture, VS and ash of each sample by wet weight

The bar charts below show the percentage of moisture, VS and ash by wet weight in original sample.

Moisture of sample is ranging from 53.5% to 55.9%, volatile solid value is ranging from 31.7% to 34.5% and ash is 10.7% to 12.4% by wet weight.

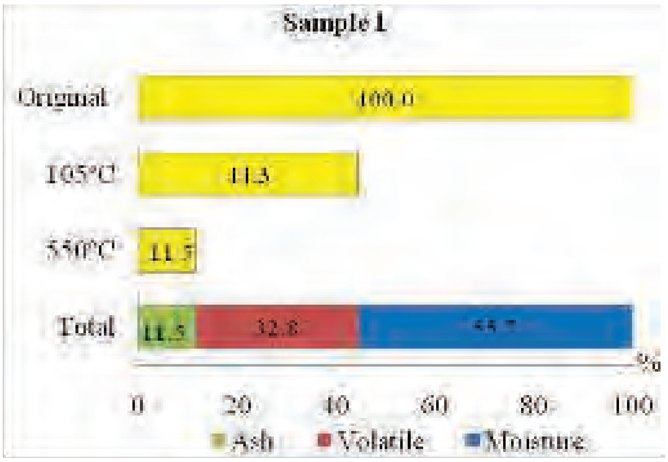


Figure 22. Correlation of moisture, VS and ash by wet weight of sample 1

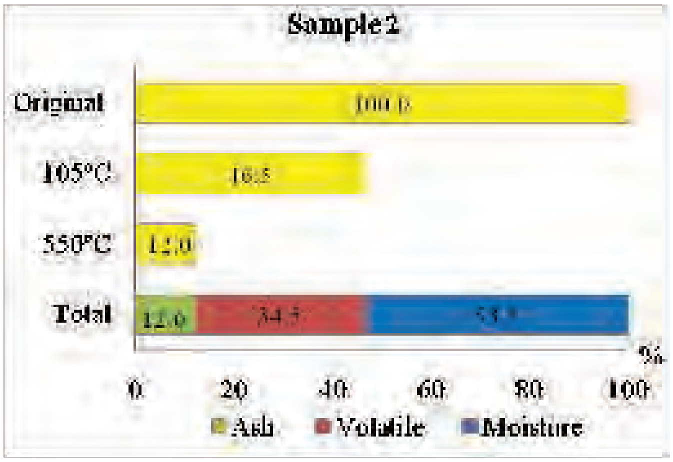
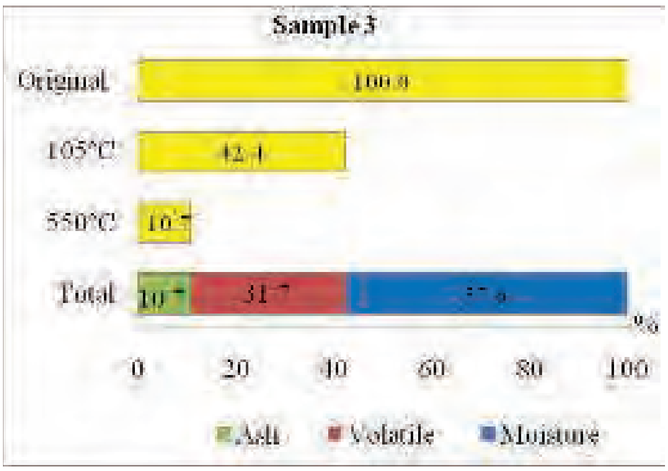


Figure 23. Correlation of moisture, VS and ash by wet weight of sample 2



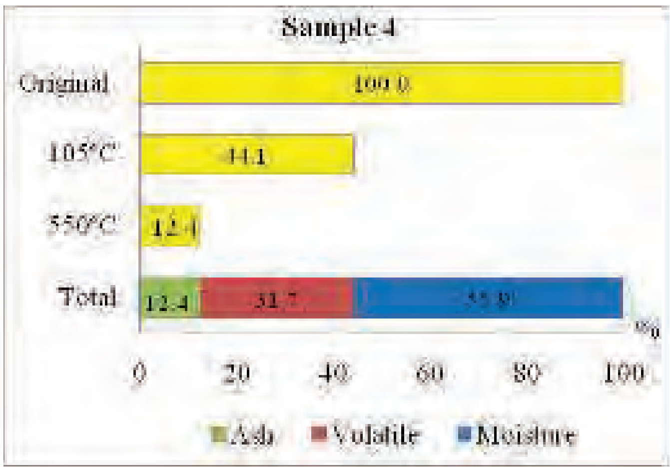


Figure 24. Correlation of moisture, VS and ash by wet weight of sample 3

Figure 25. Correlation of moisture, VS and ash by wet weight of sample 4

4.5 Gross calorific

Gross calorific values of general samples are showed in Table 13, Figure 26 and 27.

Table 13. Statistic gross calorific value by dry weight of 4 samples (January 2014)

No.	Composition	Gross Calorific (Cal/g)						
		Sample 1	Sample 2	Sample 3	Sample 4	Average	Min	Max
1	Food waste	4,449	4,043	4,168	4,325	4,246	4,043	4,449
2	Paper	4,045	3,845	4,294	4,188	4,093	3,845	4,294
3	Diaper	6,039	6,340	5,563	5,858	5,950	5,563	6,340
4	Plastic	8,571	8,071	8,657	9,172	8,618	8,071	9,172
5	Textile	5,187	4,718	4,515	5,849	5,067	4,515	5,849
6	Wood	4,531	4,326	-	-	4,429	4,326	4,531
7	Rubber and leather	6,958	6,474	7,923	5,587	6,736	5,587	7,923
8	Metal	-	-	-	-	-	-	-
9	Inorganic	-	-	-	-	-	-	-
10	Shell - Bone	-	-	-	-	-	-	-
11	Others	-	4,150	4,080	4,205	4,145	4,080	4,205

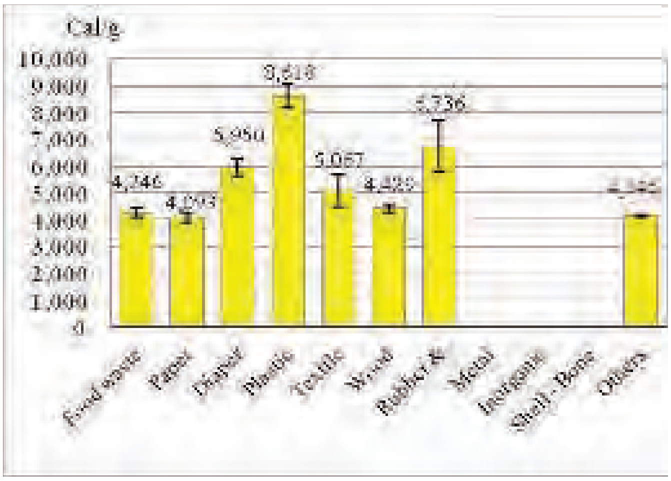


Figure 26. Average value of gross calorific of MSW composition

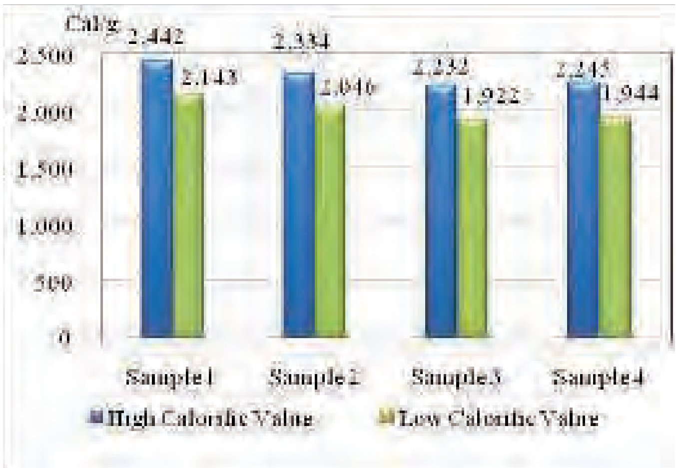


Figure 27. Gross calorific of each sample

- Gross calorific of plastic is the highest value; it oscillates from 8,071cal/g (sample 1) to 9,172cal/g (sample 4). The plastic component of sample 1 is hard plastic which has the largest proportion but in sample 4, there is color plastic.

- Plastic, textile, rubber and leather have a significant fluctuation. Their fluctuation is respectively 1,101cal/g, 1,334cal/g and 2,336cal/g.

- Paper is 3,845 – 4,294 \cal/g, diaper is 5,563 – 6,340 cal/g, wood is 4,326 - 4,531cal/g and food waste is 4,043 – 4,449 cal/g.

- Calculated results of HCV and LCV show that HCV of 4 samples fluctuates from 2,245 cal/g to 2,442 cal/g and LCV is ranging within from 1,922cal/g to 2,143 cal/g.

APPENDIX 1

FORMULA

1. Correlation of moisture, VS and ash by wet weight of each composition:

Moisture content of each composition (%) + Ash (% ww) + Volatile (% ww) = 100

Ash (% ww) $= \frac{(100 - \text{MCEC } (\%)) \times \text{ ash } (\% \text{ dw})}{100}$

Volatile (% ww)$= \frac{(100 - \text{MCEC } (\%)) \times \text{ volatile } (\% \text{ dw})}{100}$

2. Correlation of moisture, VS and ash by wet weight of each sample:

Moisture content (%) + Ash (% ww) + Volatile (% ww) = 100

Moisture content (%) $= \sum \frac{\text{PCEC } (\% \text{ ww basis}) \times \text{ MCEC } (\%)}{100}$

Ash(% ww) $= \sum \frac{\text{SFEC } (\%) \times \text{ash } (\% \text{ dw})}{100}$

Volatile(% ww) $= \sum \frac{\text{SFEC } (\%) \times \text{volatile } (\% \text{ dw})}{100}$

3. High calorific value – HCV and Low calorific value – LCV of each sample:

HCV (cal/g) $= \sum \frac{\text{Gross Calorific of composition} \times \text{SFEC } (\%)}{100}$

LCV (cal/g) = HCV (cal/g) – $\frac{540 \times \text{Moisture content } (\%)}{100}$

Conversion formula: 1 cal/g = 4.187 J/g

Solid fraction of each composition (%) $= \sum \frac{\text{PCEC } (\% \text{ ww basis}) \times (100 - \text{MCEC } (\%))}{100}$

❖ ***Note:***

- *MCEC: Moisture content of each composition*
- *PCEC: Physical composition of each composition*
- *SFEC: Solid fraction of each composition*

APPENDIX 2

FIGURE OF MSW SAMPLING AND CLASSIFICATION AT TRANSFERRING FLOOR OF PHUOC HIEP LANDFILL

APPENDIX 3

FIGURE OF MSW SAMPLE FOR MOISTURE ANALYSIS

Sample 1

Sample 2

Sample 3

Sample 4

APPENDIX 4

FIGURE OF MSW SAMPLE AFTER MOISTURE ANALYSIS (DRIED AT 105°C)

Sample 1

Sample 2

Sample 3

Sample 4

APPENDIX 5- THE RAW DATA

Sample 1

No.	Composition	Analyzing result						Calculated result				
		Bulk density (kg/l)	Physical composition (% ww)	Physical composition (% dw)	Moisture content (%)	Ash, at 550°C (%)	Gross Calorific (Cal/g) (% dw)	Moisture content (%)	Total Ash (% ww)	Total VS (% ww)	High Gross Calorific Value (Cal/g) (% ww)	Low Gross Calorific Value (Cal/g) (% ww)
1	Food waste	0.34	64.7	44.4	69.6	32.1	4,449	45.0	6.3	13.4	875	632
2	Paper		3.8	5.3	37.1	17.2	4,045	1.4	0.4	2.0	97	89
3	Diaper		5.0	5.5	52.4	12.9	6,039	2.6	0.3	2.1	144	130
4	Plastic		16.2	24.9	31.7	12.3	8,571	5.1	1.4	9.7	948	921
5	Textile		5.0	8.7	23.2	8.2	5,187	1.2	0.3	3.5	199	193
6	Wood		0.3	0.6	18.3	13.8	4,531	0.1	0.0	0.2	11	11
7	Rubber and leather		2.5	5.5	3.2	27.5	6,958	0.1	0.7	1.8	168	168
8	Metal		0.3	0.6	1.5	100	-	0.0	0.3	0.0	-	-
9	Inorganic (Brick,coal ash, broken cup)		1.5	3.2	3.7	100	-	0.1	1.4	0.0	-	-
10	Shell-Bone		0.4	0.9	8.2	100	-	0.0	0.4	0.0	-	-
11	Others (mainly hair)		0.3	0.4	24.7	2.3	-	0.1	0.0	0.2	-	-
Total								55.7	11.5	32.8	2,442	2,143

Sample 2

No.	Composition	Analyzing result						Calculated result				
		Bulk density (kg/l)	Physical composition (% ww)	Physical composition (% dw)	Moisture content (%)	Ash, at 550°C (%)	Gross Calorific (Cal/g) (% dw)	Moisture content (%)	Total Ash (% ww)	Total VS (% ww)	High Gross Calorific Value (Cal/g) (% ww)	Low Gross Calorific Value (Cal/g) (% ww)
1	Food waste	0.32	58	39.9	68.0	26.7	4,043	39.4	5.0	13.6	750	537
2	Paper		4.7	6.4	37.0	21.1	3,845	1.7	0.6	2.3	114	104
3	Diaper		2.1	0.8	82.5	14.4	6,340	1.7	0.1	0.3	23	14
4	Plastic		18.2	28.6	27.0	12.9	8,071	4.9	1.7	11.6	1,072	1,046
5	Textile		8.8	10.1	46.5	8.3	4,718	4.1	0.4	4.3	222	200
6	Wood		0.6	1.1	19.0	16.4	4,326	0.1	0.1	0.4	21	20
7	Rubber and leather		1.5	3	7.2	15.9	6,474	0.1	0.2	1.2	90	90
8	Metal		0.4	0.9	1.1	-	-	0.0	0.4	0.0	-	-
9	Inorganic (Brick,coal ash, broken cup)		1.7	3.5	4.6	-	-	0.1	1.6	0.0	-	-
10	Shell-Bone		1.9	3.6	9.9	-	-	0.2	1.7	0.0	-	-
11	Others (garden waste: grass, branch, leaves)		2.1	2.1	53.2	20.3	4,150	1.1	0.2	0.8	41	35
Total								53.5	12.0	34.5	2,334	2,046

Sample 3

No.	Composition	Analyzing result						Calculated result				
		Bulk density (kg/l)	Physical composition (% ww)	Physical composition (% dw)	Moisture content (%)	Ash, at 550°C (%)	Gross Calorific (Cal/g) (% dw)	Moisture content (%)	Total Ash (% ww)	Total VS (% ww)	High Gross Calorific Value (Cal/g) (% ww)	Low Gross Calorific Value (Cal/g) (% ww)
1	Food waste	0.32	60.6	42.2	70.5	26.3	4,168	42.7	4.7	13.2	745	514
2	Paper		4.7	7.0	36.0	19.8	4,294	1.7	0.6	2.4	129	120
3	Diaper		4.9	2.2	81.4	11.6	5,563	4.0	0.1	0.8	51	29
4	Plastic		19.3	30.5	33.2	12	8,657	6.4	1.5	11.3	1,116	1,081
5	Textile		3.7	4.9	44.6	8.6	4,515	1.7	0.2	1.9	93	84
6	Wood		1.2	2.4	13.0	17.3	-	0.2	0.2	0.9	-	-
7	Rubber and leather		1.2	2.4	13.0	16.3	7,923	0.2	0.2	0.9	83	82
8	Metal		0.1	0.4	1.6	-	-	0.0	0.1	0.0	-	-
9	Inorganic (Brick,coal ash, broken cup)		2.1	4.7	4.3	-	-	0.1	2.0	0.0	-	-
10	Shell-Bone		1.2	2.4	12.1	-	-	0.1	1.1	0.0	-	-
11	Others (garden waste: grass, branch, leaves and hair)		1.0	0.9	62.7	18.9	4,080	0.6	0.1	0.3	15	12
Total								57.6	10.7	31.7	2,232	1,922

Sample 4

No.	Composition	Analyzing result						Calculated result				
		Bulk density (kg/l)	Physical composition (% ww)	Physical composition (% dw)	Moisture content (%)	Ash, at 550°C (%)	Gross Calorific (Cal/g) (% dw)	Moisture content (%)	Total Ash (% ww)	Total VS (% ww)	High Gross Calorific Value (Cal/g) (% ww)	Low Gross Calorific Value (Cal/g) (% ww)
1	Food waste	0.37	61.7	52.7	62.3	27.2	4,325	38.4	6.3	16.9	1,006	798
2	Paper		3.5	4.4	44.5	15.3	4,188	1.6	0.3	1.6	81	73
3	Diaper		4.4	1.7	83.3	12.5	5,858	3.7	0.1	0.6	43	23
4	Plastic		15.3	19.4	44.2	16.5	9,172	6.8	1.4	7.1	783	747
5	Textile		8.1	9.9	46.7	7.8	5,849	3.8	0.3	4.0	253	232
6	Wood		0.1	0.1	19.2	20.6	-	0.0	0.0	0.1	-	-
7	Rubber and leather		1.0	1.9	20.1	23.5	5,587	0.2	0.2	0.6	45	44
8	Metal		0.1	0.1	2.2	-	-	0.0	0.1	0.0	-	-
9	Inorganic (Brick, coal ash, broken cup)		3.5	7.8	1.3	-	-	0.0	3.5	0.0	-	-
10	Shell-Bone		0.1	0.1	8	-	-	0.0	0.1	0.0	-	-
11	Others (garden waste: grass, branch, leaves)		2.2	1.9	62.9	16.7	4,205	1.4	0.1	0.7	34	27
Total								55.9	12.4	31.7	2,245	1,944

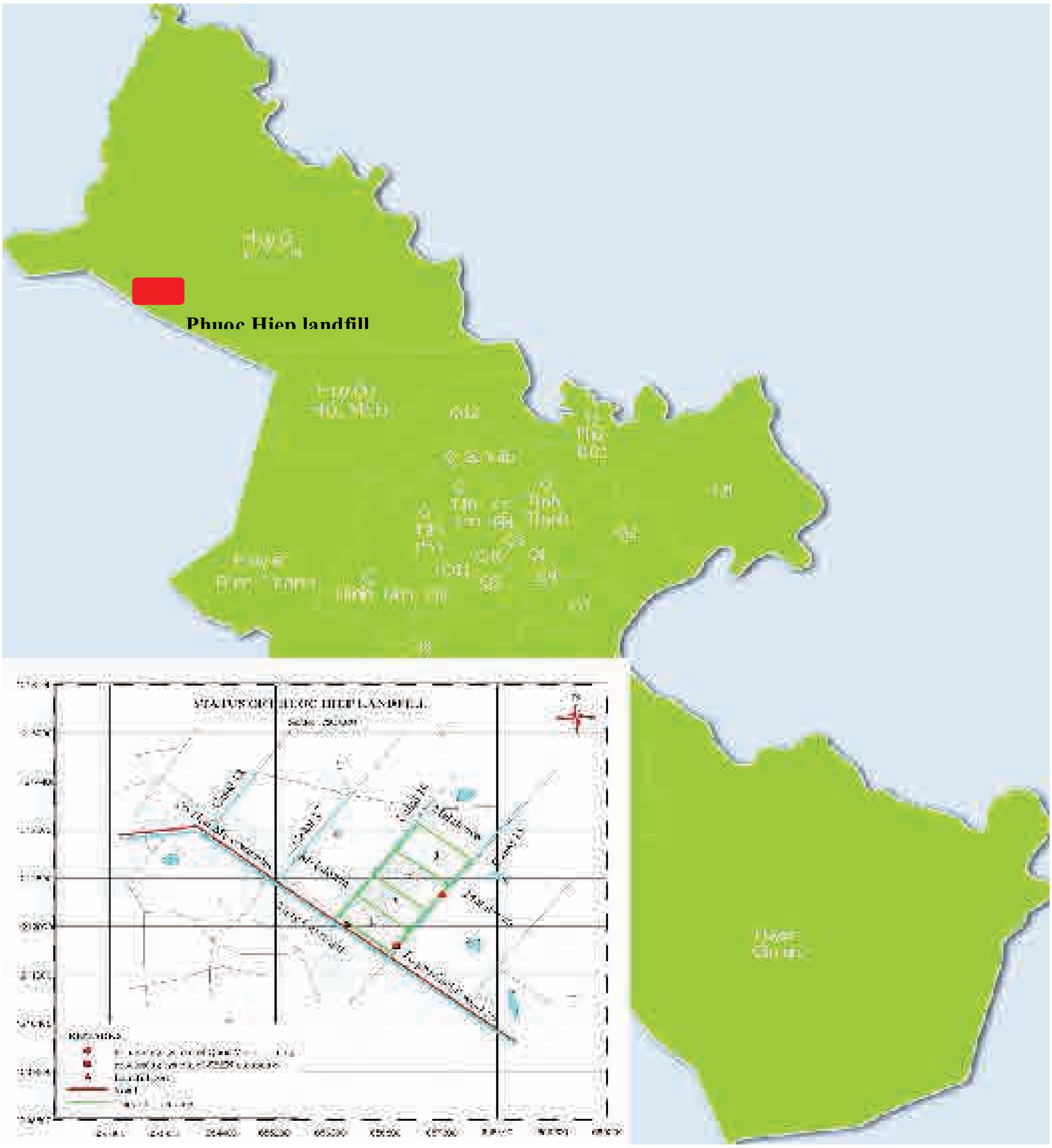
CALCULATED SAMPLE RESULT OF MOISTURE, ASH, GROSS CALORIFIC, HIGH GROSS CALORIFIC AND LOW GROSS CALORIFIC

No.Sample	1	2	3	4
Total Moisture	55.7	53.5	57.6	55.9
Total Ash (%ww)	11.5	12.0	10.7	12.4
Total VS (%ww)	32.8	34.5	37.1	31.7
High Gross Calorific	2,442	2,334	2,232	2,245
Low Gross Calorific	2,143	2,046	1,922	1,944

No	Composition	Total moisture (%)				Total Ash (%ww)				Total VS (%ww)			
		1	2	3	4	1	2	3	4	1	2	3	4
1	Food waste	45.0	39.4	42.7	38.4	6.3	5.0	4.7	6.3	13.4	13.6	13.2	16.9
2	Paper	1.4	1.7	1.7	1.6	0.4	0.6	0.6	0.3	2.0	2.3	2.4	1.6
3	Diaper	2.6	1.7	4.0	3.7	0.3	0.1	0.1	0.1	2.1	0.3	0.8	0.6
4	Plastic	5.1	4.9	6.4	6.8	1.4	1.7	1.5	1.4	9.7	11.6	11.3	7.1
5	Textile	1.2	4.1	1.7	3.8	0.3	0.4	0.2	0.3	3.5	4.3	1.9	4.0
6	Wood	0.1	0.1	0.2	0.0	0.0	0.1	0.2	0.0	0.2	0.4	0.9	0.1
7	Rubber and leather	0.1	0.1	0.2	0.2	0.7	0.2	0.2	0.2	1.8	1.2	0.9	0.6
8	Metal	0.0	0.0	0.0	0.0	0.3	0.4	0.1	0.1	0.0	0.0	0.0	0.0
9	Inorganic	0.1	0.1	0.1	0.0	1.4	1.6	2.0	3.5	0.0	0.0	0.0	0.0
10	Shell - Bone	0.0	0.2	0.1	0.0	0.4	1.7	1.1	0.1	0.0	0.0	0.0	0.0
11	Others	0.1	1.1	0.6	1.4	0.0	0.2	0.1	0.1	0.2	0.8	0.3	0.7
Total		**55.7**	**53.5**	**57.6**	**55.9**	**11.5**	**12.0**	**10.7**	**12.4**	**32.8**	**34.5**	**31.7**	**31.7**

APPENDIX 6

DIAGRAM OF PHUOC HIEP LANDFILL



REPORT OF

PHUOC HIEP MUNICIPAL SOLID WASTE RESULTS, MAY 2014

May, 2014

REPORT OF

PHUOC HIEP MUNICIPAL SOLID WASTE RESULTS, MAY 2014

ETM CENTER

Director

May, 2014

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LIST OF ACRONYMS

DW	:	Dry Weight
HCV	:	High Calorific Value
LCV	:	Low Calorific Value
MSW	:	Municipal Solid Waste
VS	:	Volatile Solid
WW	:	Wet Weight

1. GENERAL INFORMATION OF PHUOC HIEP LANDFILL

1.1 Location

Phuoc Hiep landfill locates at the North West Solid Waste Treatment Complex at Tam Tan hamlet, Phuoc Hiep commune, Cu Chi District, Ho Chi Minh City. Phuoc Hiep landfill is about 50 km far from the city center towards the North West, 5 km far from Cu Chi District center towards the South West, which is showed in the Figure in Appendix 7. The landfill shares borders with the following positions:

- The region located in the planning areas of the North West Solid Waste Treatment Complex and the existing Indigo forest area in the East and North direction;
- Canal No. 16 in the North West direction;
- Thay Cai Canal in the South West direction;
- Canal No. 15 in the South East direction.

1.2 Capacity and operation status

General information of capacity and operation status in Phuoc Hiep landfill is showed in Table 1.

Table1. General information of capacity and operation status in Phuoc Hiep landfill

No.	General information	Compartment No.1	Compartment No.1A	Compartment No.2	Compartment No.3
1	Operation duration	2003 - 2007	2007 - now	2008 - now	Both landfill and construction activities
2	Filling area (ha)	18.99	9.75	19.50	60.00
3	Designed capacity (ton/day)	3,000	3,000	3,500	3,000
4	Actual average receiving capacity (ton/day)	3,000	3,000	3,500	-
5	Landfill type	Sanitation	Sanitation	Sanitation	Sanitation
6	Landfill height from ground level (m)	25	15 - 17	-	-
7	Landfill depth from ground level (m)	-7	-7	-7	-7

Source: *Department of Natural Resource and Environment of HCM city (2010, 2013)*

1.3 Disposal technologies

Phuoc Hiep landfill is a sanitation landfill with full items of environmental protection facilities such as:

- Area of compartment No. 1 is 18.99 ha and divided into 4 sub-compartments. Each sub-compartment is about 4.74 ha in area. Maximum height of the compartment is 25 m. Municipal solid waste disposal in each compartment is covered in 10 layers. Each layer's thickness is 2.2 m (solid waste has been carefully compacted by landfill bulldozer). Thickness of soil layer between the solid waste layers is 20 cm. On the top, it is betonies layer and then 30 cm topsoil layer covered the compartment.
- Compartments No.1A and No.2 also use similar system of bottom liner and top-covering layer to compartment No. 1. Moreover, in design, pile wall system of compartment No. 1A has been reinforced in order to avoid slip and subsidence incidents surrounding the landfill.
- In compartment No.2, when the solid waste reaches appropriate level, the compartment No.2 will be connected with compartment No.1A in order to take advantage of the strong pile wall system of compartment No.1A. A part of border between compartment No.2 and compartment No.1A will be used for filling the waste in order to increase receiving ability.
- Compartment No.3 of the landfill began to operate in October, 2013 and was continuously constructed other construction items by South Korea contractor.

1.4 Objective of sampling

Sampling purposes at Phuoc Hiep landfill is to analyze physical composition, moisture, volatile solid, ash and gross calorific value of solid wastes in order to evaluate the quality of MSW.

1.5 Implementation schedule

Table2. Implementation schedule

No.	Articles	Timing plan		
		28/05, 29/05	29/05 – 22/06	23/06 – 12/07
1	Survey and sampling			
2	Classification of municipal solid waste, bulk density			
3	Analysis of physical composition and moisture			
4	- Analysis of ash, volatile solid (VS) - Analysis of gross			

	calorific value			
5	Data processing			
6	Preparation of report			

2. STATUS OF MSW TRANSPORTATION ACTIVITIES AT PHUOC HIEP LANDFILL

2.1 Process of MSW transportation at Phuoc Hiep landfill

Diagram of solid waste transportation inside Phuoc Hiep landfill is presented in Figure 1.

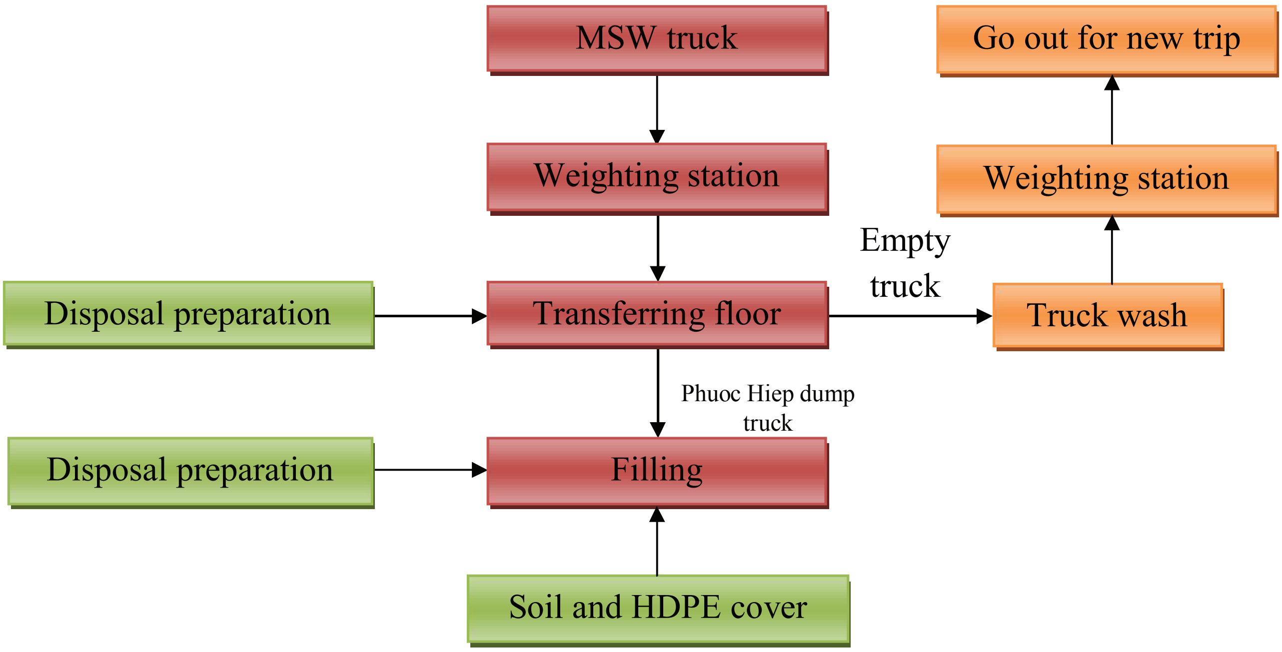


Figure1 Process of solid waste transportation inside Phuoc Hiep landfill.

2.2 Original of MSW and transporters to Phuoc Hiep landfill

There are two waste sources transported to Phuoc Hiep landfill:

(1) Municipal solid wastes (MSW) from Ho Chi Minh City and Duc Hoa District, Long An Province:

- City Environmental Company (Citenco) collects and transports solid wastes from Binh Chanh, Nha Be, Binh Thanh, Tan Phu; District 2, 7, 9, 10, 11, and 12.
- Industrial agricultural Co-operative transports wastes from District 11.
- Duc Hoa Public Service Company transports wastes from Duc Hoa District, Long An Province.
- 11 public service companies transfer wastes from their own Districts (District 1, District 2, District 9, District 12, Go Vap, Binh Thanh, Tan Binh, Thu Duc, Phu Nhuan, Hoc Mon, Cu Chi Public Service Company). On May 28th 2014 and May 29th 2014, Phu Nhuan Public Service Company transported MSW into Tam Sinh Nghia Company instead of Phuoc Hiep landfill.

(2) Residue wastes arising from processes of classifying, recycling and composting from Vietstar Company.

Table3. Original of solid wastes at Phuoc Hiep landfill

No.	Waste transporters	Transfer station	Original of solid wastes
1	Citenco	- Quang Trung-Go Vap - Tong Van Tran - District 11	Binh Thanh, Tan Phu, Binh Chanh, Nha Be, District 2, District 7, District 9, District 10, District 11, District 12
2	Cu Chi Public Service Company	- Tan An Hoi - Tan Phu Trung - Phuoc Thanh - Cu Chi - Tan Thong Hoi - Tan Thanh Tay - Phu Hoa Dong - An Nhon Tay - Lo 6 - Tan Thanh Dong - Quang Viet - Trung An - Pham Van Coi	Cu Chi District
3	Hoc Mon Public Service Company	- Ba Diem - Tan Thoi Nhi - Xuan Thoi Thuong - Thi Tran	Hoc Mon District
4	Industrial Agricultural Co-operative	- Tan Hoa	District 11
5	District 12 Public Service Company	- Hiep Thanh - Tan Thoi Hiep	District 12
6	District 2 Public Service Company	- Binh Trung Tay - An Loi Dong	District 2
7	District 9 Public Service Company	- Long Hoa - Phuoc Long A - Ben Do - Vinh Thuan	District 9
8	Binh Thanh Public Service Company	- Phan Van Tri - Thanh Da	Binh Thanh District
9	Go Vap Public Service Company	- Quang Trung	Go Vap District
10	Tan Binh Public Service Company	- Pham Van Bach	Tan Binh District
11	Thu Duc Public Service Company	- Go Dua - So Ga 4 - Linh Xuan 5 - Truong Tho 3	Thu Duc District

No.	Waste transporters	Transfer station	Original of solid wastes
		- Tam Than - Hiep Binh Chanh	
12	Duc Hoa Public Service Company	- No information	Duc Hoa District - LA
13	Vietstar	- No information	Tan Phu, Phu Nhuan, Tan Binh District, Tranport factory No.1, No.2
14	District 1 Public Service Company	- No information	District 1
15*	Phu Nhuan Public Service Company	- Nguyen Kiem	Phu Nhuan District

***(*):** On May 28th 2014 and May 29th 2014, Phu Nhuan Public Service Company transported MSW into Tam Sinh Nghia company instead of Phuoc Hiep landfill.*

2.3 Number of waste transporters, trips and total amount of solid wastes at Phuoc Hiep landfill

In the survey in May 2014, there are 13 waste transporters (except for District 2 and Phu Nhuan Public Service Company) on May 28th, 2014, and 14 waste transporters (except for Phu Nhuan Public Service Company) on May 29th, 2014.

A number of trips and solid waste mass in the survey in May 2014 decreased compared with that in January 2014. Namely, the average number of trips and total amount of solid wastes are about 208 trips/day and 2,756 tons/day compared with 273 trips/day and 3,348 tons/day in January 2014.The details are presented in Table 4.

Table4. Solid waste mass and number of trips transported into Phuoc Hiep landfill per day

Date	Total waste transporters	Number of trips	Total solid waste mass (ton)
28/05/2014	13	195	2,732
29/05/2014	14	220	2,780
Average	14	208	2,756

Moreover, the waste transport activities in day time have decreased compared with that in January 2014. There are about 58.6% numbers of trips in day time (12:00 – 18:00, about 122 trips) and 41.4% numbers of trips in night-time (18:00 – 6:00, about 86 trips). Therefore, the amount of solid waste transported to the landfill is about 57% in day time (about 1,572 tons) and 43% at night-time (about 1,184 tons). (See Table 5 and Figure 2)

Table 5. **Frequency of transporter trips and total amount of MSW into landfill during the activity time**

Time / Date	From 12:00 – 18:00		From 18:00 – 6:00	
	Number of trips	**Solid waste mass (ton)**	**Number of trips**	**Solid waste mass (ton)**
28/05/2014	112	1,456	83	1,276
29/05/2014	132	1,687	88	1,093
Average	122	1,572	86	1,184

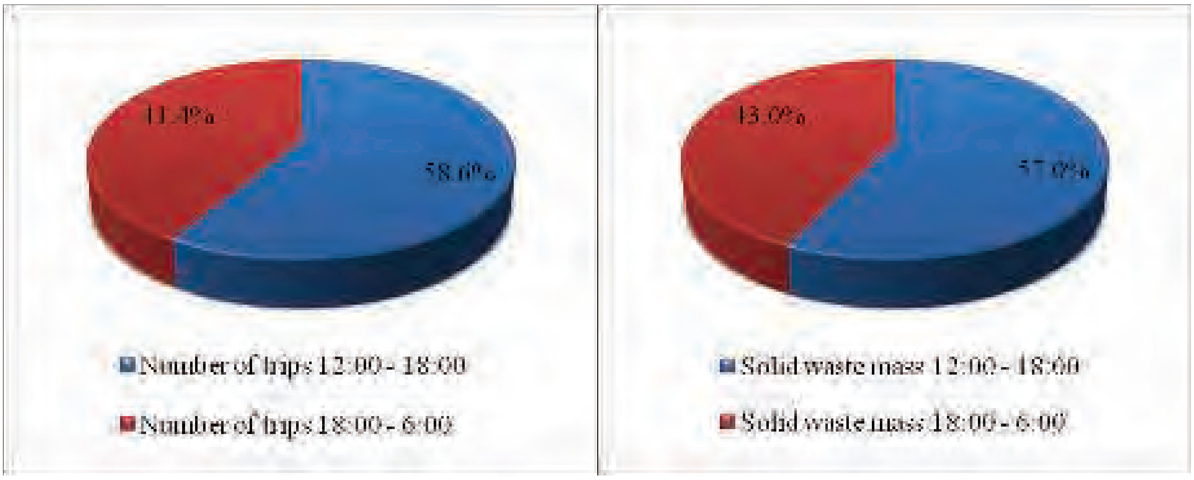


Figure2 The ratio of numbers of trips and solid waste mass in daytime and night-time.

In day time (12:00 – 18:00), the MSW trucks transport frequently into landfill. In night-time (18:00 – 6:00), rush hours are from 18:00 to 24:00, covering about 65.7 % trips of night-time.

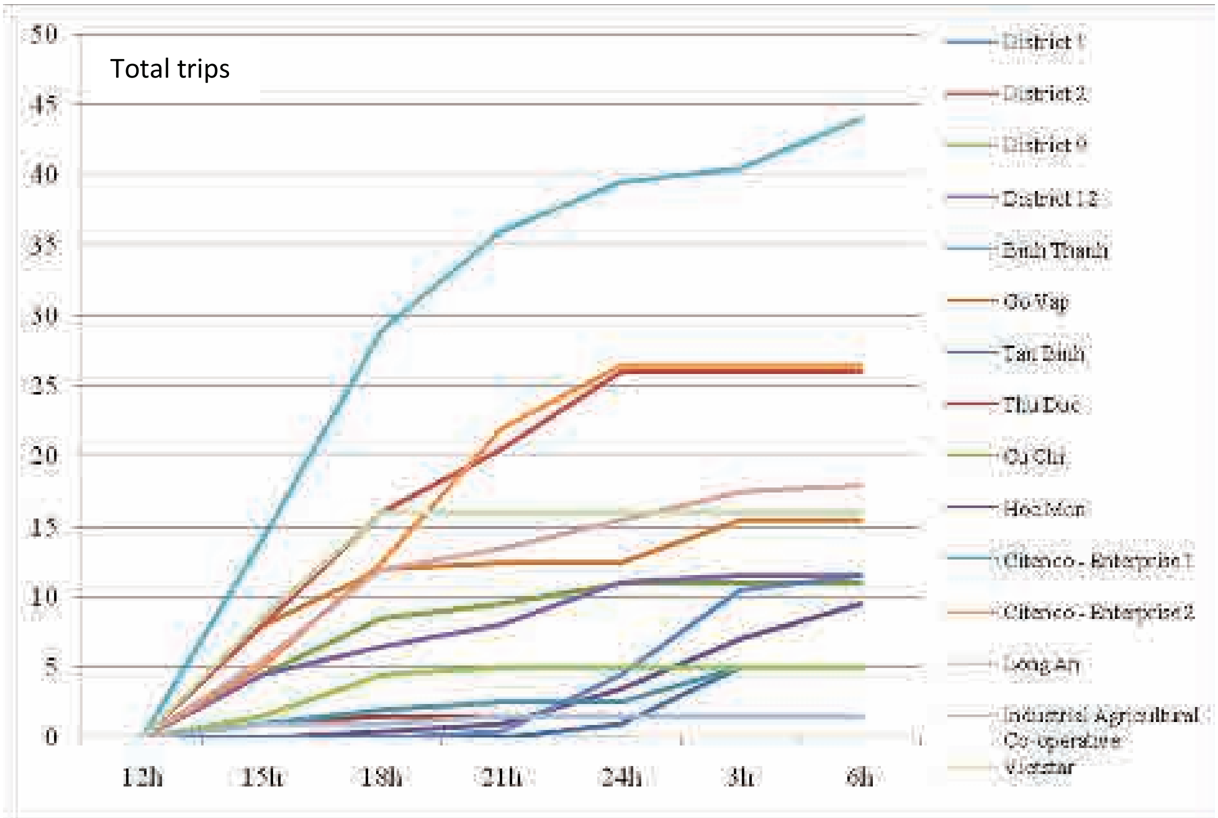


Figure3 Transport time into Phuoc Hiep landfill of transport units

The study data also shows that there are 33.7% total numbers of trips and 37.0% amount of solid wastes transported by Citenco.

Average time for a truck going into and out Phuoc Hiep landfill as a cycle is ranging from 10 to 15 minutes. The time passing weighting station is one minute in average.

There are three types of vehicles transporting MSW into Phuoc Hiep landfill: rear load refuse truck, hook lifting MSW truck, tarpaulin truck.

Hook lifting MSW truck

Rear Load Refuse Truck

Tarpaulin truck

Figure 4 Types of vehicles transporting MSW in to Phuoc Hiep landfill

Most of wastes are transported into Phuoc Hiep landfill by RLR truck (Rear Load Refuse Truck). Except:

- Vietstar Company transports wastes by tarpaulin truck.
- Citenco transports wastes by both hook-lifting MSW truck and rear load refuse truck.

Similar with the survey in January 2014, in this survey (in May 2014), the MSW trucks have loading capacity ranging from 5 tons to 18 tons, most of them range from 10 tons to 15 tons, covering 74.9% in total trips (208 total trips). Besides, Citenco is covering 38.6% in total trips ranging from 10 tons to 15 tons.

The detail data of waste transporters, vehicles, trips as well as total amount of MSW of each transporter and transport time into Phuoc Hiep landfill are presented clearly in Table 6 and Figure 5.

Table 6. Activities of waste transporters into Phuoc Hiep landfill

No.	Waste transporters	Average number of trips in day	Type of vehicle	Note: time	
				From 12:00 to 18:00	From 18:00 to 6:00
1	Citenco	71	RLR, HL	Frequently (58.9%)	Mainly from 18:00 to 24:00 (41.1%)
2	Cu Chi Public Service Company	5	RLR	From 14:00 to 16:30 (90%)	Unusually from 18:00 to 19:00 (10%)
3	Hoc Mon Public Service Company	12	RLR	From 12:00 to 15:00 (56.5%)	Mainly from 18:00 to 24:00 (43.5%)
4	Industrial agricultural Co-operative	18	RLR	Frequently (66.7%)	Mainly from 18:00 to 3:00 (33.3%)
5	District 12 Public Service Company	10	RLR	Unusually (5.3%)	Mainly from 21:00 to 6:00 (94.7%)
6	District 2 Public Service Company	2	RLR	Unusually	Unusually
7	District 9 Public Service Company	11	RLR	From 12:00 to 14:30 and 16:30 to 18:00 (77.3%)	Mainly from 18:00 to 24:00 (22.7%)
8	Binh Thanh Public Service Company	5	RLR	Unusually (40%)	Only from 0:00 to 3:00 (60%)
9	Go Vap Public Service Company	16	RLR	Frequently (77.4%)	Mainly from 24:00 to 3:00 (22.6%)

No.	Waste transporters	Average number of trips in day	Type of vehicle	Note: time	
				From 12:00 to 18:00	From 18:00 to 6:00
10	**Tan Binh Public Service Company**	12	RLR	Not entering	Mainly from 22:00 to 4:00 (100%)
11	**Thu Duc Public Service Company**	26	RLR	Frequently (61.5%)	Mainly from 18:00 to 24:00 (38.5%)
12	**Duc Hoa Public Service Company**	2	RLR	Unusually	Unusually
13	**Vietstar**	16	Tarpaulin	Frequently (100%)	Not entering
14	**District 1 Public Service Company**	6	RLR	Not entering	Only from 23:30 to 3:00 (100%)

***Statistics**: 28/05/2014 and 29/05/2014*

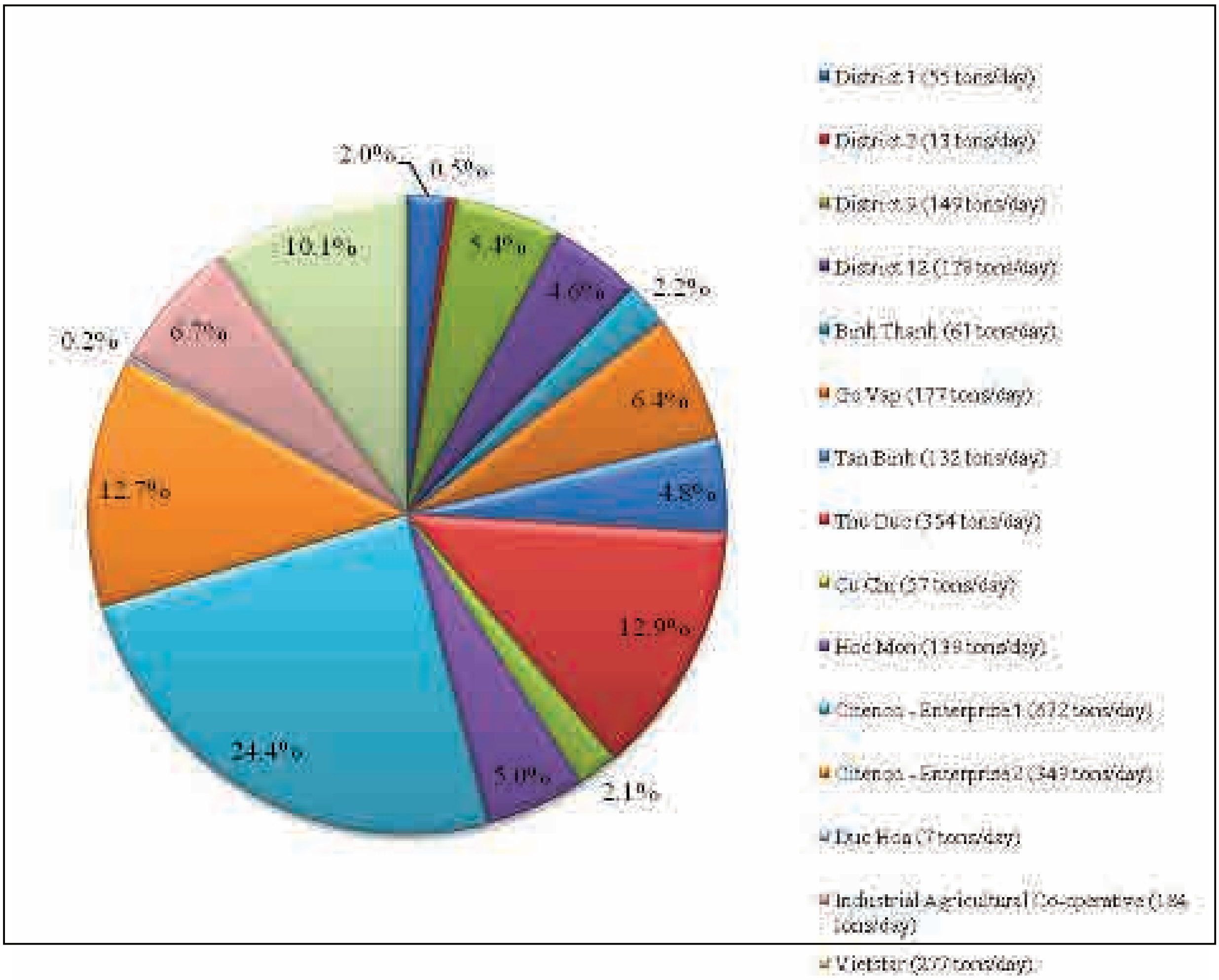


Figure 5. The average solid waste mass (%) of each transporter into Phuoc Hiep landfill

In this survey, there are 14 transporters into Phuoc Hiep landfill in May 2014, which decreases Phu Nhuan transporter compared with that in January 2014. Figure 5 shows that among 14 transporters into Phuoc Hiep landfill Citenco is the major transporter into Phuoc Hiep landfill, with 37.0% total MSW, 1,021 tons/day (Enterprise 1: 672 tons/day and Enterprise 2: 349 tons/day).

After that, Thu Duc District Public Service Company transports about 12.9% - 354 tons/day, Vietstar occupies 10.1% - 277 tons/day. From 0.2% to 6.7% (7 – 184 tons/day) total MSW are: Duc Hoa, District 2, District 1, Cu Chi, Binh Thanh, District 12, Tan Binh, Hoc Mon, District 9, Go Vap Public Service Company and Industrial Agricultural Co-operative.

Compared with the data in Report of Phuoc Hiep MSW in January 2014, it shows that:

- Amount of MSW in May 2014 are lower than that in January 2014 from 3348 tons down 2757 tons (17.6%) because Phu Nhuan Company has not transported MSW into Phuoc Hiep landfill and several waste transporters have transported a part of MSW into Tam Sinh Nghia Company.

3. SAMPLING PLAN, SAMPLING METHOD AND ANALYTICAL METHOD

3.1 Sampling plan

4 samples are taken at Phuoc Hiep landfill in two days:

Day 1: 2 samples from 12:30 to 17:30

Day 2: 2 samples from 16:30 to 22:00

3.2 Sampling method

3.2.1 Collection of sample

a. Sampling location will be decided based on work safety and specific samples.

b. The samples are taken from the MSW collection vehicles and 10^{th} MSW collection vehicle is selected to be sampled in each period of 10 vehicles. At that time, numbers of trucks, date, time, transport units, origin of waste were recorded.

c. MSW is discharged from a collection vehicle into the pile. In the pile, four sampling points are randomly selected, and 20 kg of MSW is collected from each of four points. In total, 70 - 80 kg of samples are collected from one vehicle.

d. Procedure c. is repeated four times. Final weight of samples will be approximately 300 kg.

3.2.2 Preparation of sample

a. Solid wastes after sampling are cut into pieces smaller than 15 cm by shovels and scissors. Bags and their contents should be also cut into smaller pieces. Similarly, bulky wastes such as cardboards and branch of trees are also cut into pieces smaller than 15cm.

Then, each sample is manually mixed by shovels. The sample should be mixed as homogeneously as possible.

b. After that, the mixed sample are divided and taken twice a quarter to obtain a smaller sample. By the way, the final sample, which is one-fourth of the initial sample, is analyzed. An illustration is presented as follows:

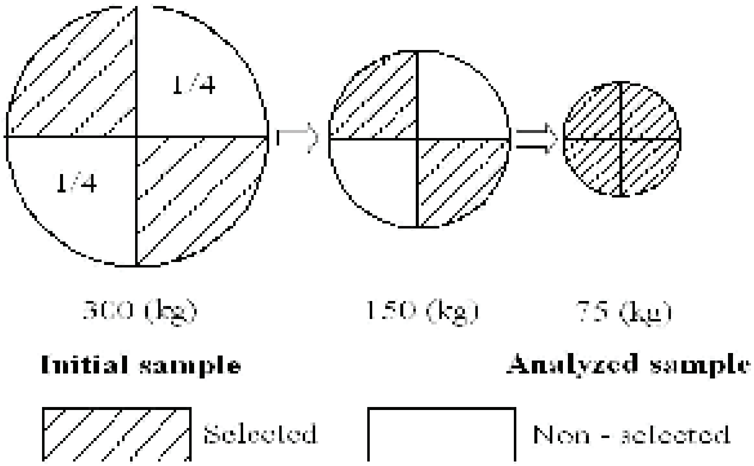


Figure 6. Sampling method

3.3 Analytical method

3.3.1 Measurement of bulk density

a. The prepared sample in section 3.2.2 is used.

b. Plastic container with capacity of 80 L is used. The capacity (V_o) and weight (W_o) of the container should be measured beforehand.

c. The sample is then filled into the container. It should be noted that the sample should not be pushed in the container.

d. The container is lifted by hand and dropped in an upright position from the height of about 30 cm. If the volume of the sample in the container decreases as a result, more samples should be added to the container (to reach the same level as in Procedure c.).

e. Procedure d. is repeated three times. Then, weight of the container containing the sample (W_1) is measured.

f. Bulk density is calculated as follows.

$$\text{Bulk density (kg/L = t/m}^3\text{)} = \frac{W_1(kg) - W_0(kg)}{V_0(L)}$$

3.3.2 Composition of samples

a. The raw samples are prepared as described in section 3.2.2

b. The samples are spread on lining at sorting area for separation.

c. The raw samples are physically separated into the following eleven compositions: ***1***-Food wastes (meat, vegetables, etc.), ***2***-Paper, ***3***-Diaper, ***4***-Plastic, ***5***-Textile, ***6***-Wood, ***7***-Rubber and leather, ***8***-Metal, ***9***-Inorganic waste (coal ash, brick, glass…), ***10***-Shell, ***11***- Others such as very small pieces not being able to be classified by visual observation.

d. Each composition (Xi) is weighted and total weight (X) of all compositions will be calculated. Each physical composition is calculated according to the following formula:

$$\text{Physical composition } x_i(\%, \text{wet weight basis}) = \frac{X_i(\text{kg, wet weight basis})}{X(\text{kg, wet weight basis})} \times 100$$

$$\text{Physical composition } x_i(\%, \text{dry weight basis}) = \frac{\text{Dried weight of each component (kg)}}{\text{Total dried weight of components (kg)}} \times 100$$

3.3.3 Moisture content

a. Moisture content of each composition is determined individually according to APHA 2540 G (2012).

b. Each composition is cut into pieces from 2 to 3 cm and individually spread in metal container with 20 cm diameter (height of wastes should be less than 10cm in the container if possible).

c. After that, wastes will be dried at 105 degrees Celsius by conductive heating for 4 to 5 days or until the constant weight obtains.

d. Finally, moisture content of each composition will be calculated according to difference between weight of wet sample and that of dried sample.

3.3.4 Volatile solid, ash and gross calorific value

08 combustible samples (food waste, paper, textile, wood, plastic, rubber & leather, diaper and others) are cut into pieces less than 1cm for analysis of volatile solid and ash content. They will be combusted at 550 degrees Celsius according to APHA 2540 G (2012).

08 combustible samples (food waste, paper, textile, wood, plastic, rubber & leather, diaper and others) are cut into pieces less than 1cm and then crushed into pieces smaller than 2mm for analysis of gross calorific value according to TCVN 200-2007 (ISO 1928:1995).

The analytical method of solid waste is presented in Table 7.

Table7. Analytical method of solid waste

No.	Parameter	Analytical method	Analytical Instrument
1	Moisture	APHA 2540 G	WTB Binder, Germany, Metter Toledo MS204 balance, Switzerland
2	Volatile solid and Ash	APHA 2540 G	Nabertherm oven, Metter Toledo MS204 balance, Switzerland
3	Gross calorific value	TCVN 200 -2011 (ISO 1928:2009)	IKA calorimeter C 4000

4. ANALYTICAL RESULTS OF PHUOC HIEP MSW

4.1 Information of Phuoc Hiep MSW samples

The Phuoc Hiep MSW samples were taken in 2 days:

- May 28th, 2014 from 12:30 to 17:30: Rainy season-Sample quantity: 2 samples
- May 29th, 2014 from 16:30 to 22:00: Rainy season- Sample quantity: 2 samples

Specific information of Phuoc Hiep MSW samples is presented in the following Table:

Table 8 Information of Phuoc Hiep MSW samples

<table>
<tr><th>Sample No.</th><th>Vehicle registration number</th><th>Time</th><th>MSW transporter</th><th>Original of Waste</th><th>Vehicle color/ Type</th><th>Sampling MSW sample (kg)</th><th>Analyzing MSW sample (kg)</th></tr>
<tr><td colspan="8">28/05/2014</td></tr>
<tr><td rowspan="4">1</td><td>51C-226.96</td><td>12h30</td><td>Hoc Mon District Public Service Company</td><td>Hoc Mon District</td><td>White – green/Rear load refuse Truck</td><td rowspan="4">356.5</td><td rowspan="4">72.4</td></tr>
<tr><td>51E-025.33</td><td>12h50</td><td>Thu Duc District Public Service Company</td><td>Thu Duc District</td><td>Green/Rear load refuse Truck</td></tr>
<tr><td>51C-165.12</td><td>13h41</td><td>Go Vap District Public Service Company</td><td>Go Vap District</td><td>White – green/Rear load refuse Truck</td></tr>
<tr><td>57H-8680</td><td>14h00</td><td>District 9 Public Service Company</td><td>District 9</td><td>Green/Rear load refuse Truck</td></tr>
<tr><td rowspan="4">2</td><td>57K-0630</td><td>14h55</td><td>Industrial-Agricultural Co-operative</td><td>Binh Tan District</td><td>Green/Rear load refuse Truck</td><td rowspan="4">340.0</td><td rowspan="4">83.4</td></tr>
<tr><td>51C-107.87</td><td>15h38</td><td>Citenco – Factory No.2</td><td>Pham Van Xao transfer station</td><td>White/Rear load refuse Truck</td></tr>
<tr><td>51C-352.93</td><td>16h20</td><td>Citenco – Factory No.1</td><td>Quang Trung transfer station</td><td>White – green/Rear load refuse Truck</td></tr>
<tr><td>51C-105.33</td><td>16h54</td><td>Thu Duc DistrictPublic Service Company</td><td>Thu Duc District</td><td>White/Rear load refuse Truck</td></tr>
</table>

29/05/2014							
3	51E-024.92	16h35	Thu Duc District Public Service Company	Thu Duc District	Green/Rear load refuse Truck	338.0	82.2
	51C-064.82	17h00	Cu Chi District Public Service Company	Cu Chi District	White – green/Rear load refuse Truck		
	57M-1118	17h32	Binh Thanh District Public Service Company	Binh Thanh District	White – orange/Rear load refuse Truck		
	51C-215.27	17h52	District 9 Public Service Company	District 9	White – green/Rear load refuse Truck		
4	51C-185.66	19h00	Hoc Mon District Public Service Company	Hoc Mon District	Green/Rear load refuse Truck	373.0	112.7
	57H-2175	20h20	Hoc Mon District Public Service Company	Hoc Mon District	Green/Rear load refuse Truck		
	51E-019.04	20h45	Tan Binh DistrictPublic Service Company	Tan Binh District	White – orange/Rear load refuse Truck		
	51E-024.92	21h20	Thu Duc District Public Service Company	Thu Duc District	Green/Rear load refuse Truck		

4.2 Physical composition of Phuoc Hiep MSW

The results of average percent of wet weight and dry weight of MSW at Phuoc Hiep landfill are presented in Figure 7 and Figure 8. The results show that:

The highest proportional compositions are food waste and plastic by both wet and dry weight. They are 68.9% and 16.1% by wet weight and 51.1% and 27.5% by dry weight, respectively. The remain compositions such as textile, paper, diaper, shell – bone, inorganic, wood, rubber and leather, metal, and others occupy lower proportion, respectively 4.1%, 3.2%, 3.0%, 2.2%, 1.4%, 0.5%,0.4%, 0.3%, and 0.1% by wet weight, and 5.4%, 4.5%, 1.7%, 4.5%, 3.1%, 0.9%, 0.7%, 0.6%, and 0.1% by dry weight.

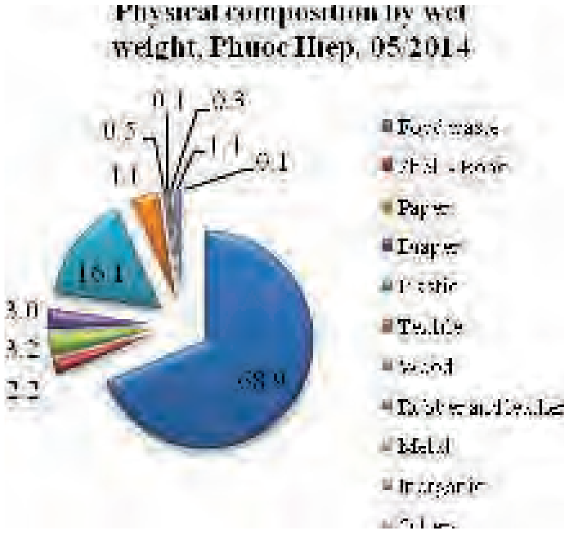


Figure 7. Average physical compositions (% wet weight) of 4 samples in May 2014

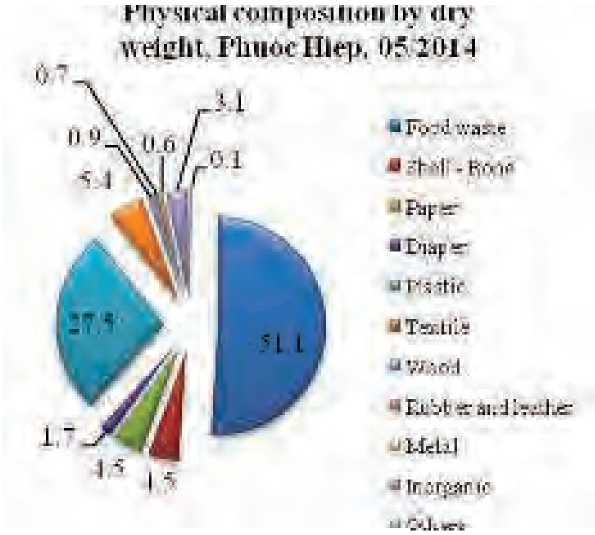


Figure 8. Average physical compositions (% dry weight) of 4 samples in May 2014

Statistic physical composition results of each physical composition (% wet weight) of each sample are presented in Table 9 and Figure 9. The proportion of each composition in each sample hasn't significantly changed among 4 samples, but sample 4 and sample 2 don't include composition of others. Composition of shell–bone in sample 2 is significantly higher than other samples because sample 2 has more shells and cockleshells

Table 9. Statistic physical composition of 4 samples (May 2014)

No.	Composition	Physical composition result (% wet weight)			
		Sample 1	Sample 2	Sample 3	Sample 4
1	Food waste (fruit peel, vegetables, leaves, crushed food,…)	66.9	59.3	71.1	78.1
2	Shell - Bone	1.2	6.0	0.5	0.9
3	Paper	3.9	4.8	2.7	1.5
4	Diaper	4.4	3.6	2.4	1.6
5	Plastic	17.9	18.0	17.0	11.5
6	Textile	3.6	4.2	3.9	4.8
7	Wood	0.7	0.2	0.5	0.5
8	Rubber and leather	0.1	0.4	1.0	0.02
9	Metal	0.2	0.6	0.1	0.2
10	Inorganic (brick, cups, glass, coal ash,...)	1.0	2.9	0.7	0.9
11	Others (Batteries, light bulbs,	0.1	-	0.1	-

	hair,...)					

- *(-):No sample/Do not analyse*

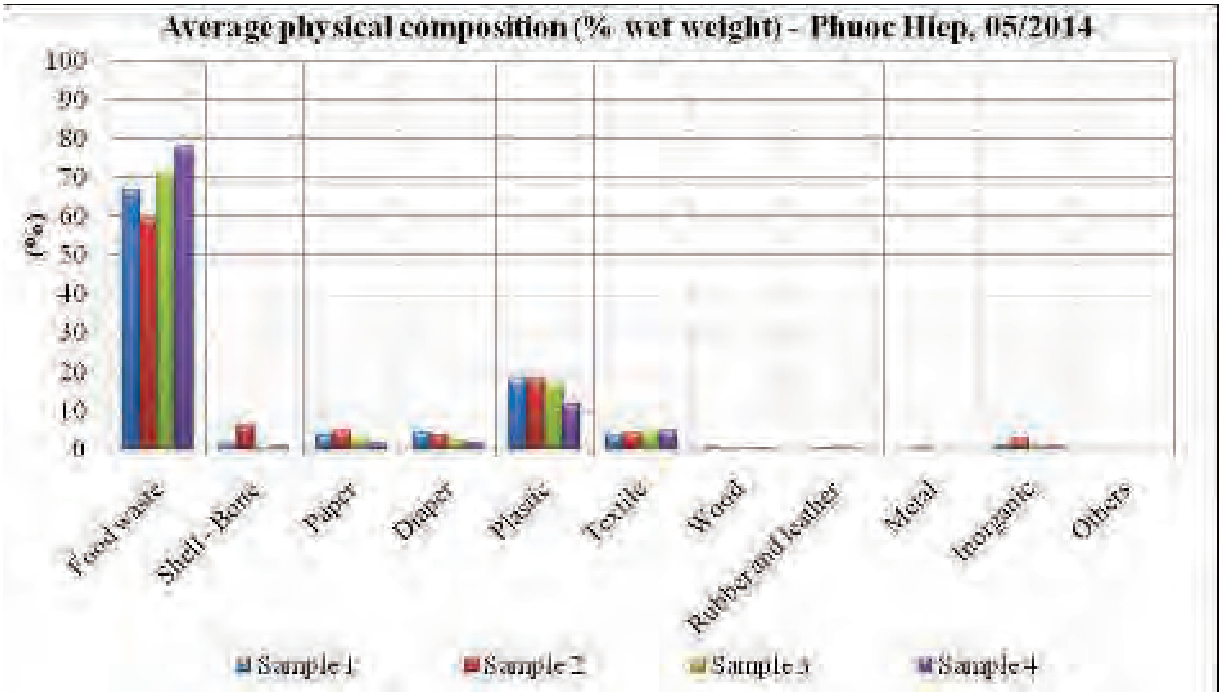


Figure9. Average physical composition (% wet weight) of 4 samples

4.3 Moisture, volatile solid and ash

4.3.1 Moisture

The moisture content's data of each sample are presented in Table 10, Figure 10 and 11.

Table 10 Statistic moisture of each composition of 4 samples

No.	Composition	Moisture content (%)						
		Sample 1	Sample 2	Sample 3	Sample 4	Average (%)	Min	Max
1	Food waste (fruit peel, vegetables, leaves, crushed foods,…)	72.1	71.0	74.2	68.8	71.5	68.8	74.2
2	Shell - Bone	11.9	12.5	10.7	7.7	10.7	7.7	12.5
3	Paper	46.2	41.6	49.6	40.8	44.5	40.8	49.6
4	Diaper	77.8	77.4	76.7	77.0	77.2	76.7	77.8
5	Plastic	31.1	30.0	37.9	36.3	33.8	30.0	37.9
6	Textile	48.0	47.5	50.4	51.4	49.3	47.5	51.4
7	Wood	35.5	40.4	40.0	18.6	33.6	18.6	40.4

8	Rubber and leather	2.3	6.7	45.0	8.9	15.7	2.3	45.0
9	Metal	6.8	8.6	7.2	7.6	7.5	6.8	8.6
10	Inorganic (brick, cups, glass, coal ash,...)	8.6	5.1	6.9	6.3	6.7	5.1	8.6
11	Others (Batteries, light bulbs, hair,...)	1.2	-	16.6	-	8.9	1.2	16.6

(-): No sample/Do not analyse

- Moisture of diaper is the highest with the average value 77.2% and ranges from 76.7% (sample 3) to 77.8% (sample 1) because of their capability of water adsorption.
- Moisture of food waste is ranging from 68.8% (sample 4) to 74.2% (sample 3) and the average value is 71.5%. It depends on differences among food waste components.
- Moisture of textile, paper, plastic, and shell-bone in 4 samples is insignificantly different. Their average values are 49.3%, 44.5%, 33.8% and 10.7%, respectively.
- Moisture of wood is significantly different among 4 samples, namely, its moisture in sample 4 is the least because it includes rough timber while other samples include bamboo basket and plywood; so, its moisture is significantly higher.
- Moisture of rubber and leather in sample 3 is significantly higher than other samples because sample 3 includes leather while other samples include tyre (sample 1), rubber shoe (sample 2) and foam rubber mattress (sample 4).
- Difference of others in these samples makes the different moisture content. Component of others in sample 1 includes batteries and light bulbs, so, its moisture is low (1.2%), while, that of others in sample 3 includes hair, so, its moisture is higher (16.6%).
- Metal and inorganic components (brick, coal ash, glass, etc) have low moisture because of their physical characteristics. Moisture of metal and inorganic components is from 6.8% to 8.6% and 5.1% to 8.6%, respectively.

Compared with the data in Report of Phuoc Hiep MSW in January, 2014, it shows that:

- The average moisture of food waste increases from 67.6% to 71.5%.
- The average moisture of textile, paper, diaper, plastic, and shell-bone has an insignificant change compared with that of January 2014.
- The average moisture of wood, rubber and leather, metal and inorganic has significantly changed. Namely, the average moisture of wood increases from17.4% (in January 2014) to 33.6% because 3 of 4 samples in this survey

contain plywood and bamboo baskets. The average moisture of rubber and leather increases 10.9% to 15.7% because sample 3 contains leather. The average moisture of inorganic increases from 3.5% to 6.7% because all samples in this survey contain coal ash. These materials including plywood, bamboo baskets, leather, and coal ash have the capability of water absorption.

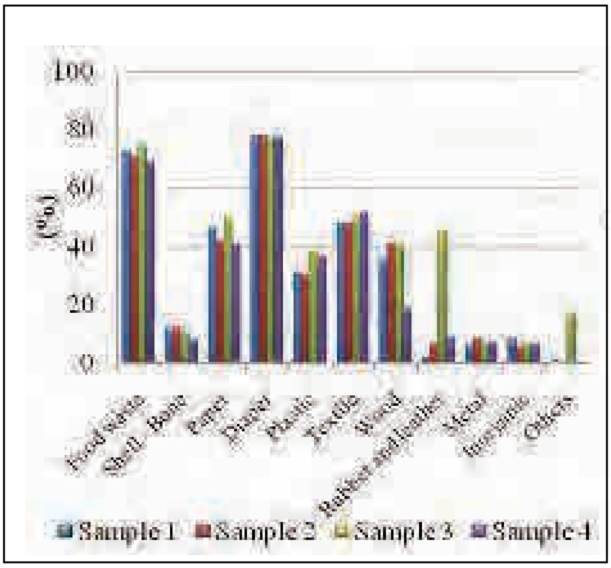


Figure10. Moisture content (%) of each composition of MSW sample

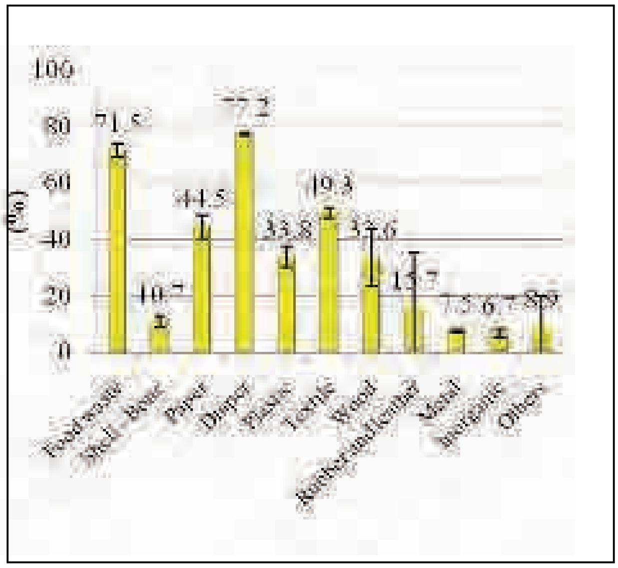


Figure11. Average moisture content (%) of each composition of MSW sample

4.3.2 Volatile solid and ash

Figures from 12 to 15 show the result of volatile solid and ash of each sample. Ash of metal and inorganic is not analyzed and estimated 100% dry weight.

- Ash of food waste is ranging from 13.0% (sample 4 includes leaves, vegetables and crushed foods…) to 17.7% (sample 3 includes coconut husk, jackfruit peel, pineapple shell, crushed foods…) by dry weight.
- The average ash of rubber and leather is 25.0% by dry weight, and is ranging from 3.8% (sample 4 includes foam rubber mattress) to 43.6% (sample 2 includes rubber shoe).
- The average ash of paper accounts for 15.9% by dry weight.
- The average ash of wood, plastic, diaper and textile is 9.5%, 8.5%, 11.0% and 10.5% respectively.
- Ash of shell – bone is high and the average is 94.5%.
- Ash of others is ranging from 4.1% (sample 3 includes hair) to 100% (sample 1 includes batteries and light bulbs).

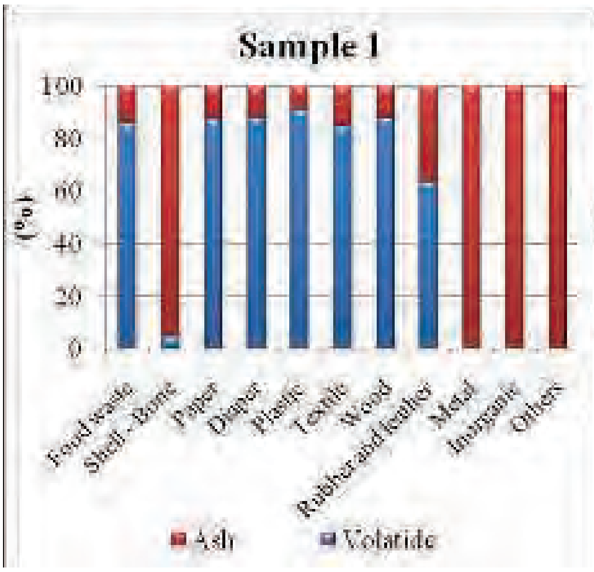


Figure12. Ash and volatile solid by dry weight (%) of sample 1

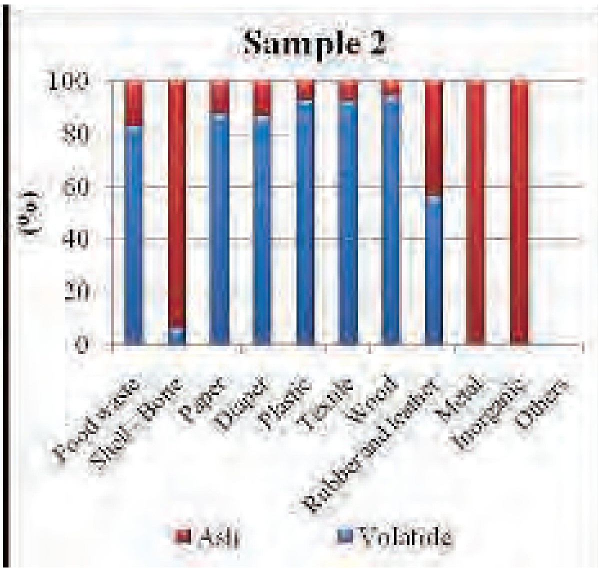


Figure13. Ash and volatile solid by dry weight (%) of sample 2

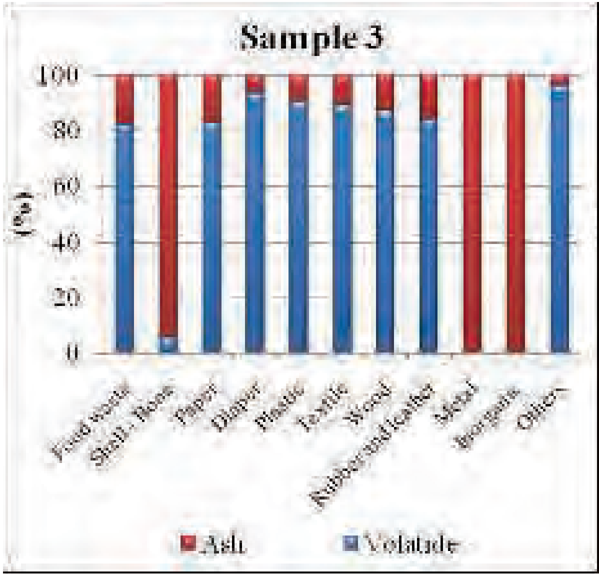


Figure14. Ash and volatile solid by dry weight (%) of sample 3

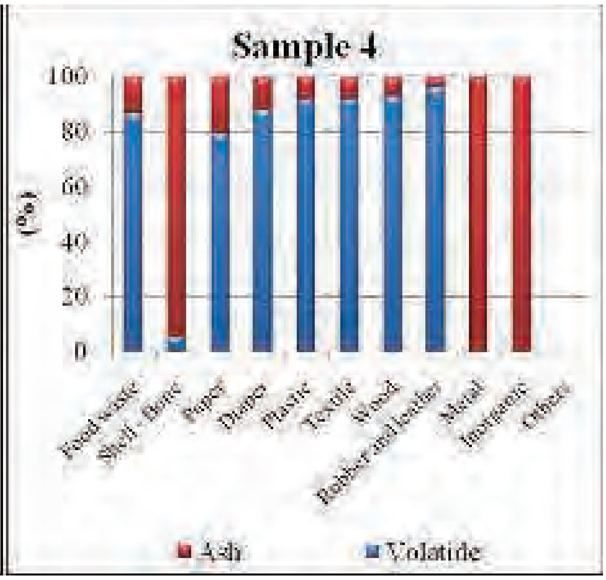


Figure15. Ash and volatile solid by dry weight (%) of sample 4

The VS and ash values by dry weight and wet weight are presented in Table 11 and 12.

Table11. Statistic VS value by dry weight of 4 samples (May 2014)

No.	Composition	VS % dry weight		
		Average	Min	Max
1	Food waste (fruit peel, vegetables, leaves, crushed foods,…)	84.5	82.3	87.0
2	Shell - Bone	5.5	4.8	6.2

3	Paper	84.1	79.4	87.4
4	Diaper	89.0	86.8	93.5
5	Plastic	91.5	90.5	92.7
6	Textile	89.5	85.1	92.1
7	Wood	90.5	87.2	94.1
8	Rubber and leather	75.0	56.4	96.2
9	Metal	0.0	0.0	0.0
10	Inorganic (brick, cups, glass, coal ash,...)	0.0	0.0	0.0
11	Others (Batteries, light bulbs, hair,...)	47.9	0.0	95.9

Table12. Statistic ash value by dry weight of 4 samples (May 2014)

No.	Composition	Ash % dry weight		
		Average	**Min**	**Max**
1	Food waste (fruit peel, vegetables, leaves, crushed foods,…)	15.5	13.0	17.7
2	Shell - Bone	94.5	93.8	95.2
3	Paper	15.9	12.6	20.6
4	Diaper	11.0	6.5	13.2
5	Plastic	8.5	7.3	9.5
6	Textile	10.5	7.9	14.9
7	Wood	9.5	8.9	15.8
8	Rubber and leather	25.0	3.8	43.6
9	Metal	100.0	100.0	100.0
10	Inorganic (brick, cups, glass, coal ash,...)	100.0	100.0	100.0
11	Others (Batteries, light bulbs, hair,...)	52.1	4.1	100.0

VS and ash by dry weight of metal, inorganic and others (sample 1 – Batteries, light bulbs) are estimated 0% VS and 100% ash.

The average values of ash and VS value by dry weight are presented in Figure 16 and 17.

As data recorded in Figure 16, the average VS values of 7 of 11 compositions (excluding metal, inorganic waste, shell-bone and others) are high between 75.0% and 91.5%.

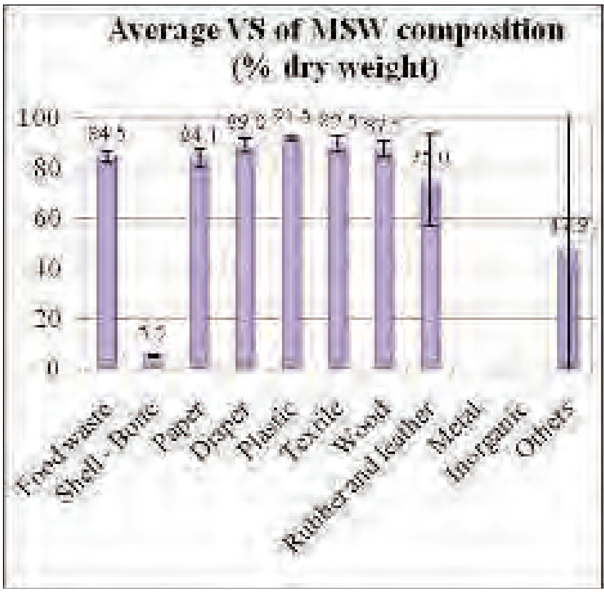


Figure16. Average value of VS by dry weight of MSW composition.

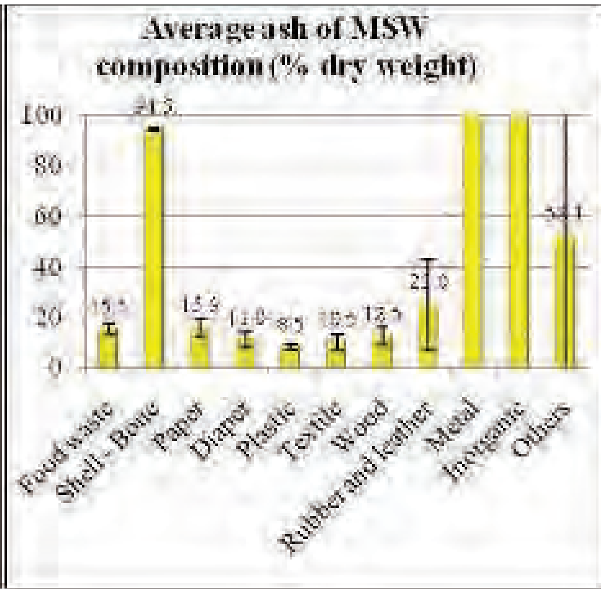
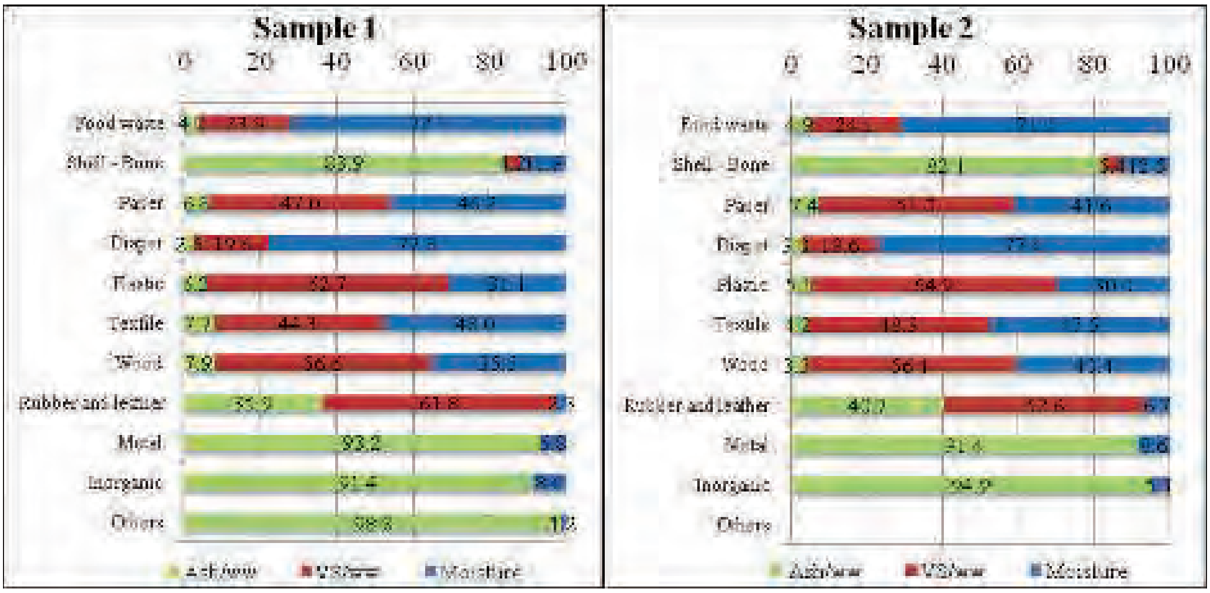


Figure17. Average value of ash by dry weight of MSW composition.

4.4 Correlation of moisture, VS and ash

4.4.1 Correlation of moisture, VS and ash of each composition by wet weight.

The correlation of moisture, VS and ash of each composition is presented in 4 Figures, from Figure 18 to Figure 21.



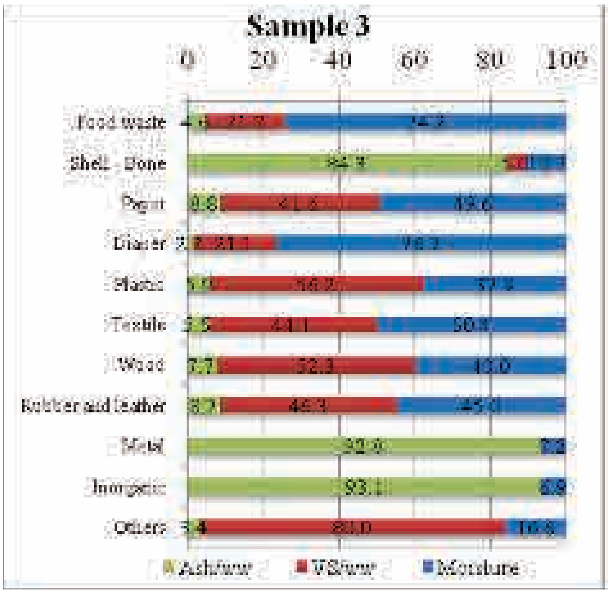


Figure18. Correlation of moisture, VS and ash of each composition of sample 3

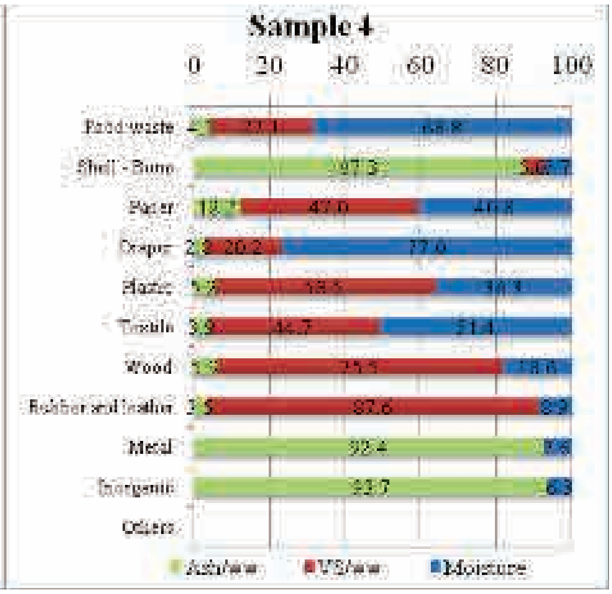


Figure19. Correlation of moisture, VS and ash of each composition of sample 4

According to these Figures, correlation of moisture, VS and ash in each composition is based on natural characteristics.

- Food waste has the highest proportion of physical composition with moisture 68.8% - 74.2%, VS: 21.2% - 27.1% and ash: 4.0% - 4.9% by wet weight.
- The second high proportion of physical composition is plastic with moisture fluctuating from 30.0% - 37.9%, VS: 56.2% - 64.9% and ash: 5.1% - 6.2% by wet weight.
- Textile's moisture, VS and ash values are 47.5% - 51.4%, 44.1% - 48.3% and 3.9% -7.7%, respectively.
- Diaper has the highest moisture 76.7% - 77.8% and the lowest ash 2.2% - 3.0%.
- Ash of shell-bone is high 82.1% - 87.3%, VS and moisture values are 4.2% - 5.4% and 7.7% - 12.5%, respectively.
- Other compositions have low percentage of physical composition. Any that, moisture of metal is 6.8% to 8.6%, and moisture of inorganic is 5.1% - 8.6%. The remaining dryness of these compositions is estimated 100.0% ash.

4.4.2 Correlation of moisture, VS and ash of each sample by wet weight

The bar charts below showed the percentage of moisture, VS and ash by wet weight in original sample.

Moisture of sample is ranging from 55.4% to 65.2%, volatile solid value is ranging from 28.8 % to 32.1% and ash is 6.0% to 12.8% by wet weight. Among samples, the moisture of sample 2 is the lowest because sample 2 includes less food waste than other samples. However, the ash of sample 2 is significantly higher than other samples because of including more shell-bone and inorganic (6.0% and 2.9% by wet weight, respectively) whereas the percentage of shell-bone and inorganic in other samples ranges from 0.5% and 0.7% to 1.2% and 1.0% by wet weight.

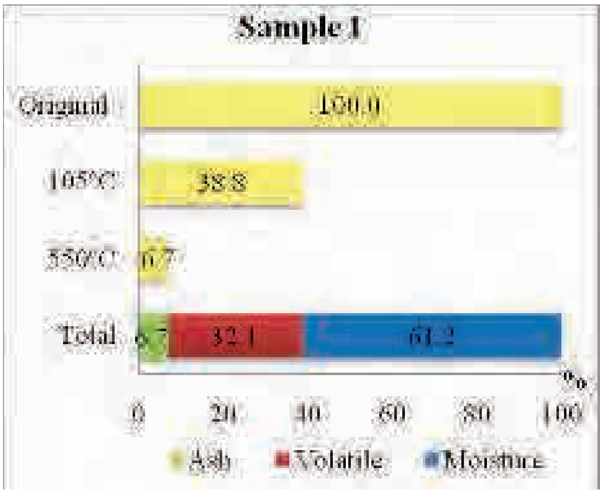


Figure20. Correlation of moisture, VS and ash by wet weight of sample 1

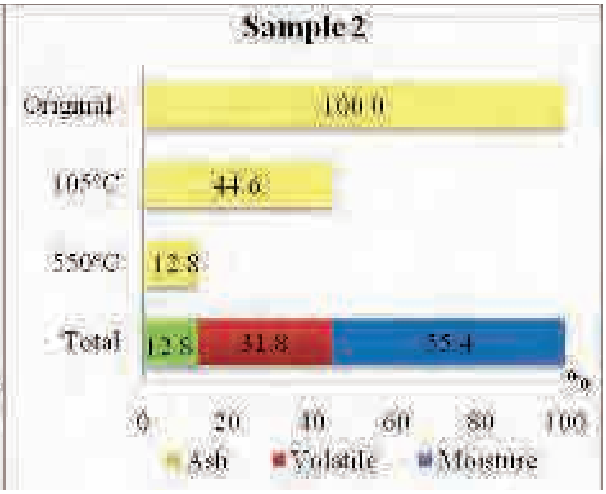


Figure21. Correlation of moisture, VS and ash by wet weight of sample 2

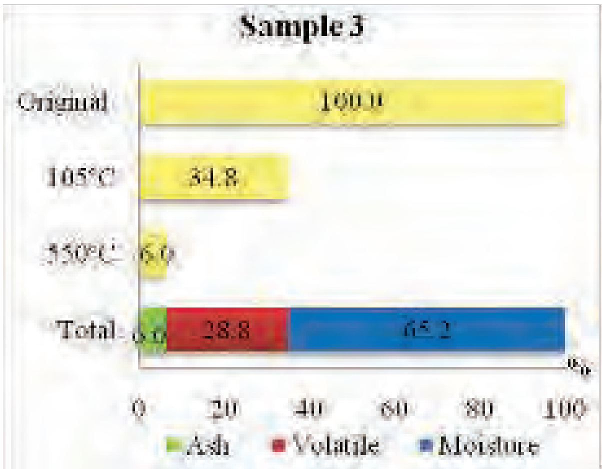


Figure22. Correlation of moisture, VS and ash by wet weight of sample 3

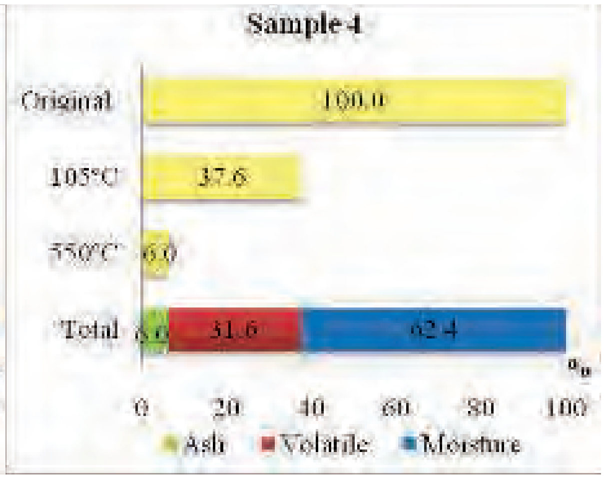


Figure23. Correlation of moisture, VS and ash by wet weight of sample 4

4.5 Gross calorific

Gross calorific values of general samples are showed in Table 13, Figure 26 and 27.

Table13. Statistic gross calorific value by dry weight of 4 samples (May 2014)

No.	Composition	Gross Calorific (Cal/g)						
		Sample 1	Sample 2	Sample 3	Sample 4	Average	Min	Max
1	Food waste (fruit peel, vegetables, leaves, crushed foods,…)	4,731	3,893	3418	2696	3,685	2,696	4,731

2	Shell - Bone	-	-	-	-	-	-	-
3	Paper	4,686	4,307	3,422	5,282	4,424	3,422	5,282
4	Diaper	5,261	5,488	3,507	5,908	5,041	3,507	5,908
5	Plastic	8,777	9,591	9,676	8,772	9,204	8,772	9,676
6	Textile	5,326	4,576	4,841	5,157	4,975	4,576	5,326
7	Wood	3,962	-	4,326	4,475	4,254	3,962	4,475
8	Rubber and leather	-	5,005	4,646	-	4,826	4,646	5,005
9	Metal	-	-	-	-	-	-	-
10	Inorganic (brick, cups, glass, coal ash,...)	-	-	-	-	-	-	-
11	Others (Batteries, light bulbs, hair,...)	-	-	-	-	-	-	-

(-): No sample/Do not analyse

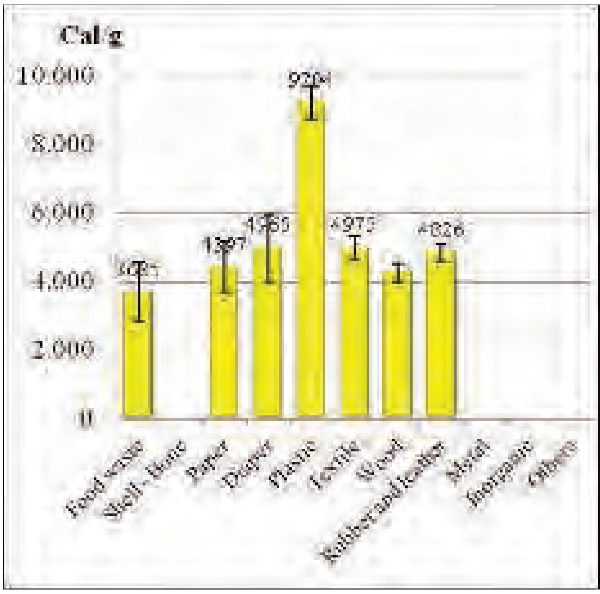


Figure24. Average value of gross calorific of MSW composition

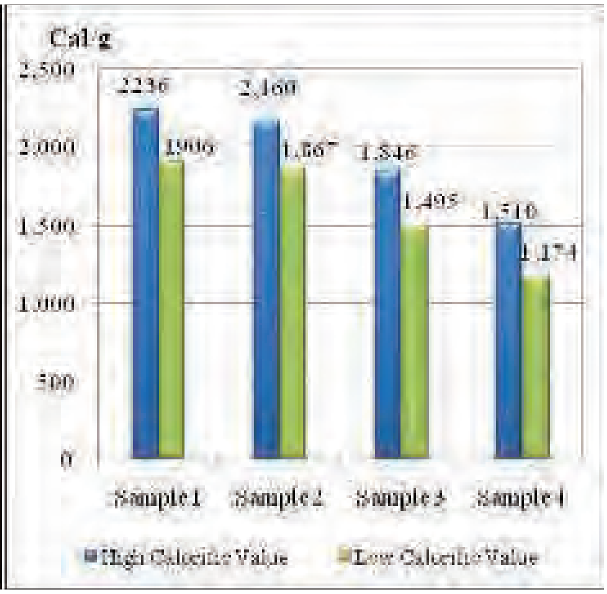


Figure25. Gross calorific of each sample

- Gross calorific of plastic is the highest value; it oscillates from 8,772 cal/g (sample 1) to 9,676cal/g (sample 3).
- Food waste, paper and diaper have a significant fluctuation. Their fluctuation is respectively 2,696 – 4,731 cal/g, 3,422 – 5,282cal/g and 3,507 – 5,908cal/g. The compositions of food waste in all samples include fruit peels, coconut husk, leaves, vegetables, and crushed foods. However, sample 4 includes more

vegetables and crushed food, so, gross calorific of food waste in sample 4 is the lowest.

- Textile is 4,576 – 5,326 cal/g, wood is 3,962 – 4,475 cal/g, rubber and leather is 4,646 – 5,005 cal/g.
- Calculated result of HCV and LCV shows that HCV of 4 samples fluctuates from 1,510 cal/g to 2,236 cal/g and LCV is ranging within from 1,174cal/g to 1,906 cal/g. These values are lower than values in January 2014 (HCV and LCV range from 2,245 cal/g to 2,442 cal/g and 1,922cal/g to 2,143 cal/g, respectively) because these samples include more food waste (59.4 – 78.1% by wet weight) than samples in January 2014 (58.0% - 67.0% by wet weight).

APPENDIX 1
FORMULA

1. Correlation of moisture, VS and ash by wet weight of each composition:

Moisture content of each composition (%) + Ash (% ww) + Volatile (% ww) = 100

Ash (% ww) $= \frac{(100 - MCEC\ (\%)) \times ash\ (\%\ dw)}{100}$

Volatile (% ww)$= \frac{(100 - MCEC\ (\%)) \times volatile\ (\%\ dw)}{100}$

2. Correlation of moisture, VS and ash by wet weight of each sample:

Moisture content (%) + Ash (% ww) + Volatile (% ww) = 100

Moisture content (%) $= \sum \frac{PCEC\ (\%\ ww\ basis) \times MCEC\ (\%)}{100}$

Ash(% ww) $= \sum \frac{SFEC\ (\%) \times ash\ (\%\ dw)}{100}$

Volatile(% ww) $= \sum \frac{SFEC\ (\%) \times volatile\ (\%\ dw)}{100}$

3. High calorific value – HCV and Low calorific value – LCV of each sample:

HCV (cal/g) $= \sum \frac{Gross\ Calorific\ of\ composition \times SFEC\ (\%)}{100}$

LCV (cal/g) = HCV (cal/g) – $\frac{540 \times Moisture\ content\ (\%)}{100}$

Conversion formula: 1 cal/g = 4.187 J/g

Solid fraction of each composition (%) $= \sum \frac{PCEC\ (\%\ ww\ basis) \times (100 - MCEC\ (\%))}{100}$

❖ ***Note:***

- *MCEC: Moisture content of each composition*
- *PCEC: Physical composition of each composition*
- *SFEC: Solid fraction of each composition*

APPENDIX 2
FIGURE OF MSW SAMPLING AND CLASSIFICATION AT TRANSFERRING FLOOR OF PHUOC HIEP LANDFILL

APPENDIX 3
FIGURE OF MSW SAMPLE FOR MOISTURE ANALYSIS

Sample 1

Sample 2

Sample 3

Sample 4

APPENDIX 4
FIGURE OF MSW SAMPLE AFTER MOISTURE ANALYSIS
(DRIED AT 105°C)


Sample 1 **Sample 2**


Sample 3 **Sample 4**

APPENDIX 5- THE RAW DATA

Sample 1

No.	Composition	Analyzing result						Calculated result				
		Bulk density (kg/l)	Physical composition (% ww)	Physical composition (% dw)	Moisture content (%)	Ash, at 550^{o}C (%)	Gross Calorific (Cal/g) (% dw)	Moisture content (%)	Total Ash (% ww)	Total VS (% ww)	High Gross Calorific Value (Cal/g) (% ww)	Low Gross Calorific Value (Cal/g) (% ww)
1	Food waste	0.38	66.9	48.3	72.1	14.3	4,731	48.3	2.7	16.0	884	624
2	Shell - Bone		1.2	2.8	11.9	95.2	-	0.1	1.0	0.1	-	-
3	Paper		3.9	5.4	46.2	12.7	4,686	1.8	0.3	1.8	98	88
4	Diaper		4.4	2.5	77.8	11.9	5,261	3.4	0.1	0.9	52	33
5	Plastic		17.9	31.9	31.1	9.0	8,777	5.6	1.1	11.2	1,085	1,055
6	Textile		3.6	4.8	48.0	14.9	5,326	1.7	0.3	1.6	99	90
7	Wood		0.7	1.1	35.5	15.2	3,962	0.2	0.1	0.4	18	16
8	Rubber and leather		0.1	0.3	2.3	36.7	-	0.0	0.0	0.1	-	-
9	Metal		0.2	0.4	6.8	100.0*	-	0.0	0.1	0.0	-	-
10	Inorganic (Enamelled tiles, broken cups, coal ash)		1.0	2.3	8.6	100.0*	-	0.1	0.9	0.0	-	-
11	Others (Batteries, light bulbs)		0.1	0.2	1.2	100.0*	-	0.0	0.1	0.0	-	-
Total								**61.2**	**6.7**	**32.1**	**2,236**	**1,906**

(-): No sample/Do not analyse
**: ash is estimated 100% dw*

Sample 2

No.	Composition	Analyzing result						Calculated result				
		Bulk density (kg/l)	Physical composition (% ww)	Physical composition (% dw)	Moisture content (%)	Ash, at 550^oC (%)	Gross Calorific (Cal/g) (% dw)	Moisture content (%)	Total Ash (% ww)	Total VS (% ww)	High Gross Calorific Value (Cal/g) (% ww)	Low Gross Calorific Value (Cal/g) (% ww)
1	Food waste	0.31	59.3	38.6	71.0	17.0	3,893	42.2	2.9	14.3	670	442
2	Shell - Bone		6.0	11.8	12.5	93.8	-	0.7	4.9	0.3	-	-
3	Paper		4.8	6.3	41.6	12.6	4,307	2.0	0.4	2.5	120	110
4	Diaper		3.6	1.8	77.4	13.3	5,488	2.8	0.1	0.7	44	29
5	Plastic		18.0	28.2	30.0	7.3	9,591	5.4	0.9	11.7	1,208	1,179
6	Textile		4.2	4.9	47.5	7.9	4,576	2.0	0.2	2.0	101	90
7	Wood		0.2	0.3	40.4	8.9	-	0.1	0.0	0.1	-	-
8	Rubber and leather		0.4	0.8	6.7	43.6	5,005	0.0	0.1	0.2	17	17
9	Metal		0.6	1.2	8.6	100.0*	-	0.1	0.6	0.0	-	-
10	Inorganic (Brick, glass, coal ash)		2.9	6.1	5.1	100.0*	-	0.1	2.7	0.0	-	-
11	Others		-	-	-	-	-	-	-	-	-	-
Total								**55.4**	**12.8**	**31.8**	**2,160**	**1,867**

(-): No sample/Do not analyse
**: ash is estimated 100% dw*

Sample 3

No.	Composition	Analyzing result						Calculated result				
		Bulk density (kg/l)	Physical composition (% ww)	Physical composition (% dw)	Moisture content (%)	Ash, at 550^{o}C (%)	Gross Calorific (Cal/g) (% dw)	Moisture content (%)	Total Ash (% ww)	Total VS (% ww)	High Gross Calorific Value (Cal/g) (% ww)	Low Gross Calorific Value (Cal/g) (% ww)
1	Food waste	0.32	71.1	52.7	74.2	17.7	3,418	52.8	3.2	15.1	627	342
2	Shell - Bone		0.5	1.3	10.7	94.4	-	0.1	0.4	0.0	-	-
3	Paper		2.7	3.9	49.6	6.5	3,422	1.3	0.2	1.1	46	39
4	Diaper		2.4	1.6	76.7	9.5	3,507	1.9	0.1	0.5	20	10
5	Plastic		17.0	30.3	37.9	11.1	9,676	6.5	1.0	9.6	1,022	987
6	Textile		3.9	5.5	50.4	15.8	4,841	2.0	0.2	1.7	93	83
7	Wood		0.5	0.8	40.0	6.5	4,326	0.2	0.0	0.3	13	12
8	Rubber and leather		1.0	1.5	45.0	15.8	4,646	0.4	0.1	0.5	25	22
9	Metal		0.1	0.3	7.2	100.0*	-	0.0	0.1	0.0	-	-
10	Inorganic (Broken cups, glass bottles, coal ash)		0.7	2.0	6.9	100.0*	-	0.0	0.7	0.0	-	-
11	Others (hair)		0.1	0.1	16.6	4.1	-	0.0	0.0	0.0	-	-
Total								**65.2**	**6.0**	**28.8**	**1,846**	**1,495**

(-): No sample/Do not analyse
**: ash is estimated 100% dw*

Sample 4

No.	Composition	Analyzing result						Calculated result				
		Bulk density (kg/l)	Physical composition (% ww)	Physical composition (% dw)	Moisture content (%)	Ash, at 550^{o}C (%)	Gross Calorific (Cal/g) (% dw)	Moisture content (%)	Total Ash (% ww)	Total VS (% ww)	High Gross Calorific Value (Cal/g) (% ww)	Low Gross Calorific Value (Cal/g) (% ww)
1	Food waste	0.38	78.1	64.9	68.8	13.0	2,696	53.7	3.2	21.2	657	367
	Shell - Bone		0.9	2.2	7.7	94.6	-	0.1	0.8	0.1	-	-
2	Paper		1.5	2.4	40.8	20.6	5,282	0.6	0.2	0.7	47	44
3	Diaper		1.6	1.0	77.0	12.2	5,908	1.2	0.0	0.3	22	15
4	Plastic		11.5	19.6	36.3	8.2	8,772	4.2	0.6	6.8	645	622
5	Textile		4.8	6.2	51.4	8.0	5,157	2.5	0.2	2.1	120	107
6	Wood		0.5	1.1	18.6	10.3	4,475	0.1	0.0	0.4	19	19
8	Rubber and leather		0.02	0.04	8.9	3.8	-	0.0	0.0	0.0	-	-
9	Metal		0.2	0.4	7.6	100.0*	-	0.0	0.2	0.0	-	-
10	Inorganic (Glass, flower vase, coal ash)		0.9	2.2	6.3	100.0*	-	0.0	0.8	0.0	-	-
11	Others		-	-	-	-	-	-	-	-	-	-
Total								**62.4**	**6.0**	**31.6**	**1,510**	**1,174**

(-): No sample/Do not analyse
**: ash is estimated 100% dw*

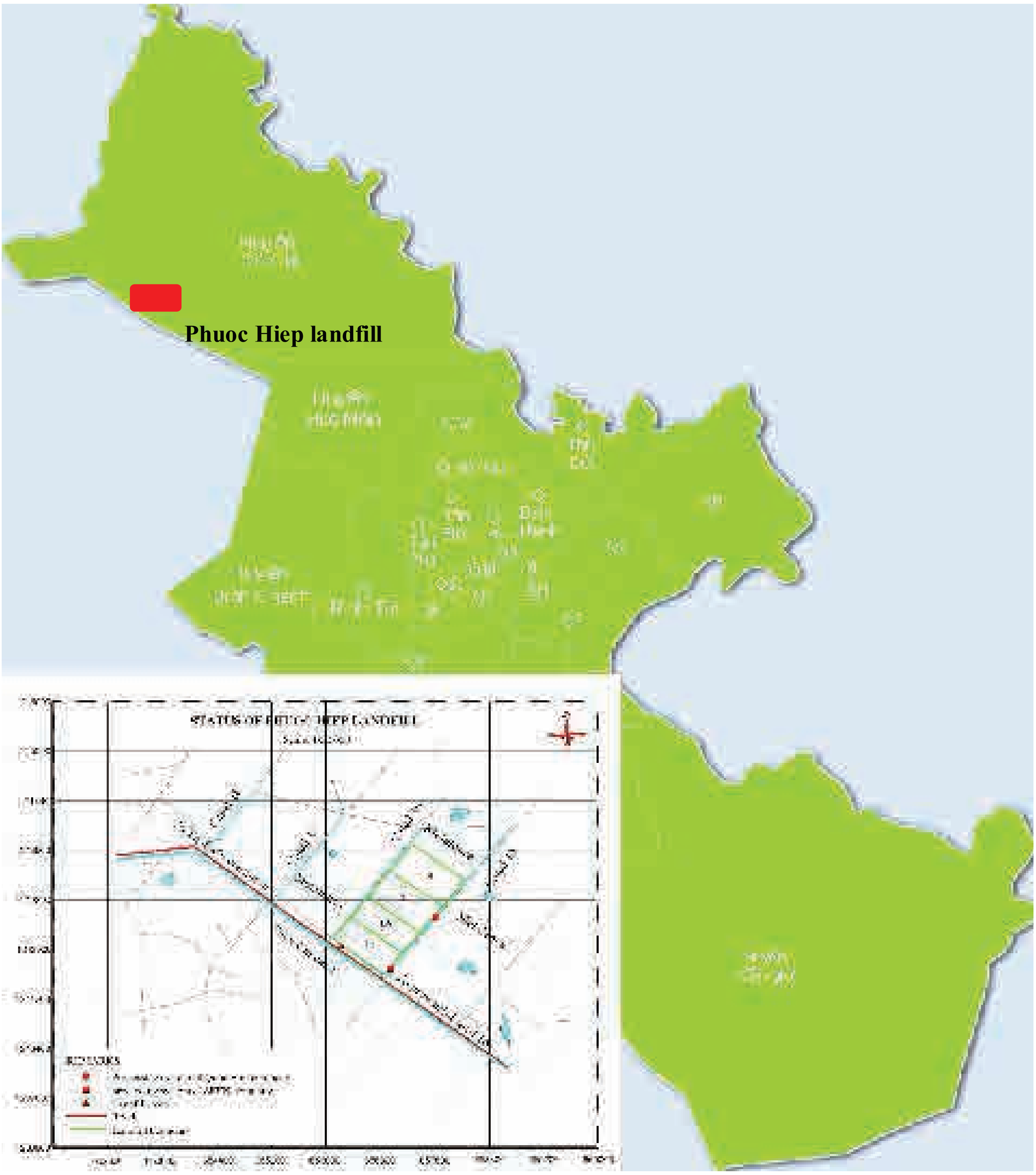
CALCULATED SAMPLE RESULT OF MOISTURE, ASH, HIGH GROSS CALORIFIC AND LOW GROSS CALORIFIC

No.Sample	1	2	3	4
Total Moisture	61.2	55.4	65.2	62.4
Total Ash (%ww)	6.7	12.8	6.0	6.0
Total VS (%ww)	32.1	31.8	28.8	31.6
High Gross Calorific	2,236	2,160	1,846	1,510
Low Gross Calorific	1,906	1,867	1,495	1,174

No	Composition	Total moisture (%)				Total Ash (%ww)				Total VS (%ww)			
		1	2	3	4	1	2	3	4	1	2	3	4
1	Food waste	48.3	42.2	52.8	53.7	2.7	2.9	3.2	3.2	16.0	14.3	15.1	21.2
2	Shell - Bone	0.1	0.7	0.1	0.1	1.0	4.9	0.4	0.8	0.1	0.3	0.0	0.1
3	Paper	1.8	2.0	1.3	0.6	0.3	0.4	0.2	0.2	1.8	2.5	1.1	0.7
4	Diaper	3.4	2.8	1.9	1.2	0.1	0.1	0.1	0.0	0.9	0.7	0.5	0.3
5	Plastic	5.6	5.4	6.5	4.2	1.1	0.9	1.0	0.6	11.2	11.7	9.6	6.8
6	Textile	1.7	2.0	2.0	2.5	0.3	0.2	0.2	0.2	1.6	2.0	1.7	2.1
7	Wood	0.2	0.1	0.2	0.1	0.1	0.0	0.0	0.0	0.4	0.1	0.3	0.4
8	Rubber and leather	0.0	0.0	0.4	0.0	0.0	0.1	0.1	0.0	0.1	0.2	0.5	0.0
9	Metal	0.0	0.1	0.0	0.0	0.1	0.6	0.1	0.2	0.0	0.0	0.0	0.0
10	Inorganic	0.1	0.1	0.0	0.0	0.9	2.7	0.7	0.8	0.0	0.0	0.0	0.0
11	Others	0.0	-	0.0	-	0.1	-	0.0	-	0.0	-	0.0	-
Total		**61.2**	**55.4**	**65.2**	**62.4**	**6.7**	**12.8**	**6.0**	**6.0**	**32.1**	**31.8**	**28.8**	**31.6**

(-): No sample/Do not analyse

APPENDIX 6
LOCATION OF PHUOC HIEP LANDFILL



Appendix

2-1 Analysis of Phuoc Hiep Municipal Solid Waste (MSW) Composition

REPORT OF

PHUOC HIEP MUNICIPAL SOLID WASTE RESULTS, NOVEMBER 2013

December, 2013

REPORT OF

PHUOC HIEP MUNICIPAL SOLID WASTE RESULTS, NOVEMBER 2013

ETM CENTER

Director

December, 2013

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DW	:	Dry Weight
HCV	:	High Calorific Value
LCV	:	Low Calorific Value
MSW	:	Municipal Solid Waste
VS	:	Volatile Solid
WW	:	Wet Weight

1. GENERAL INFORMATION OF PHUOC HIEP LANDFILL

1.1 Location

Phuoc Hiep landfill located on the North West Solid Waste Treatment Complex at Tam Tan hamlet, Phuoc Hiep commune, Cu Chi district, Ho Chi Minh city. Phuoc Hiep landfill is about 50 km far from the city center directed to the North West, 5 km far from Cu Chi District center directed to the the South West, that is showed in the picture in Appendix 6. The landfill shares the borders with the following positions:

- The region has been in the planning areas for the North West Solid Waste Treatment Complex and the existing Indigo forest area in the East and North direction;
- Canal No. 16 in the North West direction;
- Thay Cai Canal in the South West direction;
- Canal No. 15 in the South East direction.

1.2 Capacity and operation status

General information of capacity and operation status in Phuoc Hiep landfill are shown in Table 1.

Table 1 General information of capacity and operation status in Phuoc Hiep landfill

No.	General information	No.1 compartment	No.1A compartment	No.2 compartment	No.3 compartment
1	Operation duration	2003 - 2007	2007 - now	2008 - now	Both landfill and construction activities
2	Filling compartment area (ha)	18.99	9.75	19.50	60.00
3	Designed capacity (ton/day)	3,000	3,000	3,500	3,000
4	Actual average receiving capacity (ton/day)	3,000	3,000	3,500	-
5	Landfill type	Sanitation	Sanitation	Sanitation	Sanitation
6	Landfill height from ground level (m)	25	15 - 17	-	-
7	Landfill depth from ground level (m)	-7	-7	-7	-7

Source: *Department of Natural Resource and Environment of HCM city (2010, 2013)*

1.3 Disposal technologies

Phuoc Hiep landfill is a sanitation landfill with full items of environmental protection facilities such as

- Area of No. 1 compartment is 18.99 ha and divided into 4 sub-compartments. Each sub-compartment is about 4.74 ha in area. Maximum height of the compartments is 25 m. Municipal solid waste disposal in each compartment was covered in 10 layers. Each layer's thickness was 2.2 m (solid waste was carefully compacted by landfill bulldozer). Between the solid waste layers was 20 cm of thickness soil layer. On the top the compartment was covered by bentonite layer and then 30 cm topsoil layer.

- No.1A and No.2 compartments also use similar system of bottom liner and top-covering layer to No.1 compartment. Moreover, in design, pile wall system of No. 1A compartment has reinforce in order to avoid slip and subsidence incidents surrounding the landfill.

- In No.2 compartment, when the solid waste reaches to appropriate level, the No.2 compartment will connect with No.1A in order to take advantage of the strong pile wall system of No.1A compartment. A part of border between No.2 compartment and No.1A compartment will use to fill the waste in order to increase receiving ability.

- Compartment No.3 began to carry out landfill activities in October, 2013 and continued to construction activities by South Korea contractor.

1.4 Objective of sampling

Sampling purposes Phuoc Hiep landfill is analyzed physical composition, moisture, VS, ash and gross calorific value of solid wastes in order to evaluated the quality an quality of MSW.

1.5 Implementation schedule

Table 2. Implementation schedule

No.	Articles	Timing plan		
		31/10, 1/11	1/11-20/11	21/11-10/12
1	Survey and sampling	▬		
2	Classification of municipal solid waste, bulk density	▬		
3	Analysis of physical composition and moisture		▬	
4	Analysis of gross calorific value, ash and VS (VS)		▬	
5	Data processing			▬
6	Preparation of report			▬

2. STATUS OF MSW TRANSPORTATION ACTIVITIES AT PHUOC HIEP LANDFILL

2.1 MSW transportation process at Phuoc Hiep landfill

Solid waste transportation process at Phuoc Hiep landfill is presented in Figure 1.

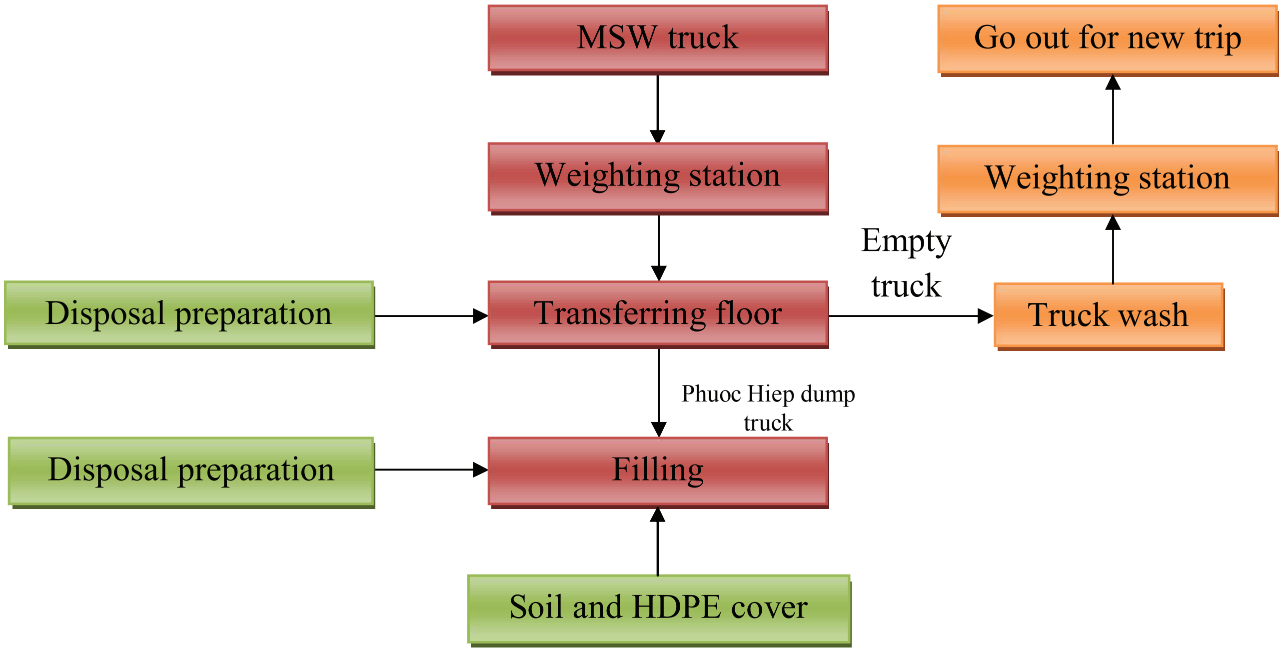


Figure 1 Solid waste transportation process at Phuoc Hiep landfill.

2.2 MSW source and transport unit to Phuoc Hiep landfill

There are two waste sources transported to Phuoc Hiep landfill:

(1) Municipal solid waste (MSW) generated from Ho Chi Minh City and Duc Hoa District, Long An Province as follows:

- City Environmental Company (CITENCO) is responsible for collecting and delivering MSW from Binh Chanh, Nha Be, Binh Thanh, Tan Phu District; District 2, 7, 9, 10, 11, and 12.
- Industrial agricultural Co-operative is responsible for collecting and delivering MSW from District 11.
- Duc Hoa Public Service Company is responsible for collecting and delivering MSW from Duc Hoa District, Long An Province.
- 11 public benefit service companies are responsible for collecting and delivering MSW from their own districts.

(2) Residue waste arising from classification, recycling and compost production from Vietstar Company.

Table 3 MSW source at Phuoc Hiep landfill

No.	Transport unit	Transfer station	MSW generation source
1	CITENCO	- Quang Trung- Go Vap - Tong Van Tran- District 11	Binh Thanh, Tan Phu, Binh Chanh, Nha Be, District 2, District 7, District 9, District 10, District 11, District 12
2	Public benefit service company of Cu Chi District	- Tan An Hoi - Tan Phu Trung - Phuoc Thanh - Cu Chi - Tan Thong Hoi - Tan Thanh Tay - Phu Hoa Dong - An Nhơn Tay - Lo 6 - Tan Thanh Dong - Quang Viet - Trung An - Pham Van Coi	Cu Chi District
3	Public benefit service company of Hoc Mon District	- Ba Diem - Tan Thoi Nhi - Xuan Thoi Thuong - Thi Tran	Hoc Mon District
4	Industrial agricultural Co-operative	- Tan Hoa	District 11
5	Public benefit service company of District 12	- Hiep Thanh - Tan Thoi Hiep	District 12
6	Public benefit service company of District 2	- Binh Trung Tay - An Loi Dong	District 2
7	Public benefit service company of District 9	- Long Hoa - Phuoc Long A - Ben Do - Vinh Thuan	District 9
8	Public benefit service company of Binh Thanh District	- Phan Van Tri - Thanh Da	Binh Thanh District
9	Public benefit service company of Go Vap District	- Quang Trung	Go Vap District
10	Public benefit service company of Tan Binh District	- Pham Van Bach	Tan Binh District
11	Public benefit service company of Thu Duc District	- Go Dua - So Ga 4 - Linh Xuan 5 - Truong Tho 3	Thu Duc District

No.	Transport unit	Transfer station	MSW generation source
		- Tam Than - Hiep Binh Chanh	
12	Public benefit service company of Duc Hoa District	- No information	Duc Hoa District – Long An Province
13	Vietstar	- No information	Tan Phu, Phu Nhuan, Tan Binh district, Tranport factory No.1, No.2
14	Public benefit service company of District 1	- No information	District 1
15	Public benefit service company of Phu Nhuan District	- Nguyen Kiem	Phu Nhuan District

2.3 Number of MSW transport units, trips and MSW quantity at Phuoc Hiep landfill

According to field survey in October and November 2013, there are 15 MSW transport units into Phuoc Hiep landfill with about 273 trips/day in average. Total average quantity of MSW that is about 3,297 tons/day is presented in Table 4.

Table 4 Number of trips and MSW quantity at Phuoc Hiep landfill

Date	Total waste transporters	Number of trips	Quantity (ton/day)
31/10/2013	15	270	3,284
1/11/2013	15	276	3,310
Average	15	273	3,297

There are about 43.0% of total trips of MSW transport in the daytime (12:00 – 18:00, about 117 trips) and 57.0% in the night-time (18:00 – 6:00, about 156 trips). Therefore, the quantity of MSW delivered to the landfill is about 42.6% in the daytime and 57.4% in the night-time). (See Table 5 and Figure 2).

In the daytime (12:00 – 18:00), the rush hours are from 12:00 to 15:00 when there are over 68.5% of total daytime trips. In the night-time (18:00 – 6:00), the rush hours are from 18:00 to 19:30 when there are about 29.6% of total night-time trips.

Table 5 Number of trips and MSW quantity at Phuoc Hiep landfill in a day

Time / Date	From 12:00 – 18:00		From 18:00 – 6:00	
	Number of trips	MSW quantity (ton)	Number of trips	MSW quantity (ton)
31/10/2013	119	1,441	151	1,843
1/11/2013	116	1,369	160	1,941

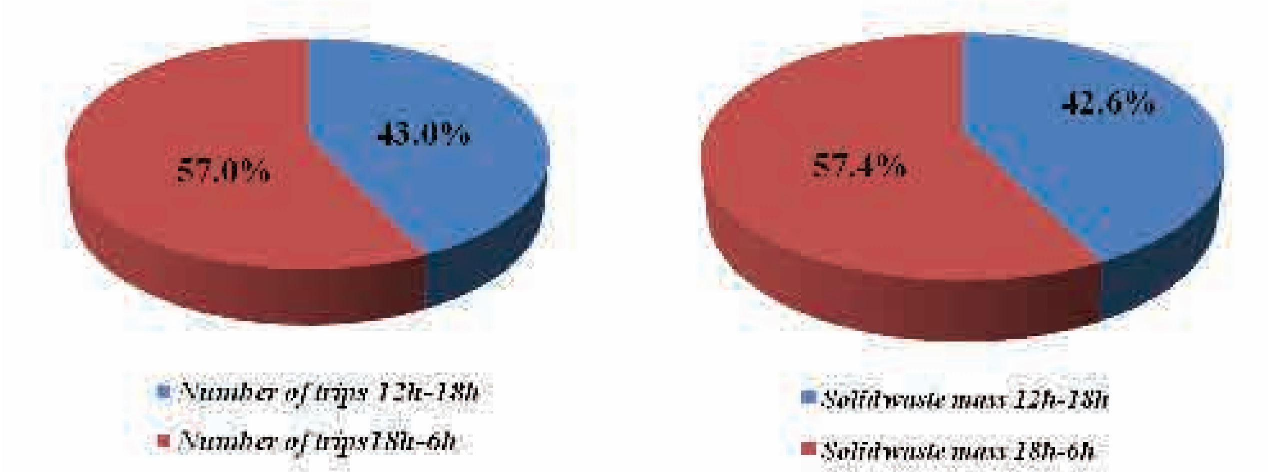


Figure 2 Diagram of number of trips and MSW quantity in the daytime and the night-time.

In comparison with the previous report (Phuoc Hiep MSW report dated February, 2013), the number of trips in the night-time (18:00 to 6:00) is increased from 44.0% (133 trips) to 57.0% (156 trips) in order to limit negative impacts on domestic activities of residential areas, especially in the daytime.

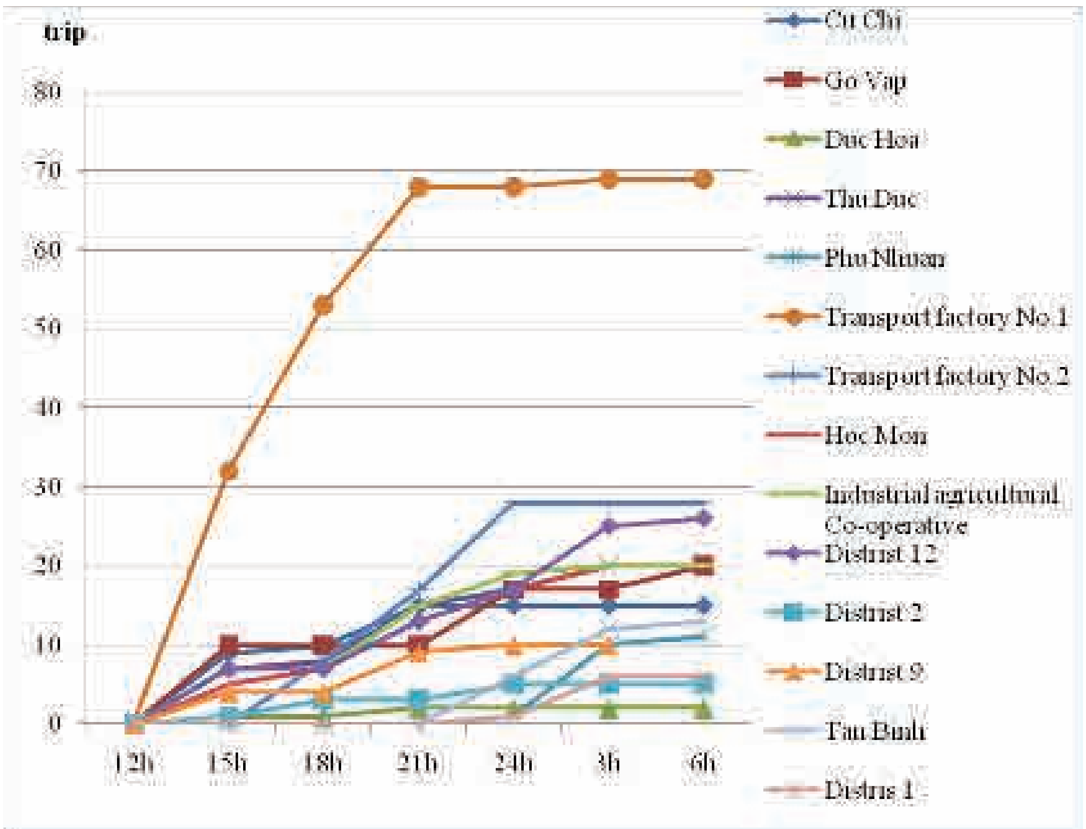


Figure 3 Schedule of transport units at Phuoc Hiep landfill.

The study data also showed that there were 34.2% of total trips and 35.9% of the MSW quantity transported by CITENCO.

It takes from 10 to 15 minutes in average for a truck going in and out Phuoc Hiep landfill and one minute in average for a truck passing weighing station.

There are three types of vehicles used for transporting MSW to Phuoc Hiep landfill such as rear load refuse truck; hook lifting garbage truck, tarpaulin truck.

Hook lifting garbage truck

Rear Load Refuse Truck

Tarpaulin truck

Figure 4 Types of MSW transport vehicles to Phuoc Hiep landfill.

MSW is mostly transported to Phuoc Hiep landfill by RLR truck (Rear Load Refuse Truck), except for the following cases:

- Vietstar Company has used tarpaulin truck for MSW transport.

- CITENCO has used hook-lifting garbage truck for MSW transport.

- According to Phuoc Hiep MSW report dated February, 2013, the public benefit service company of Phu Nhuan District used normal truck without upper canvas for MSW transport. However, MSW is now delivered to Phuoc Hiep landfill by RLR truck.

In this survey (October and November 2013), the garbage trucks, which are used for MSW transport, have loading capacity in range of 4 tons - 18 tons, mostly 10 tons - 15 tons, occupied 80.8% of total trips (221 trips). Besides, the garbage trucks with a loading capacity of 10 tons -

15 tons, which are used by CITENCO for MSW transport, are occupied about 33.8% of total trips.

The number and type of vehicles, number of trips as well as total MSW quantity performed by each transport unit and transport time into Phuoc Hiep landfill are specifically presented in Table 6 and Figure 5.

Table 6 Activities of MSW transport units into Phuoc Hiep landfill

No.	Transport unit	Number of garbage trucks	Average number of trips per day	Type of vehicle	Time	
					From 12:00 to 18:00	From 18:00 to 6:00
1	CITENCO	55	94	RLR, HL	Frequently (61%)	Mainly from 18:00 to 12:00 (39%)
2	Public benefit service company of Cu Chi District	5	17	RLR	Frequently (56%)	Not entering (44%)
3	Public benefit service company of Hoc Mon District	4	20	RLR	Frequently (36%)	Mainly from 19:00 to 22:30 and 12:00 to 3:00
4	Industrial agricultural Co-operative	22	21	RLR	From 12:00 to 14:30 (38%)	Mainly from 18:00 to 23:30 (62%)
5	Public benefit service company of District 12	7	25	RLR	From 12:00 to 15:00 (29%)	Frequently (71%)
6	Public benefit service company of District 2	4	5	RLR	Unusually (67%)	Unusually (33%)
7	Public benefit service company of District 9	7	10	RLR	From 12:00 to 14:00 (40%)	Mainly from 18:00 to 19:30 (60%)
8	Public benefit service company of Binh Thanh District	6	6	RLR	Not entered	Only from 23:30 to 3:00

No.	Transport unit	Number of garbage trucks	Average number of trips per day	Type of vehicle	Time	
					From 12:00 to 18:00	From 18:00 to 6:00
9	Public benefit service company of Go Vap District	14	20	RLR	From 12:00 to 15:00 (50%)	Only from 18:00 and 2:30 to 3:30
10	Public benefit service company of Tan Binh District	11	15	RLR	Not entered	Mainly from 21:00 to 3:30
11	Public benefit service company of Thu Duc District	7	21	RLR	From 12:00 to 14:30 (37%)	Mainly from 18:00 to 2:30 (63%)
12	Public benefit service company of Duc Hoa District	1	2	RLR	Unusually (33%)	Unusually (67%)
13	Vietstar	5	5	Tarpaulin	Frequently (80%)	Only from 18:00 to 19:00
14	Public benefit service company of District 1	7	6	RLR	Not entered	Only from 23:30 to 3:00
15	Public benefit service company of Phu Nhuan District	9	10	RLR	Not entered	Only from 23:30 to 2:30
Note: **RLR**: Rear load refuse truck; **HL**: Hook lifting garbage truck **Tarpaulin:** tarpaulin truck						

Source: *Statistics dated 31/10/2013 and 1/11/2013.*

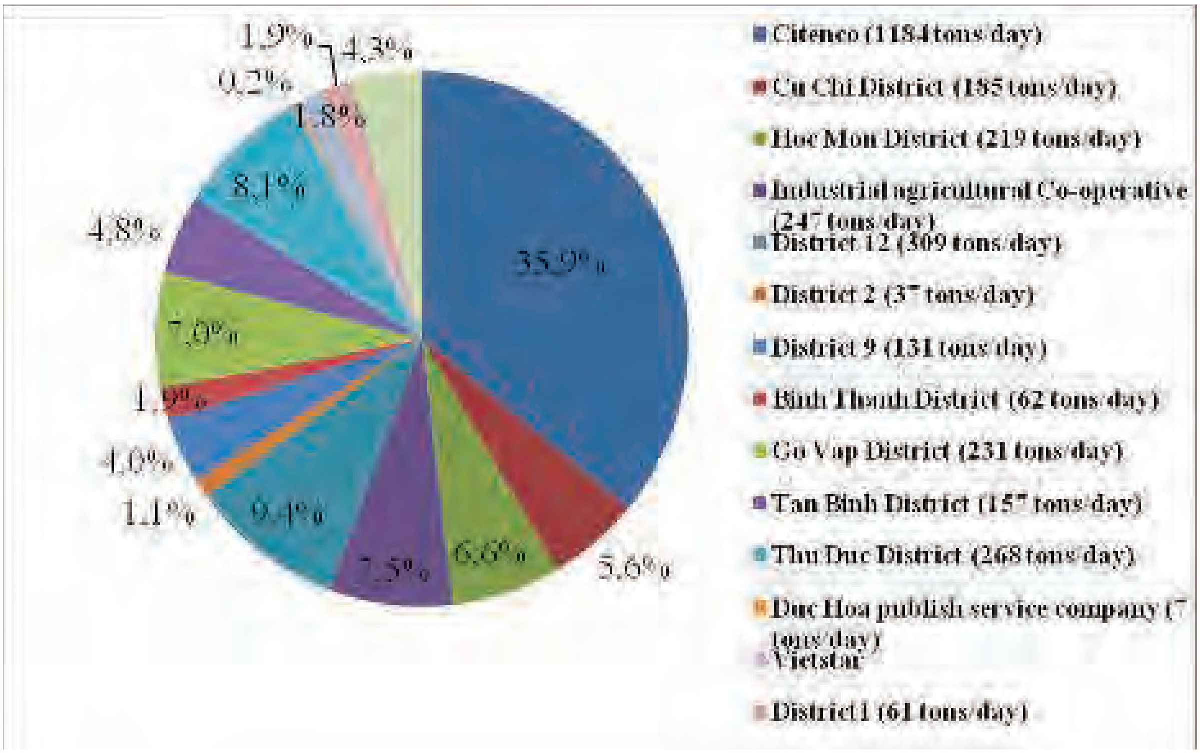


Figure 5 Average quantity of MSW (%) transported by each transport unit into Phuoc Hiep landfill.

Figure 5 shows that among 15 transport units, CITENCO is the major transport unit for MSW to Phuoc Hiep landfill, occupied 35.9% of total MSW quantity, equivalent to 1,184 tons/day.

- After that, there are about 9.4% of total MSW quantity, equivalent to 309 tons/day transported by the public benefit service company of District 12; about 8.1%, equivalent to 268 tons/day transported by the public benefit service company of Thu Duc District. The other transport units, which occupy from 0.2% to 7.5% (equivalent to 7–247 tons/day) of total MSW quantity, are the public benefit service company of districts namely Duc Hoa, Binh Thanh, Phu Nhuan, Tan Binh, Cu Chi, Hoc Mon, Go Vap District, District 2, District 1, District 9; and Industrial agricultural Co-operative.

3. SAMPLING PLAN, SAMPLING METHOD AND ANALYTICAL METHOD

3.1 Sampling plan

4 samples are taken at Phuoc Hiep landfill in two days:

Day 1: 2 samples in daytime

Day 2: 1 sample in daytime and 1 sample in nighttime

3.2 Sampling method

3.2.1 Collection of sample

a. Sampling location will be decided based on work safety and specific samples.

b. The samples are taken from the MSW collection vehicles selected one of ten. At that time number of truck, date, time, transport units, origin of waste are recorded.

c. MSW is discharged from a collection vehicle into the pile. In the pile, four sampling points are randomly selected , and 20 kg of MSW is collected from each of the four points. In total, 80 kg of sample is collected from one vehicle.

d. Procedure c. is repeated four times. Final weight of samples will be approximately 300 kg .

3.2.2 Preparation of sample

a. Solid wastes after sampling are cut into pieces smaller than 15 cm by shovels and scissors. Bags and its contents should also be cut into smaller pieces. Similarly, bulky wastes such as cardboards and branch of trees are also cut into pieces smaller than 15cm.
Each sample is then mixed manually by shovels. The sample should be mixed as homogeneous as possible.

b. The mixed sample is then divided and taken twice a quarter to obtain a smaller sample. By the way, the final sample, which is one-four of the initial sample, is analyzed. An illustration is presented as follows:

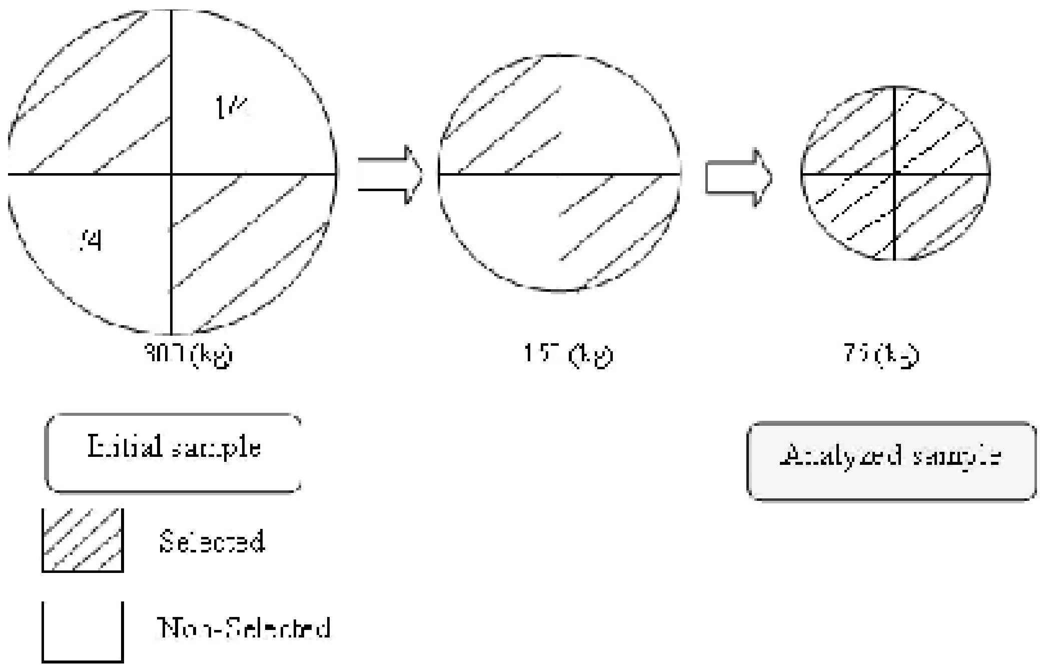


Figure 6 Sampling method

3.3 Analytical method

3.3.1 Measurement of bulk density

a. The prepared sample in 3.2.2 is used.

b. Plastic container with capacity of 80 L is used. The capacity (V_o) and weight (W_o) of the container should be measured beforehand.

c. The sample is then filled into the container . It should be noted that the sample should not be pushed in the container.

d. The container is lifted by hand and dropped in an upright position from the height of about 30 cm. If the volume of the sample in the container should decrease as a result, more samples are added to the container (to the same level as in Procedure c.).

e. Procedure d. is repeated three times. Then the weight of the container containing the sample (W_1) is measured.

f. Bulk density is calculated as follows.

$$\text{Bulk density (kg/L = t/m}^3\text{)} = \frac{W_1(kg) - W_0(kg)}{V_0(L)}$$

3.3.2 Composition of samples

a. The raw samples are prepared as described in 3.2.2

b. The samples are spread on lining at sorting area for separation.

c. The raw samples are physically separated into the following eleven composition.

1-Food wastes (meat, vegetable, etc.), ***2***-Paper, ***3***-Diaper, ***4***- Plastic, ***5***-Textile, ***6***-Wood, ***7***-Rubber and leather, ***8***-Metal, ***9***-Inorganic waste (coal ash, brick, glass…),***10***-Shell, ***11***- Others such as very small pieces that cannot be classified by visual observation.

d. Each composition (Xi) is weighted and the total weight (X) of all composition will be calculated. Each physical composition is calculated according to the following formula:

$$\text{Physical composition } x_i(\text{ \%, wet weight basis}) = \frac{X_i(\text{kg, wet weight basis})}{X(\text{kg, wet weight basis})} \times 100$$

$$\text{Physical composition } x_i(\text{ \%, dry weight basis}) = \frac{\text{Dried weight of each component (kg)}}{\text{Total dried weight of components (kg)}} \times 100$$

3.3.3 Moisture content

a. Moisture content of each composition is determined individually according to APHA 2540 G (2012).

b. Each composition is cut into pieces of 2 to 3 cm and individually spread in metal container with 20 cm diameter (height of wastes should be less than 10cm in the container if possible).

c. After that, the wastes are dried at 105 degrees Celsius by conductive heating for 4 to 5 days or until the constant weight obtained.

d. Finally, moisture content of each composition will be calculated according to a difference between weight of wet sample and dried sample.

3.3.4 VS, ash and gross calorific value

08 combustible samples (food waste, paper, textile, wood, plastic, rubber & leather, diaper and others) are cut into pieces less than 1cm for analysis of VS and ash content. They will be combusted at 550 degrees Celsius according to APHA 2540 G (2012).

08 combustible samples (food waste, paper, textile, wood, plastic, rubber & leather, diaper and others) are cut into pieces less than 1cm and then crushed into pieces smaller than 2mm for analysis of gross calorific value according to TCVN 200-2007 (ISO 1928:1995).

The analytical method of solid waste is presented in Table 7.

Table 7. Analytical method of solid waste

No.	Parameter	Analytical method	Analytical Instrument
1	Moisture	APHA 2540 G	WTB Binder, Germany, Mettler Toledo MS204 balance, Switzerland
2	VS and Ash	APHA 2540 G	Nabertherm oven, Mettler Toledo MS204 balance, Switzerland
3	Gross calorific value	TCVN 200 -2011 (ISO 1928:2009)	IKA calorimeter C 4000

4. ANALYTICAL RESULTS OF PHUOC HIEP MSW

4.1 Information of Phuoc Hiep MSW samples

The Phuoc Hiep MSW samples were taken in two days as follows:

- October 31st, 2013 from 12:00 to 18:30: in rainy season - Sample quantity: 2 samples

- November 1st, 2013 from 16:30 to 22:00: in rainy season - Sample quantity: 2 samples

However, there was no rain at the sampling time on these days.

Specific information of Phuoc Hiep MSW samples is presented in Table 8 below:

Table 8 Information of Phuoc Hiep MSW samples

Sample No.	Vehicle registration number	Time	Transport unit	MSW source	Vehicle colour/ Type	Quantity of MSW taken (kg)	Quantity of MSW analyzed (kg)
31/11/2013							
1	51E-01682	12h25	Public benefit service company of Cu Chi District	Cu Chi District	Blue/ Rear load refuse Truck	298	100
	51C-26104	12h45	CITENCO	Thu Duc District	Green/ Hooklift Truck		
	57K-0963	13h20	Industrial-Agricultural Co-operative	Binh Tan District	Green/ Rear load refuse Truck		
	57H-8406	13h50	Industrial-Agricultural Co-operative	District 11	Blue/ Rear load refuse Truck		
2	51C-18567	14h20	Public benefit service company of Hoc Mon District	Hoc Mon District	Green/ Rear load refuse Truck	312	74
	51C-06741	14h55	Public benefit service company of District 12	District 12	Green/ Hooklift Truck		
	51C-01347	16h00	Public benefit service company of District 2	District 2	White/ Rear load refuse Truck		
	51C-09852	16h35	CITENCO	Go Vap District	Green/ Rear load refuse Truck		
01/11/2013							

Sample No.	Vehicle registration number	Time	Transport unit	MSW source	Vehicle colour/ Type	Quantity of MSW taken (kg)	Quantity of MSW analyzed (kg)
3	51C-16512	16h40	Public benefit service company of Go Vap District	Go Vap District	Green/ Rear load refuse Truck	303	64
	51C-09993	17h20	CITENCO	Quang Trung Transfer station	Green/ Hooklift Truck		
	51E-02443	17h40	Public benefit service company of Thu Duc District	Thu Duc District	Green/ Rear load refuse Truck		
	57K-0902	17h50	Public benefit service company of District 9	District 9	Green/ Rear load refuse Truck		
4	62 L-5502	18h	Public benefit service company of Duc Hoa District	Duc Hoa Town- Long An Provine	Red-White/ Rear load refuse Truck	300.5	64
	51C-26084	18h25	Public benefit service company of Binh Thanh District	Binh Thanh District	Organe/ Rear load refuse Truck		
	51C-09994	19h45	CITENCO – Factory No.1	Quang Trung Transfer station	Green/ Hooklift Truck		
	51C- 10460	19h40	CITENCO – Factory No.2	Tong Van Tran Transfer station	Green/ Hooklift Truck		

4.2 Physical composition of Phuoc Hiep MSW

The average percentage of MSW by wet weight and dry weight in Phuoc Hiep landfill is presented in Figure 6 and 7. The results are summarized as follows:

- Food waste of MSW in Phuoc Hiep landfill is observed with the highest percentage but lower than the previous value determined. According to food waste data of CENTEMA (2002) and Phuoc Hiep MSW report in February, 2013, the average percentage of food waste is decreased from 74.1% to 68.6% and is currently 61.3% by wet weight.

- Plastic has the second highest percentage after food waste. According to plastic data of CENTEMA (2002), the plastic percentage fluctuates from 5.6% to 7.4% by wet weight. In the Phuoc Hiep MSW report in February, 2013, the average percentage of plastic was about 16.4% and is currently 19.6% by wet weight.

- Textile and diaper have the percentage insignificantly higher than the previous value determined. Particularly, the textile percentage is increased from 5.8% (Phuoc Hiep MSW Report in February, 2013) to 6.8% (existing value) by wet weight. Textile includes small pieces of fabric generated mainly from the private companies. The diaper percentage is increased from 3.2% to 4.2% due to convenient and diversified production process.

- Paper, inorganic, others, wood, rubber and leather, shell-bone and metal with rather low percentage by wet weight is 2.7%, 2.2%, 1.6%, 1%, 0.7%, 0.6% respectively.

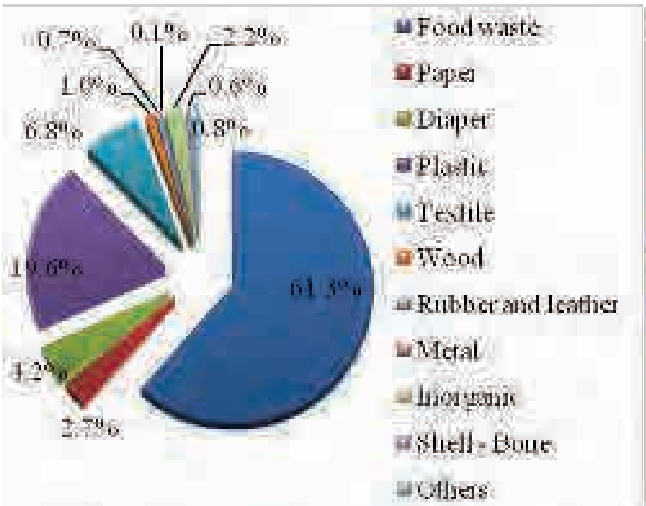


Figure 7 Average percentage of physical compositions (% wet weight) in four samples in October, November 2013.

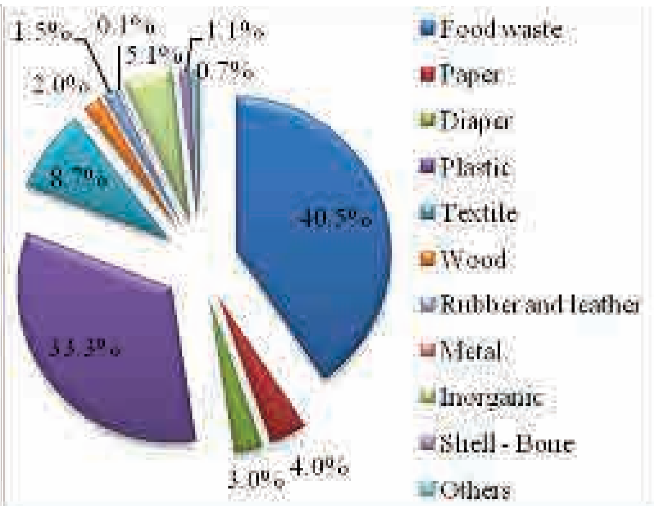


Figure 8 Average percentage of physical compositions (% dry weight) in four samples in October, November 2013.

- For dry weight percentage, some physical compositions of classified waste namely food waste and plastic, which are observed with high percentage, are 40.5% and 33.3% respectively.

- Textile occupies about 8.7% and inorganic matters (glass, coal ash, broken cup, etc.) occupy about 5.1% by dry weight. Paper, diaper occupies about 4.0% and 3.0% respectively and the others occupy from 0.1% to 4% by dry weight.

The percentage of each physical composition (% wet weight) of each sample is presented in Table 9 and Figure 9. Wood, rubber and leather, metal, inorganic matters and shell-bone are observed with low percentage in each sample and with insignificant fluctuation between 2 samples, between this data and previous data of recently report.

Table 9 Average percentage (by wet weight) of each physical composition in four samples (October, November 2013)

No	Composition	Average percentage (% wet weight)			
		Sample 1	Sample 2	Sample 3	Sample 4
1	Food waste	51.6	66.5	66.1	61.2
2	Paper	4.0	0.7	2.3	3.7
3	Diaper	4.7	4.1	5.1	3.0
4	Plastic	21.9	16.6	20.2	19.6
5	Textile	9.7	7.1	3.9	6.7
6	Wood	1.0	1.1	0.3	1.7
7	Rubber and leather	0.4	1.1	0.8	0.3
8	Metal	0.1	0.1	0.1	-
9	Inorganic matter	2.7	2.4	0.9	3.0
10	Shell - Bone	0.9	0.2	0.3	0.8
11	Others	3.0	0.1	-	-

"-" No sample

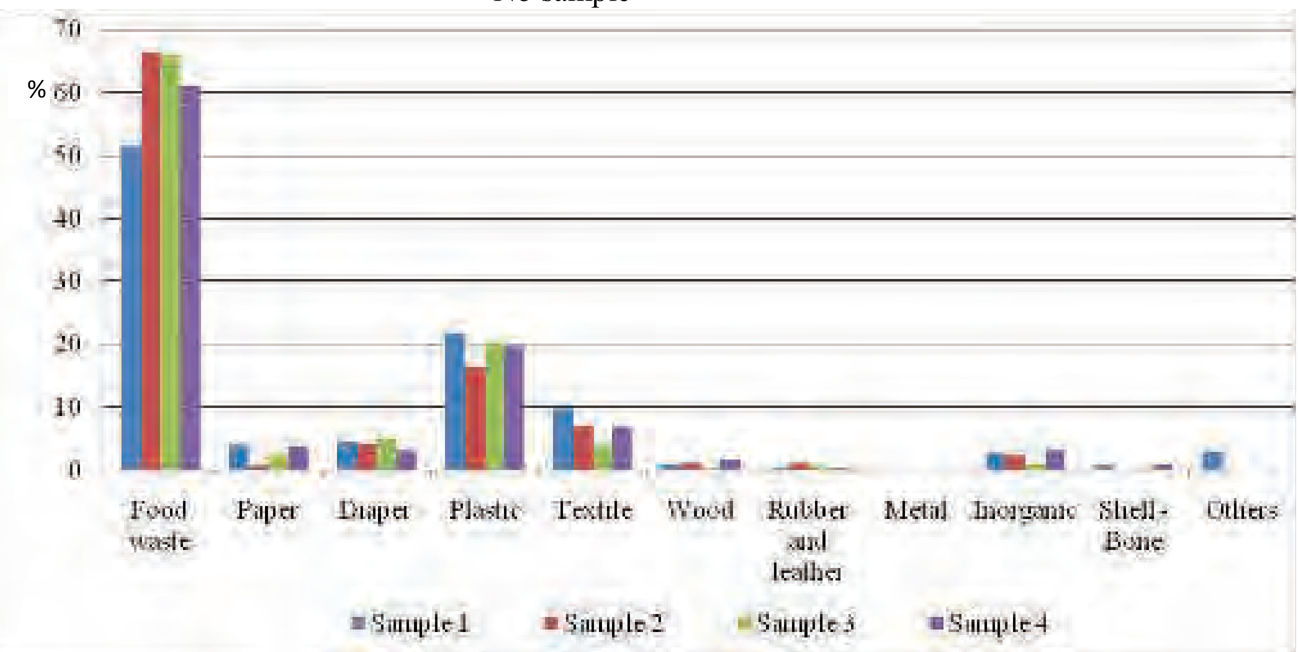


Figure 9 Average percentage (by wet weight) of each physical composition in four samples

4.3 Moisture content, VS and ash

4.3.1 Moisture content

The moisture content of each sample is presented in Table 10, Figure 10 and 11

Table 10 Moisture content of each physical composition in four samples

No	Composition		Moisture content (%)					
		Sample 1	Sample 2	Sample 3	Sample 4	Average (%)	Min	Max
1	Food waste	73.1	68.8	78.5	70.4	72.7	68.8	78.5
2	Paper	30.7	46.8	42.4	39.5	39.9	30.7	46.8
3	Diaper	75.4	78.1	67.3	64.1	71.2	64.1	78.1
4	Plastic	28.5	29.8	32.4	28.7	29.9	28.5	32.4
5	Textile	48.3	53.4	41.3	39.1	45.5	39.1	53.4
6	Wood	12.2	15.9	25.4	20.8	18.6	12.2	25.4
7	Rubber and leather	8.6	4.3	9.6	1.5	6.0	1.5	9.6
8	Metal	1.7	1.1	1.6	-	1.5	1.1	1.7
9	Inorganic matter	4.8	4.7	3.1	1.2	3.5	1.2	4.8
10	Shell - Bone	15.2	13.5	9.3	9.3	11.8	9.3	15.2
11	Others	57.1	1.0	-	-	14.5	0.0	57.1

- Food waste has moisture content in range of 68.8% (sample 2) to 78.5% (sample 3) and 72.7% as average value. The moisture content depends on the composition difference in food waste.
- Similarly, paper has moisture content in range of 30.7% (sample 1) to 46.8% (sample 2) and 39.9% as average value. The moisture content of paper in sample 1 is lower than one in sample 2 because the main compositions of sample 1 namely cartons, cards, newspapers are relative dry while the main compositions of sample 2 is wet tissue, milk box shot.

- Diaper has moisture content in range of 64.1% - 78.1% because of its absorption to water and leachate.

- The moisture content is 28% - 32% for plastic, 9.3% - 15.2% for shell-bone; and from 2% to over 9% for rubber and leather.

- Metal and inorganic matters (brick, coal ash, glass, etc.), which have low moisture content due to their physical characteristics, are 1.1% - 1.7% and 1.2% - 4.8% respectively.

- The different compositions of others in these samples make the different moisture content. Specifically, the others of sample 1 is garden waste such as grass, leaves, branches and one of sample 2 is batteries, so the moisture content is about 57.1% and 1% respectively.

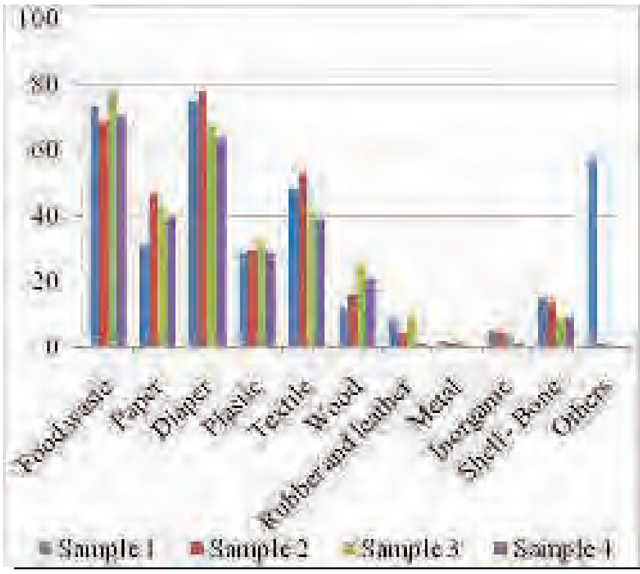


Figure 10 Moisture content (%) of each physical composition in four samples.

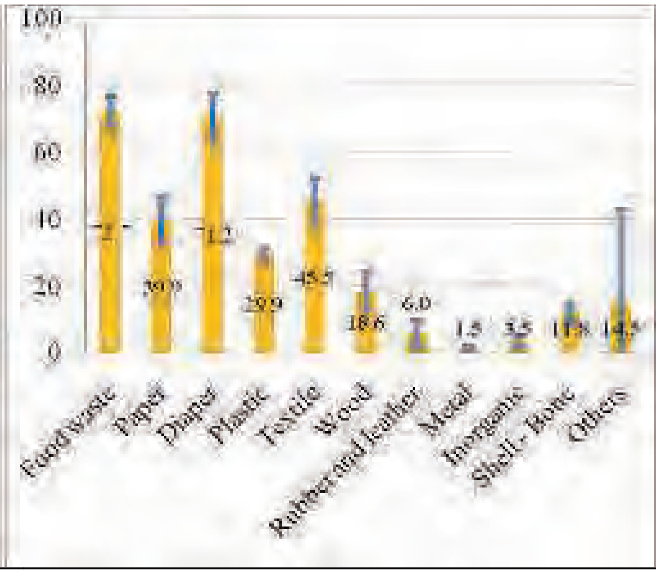


Figure 11 Average moisture content of each physical composition.

4.3.2 VS and Ash

The results of VS and ash of each sample are shown from Figure 12 to Figure 15. Ash content of metal, inorganic matter and shell is not analyzed and estimated by 100% dry weight.

- The ash content of food waste ranges from 17.7% (sample 1) to 25.6% (sample 4) by dry weight. In sample 4, the ash content is higher than other samples due to wet food waste attached with sand.

- The ash content of rubber and leather is 19.5% in average by dry weight. The ash content of rubber and leather in sample 3 and sample 4, which is significantly different, is 8.3% and 27.3% by wet weight respectively. The main reason is the difference in their compositions. Specifically, a soft rubber like a glove is observed in sample 4. On the other hand, a hard rubber like belts, shoes is observed in sample 3.

- The ash content of paper is approximately 17.6% in average by dry weight. The ash content of the other compositions is approximately 10% in average including plastic (12.4%), wood (11%), diaper (10.5%) and textile (9.7%).

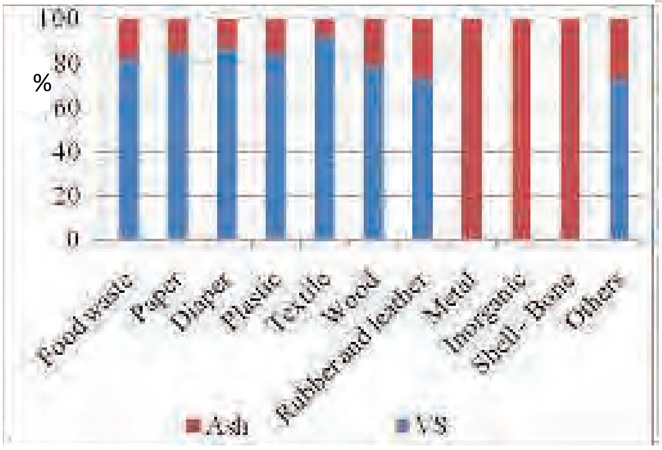


Figure 12 Ash and VS by dry weight (%) of each physical composition in sample 1

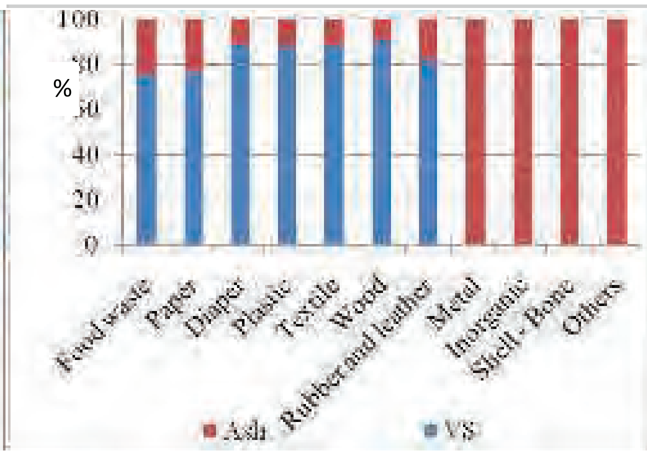


Figure 13 Ash and VS by dry weight (%) of each physical composition in sample 2

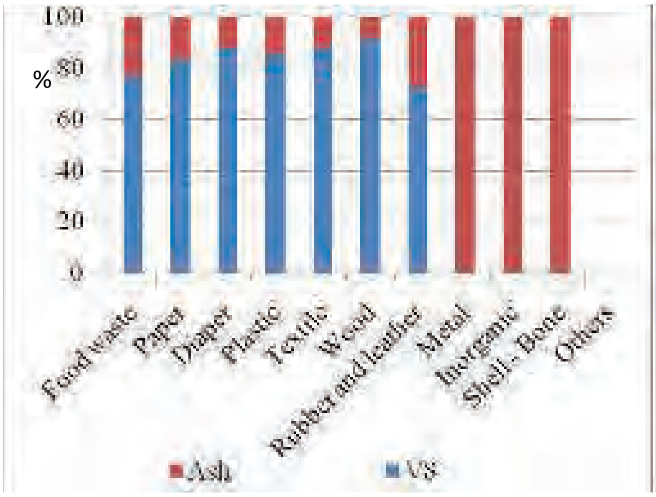


Figure 14 Ash and VS by dry weight (%) of each physical composition in sample 3

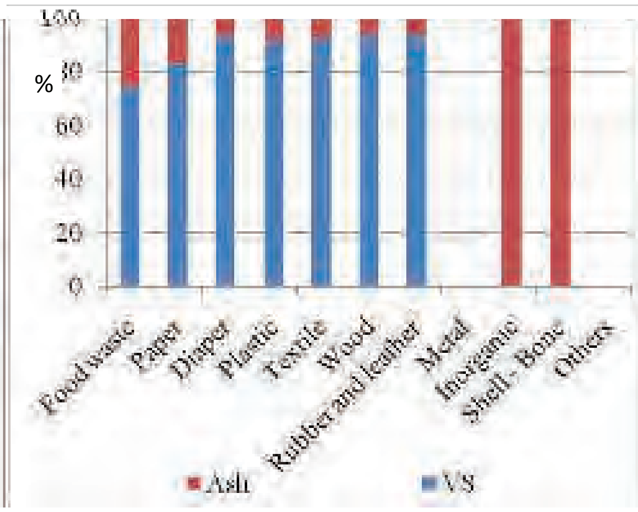


Figure 15 Ash and VS by dry weight (%) of each physical composition in sample 4

The VS and ash content by dry weight and wet weight are presented in Table 11 and Table 12.

Table 11 VS values by dry weight and wet weight of each physical composition in four samples (October, November 2013)

No	Composition	VS by dry weight (%)			VS by wet weight (%) Calculated		
		Average	Min	Max	Average	Min	Max
1	Food waste	77.3	74.4	82.3	12.9	10.9	15.6
2	Paper	82.4	77.7	85.6	1.4	0.3	2.4
3	Diaper	89.5	87.3	93.3	1.1	0.8	1.5
4	Plastic	87.6	84.8	91.8	12.0	10.3	13.3
5	Textile	90.3	88.5	92.5	3.3	2.0	4.6

6	Wood	89.1	79.4	93.9	0.8	0.2	1.3
7	Rubber and leather	80.5	72.7	93.7	0.5	0.3	0.9
8	Metal	0.0	0.0	0.0	-	-	-
9	Inorganic matter	0.0	0.0	0.0	-	-	-
10	Shell - Bone	0.0	0.0	0.0	-	-	-
11	Others	36.5	0.0	73.0	0.9	0.9	0.9

"-" Not analyzed

Table 12 Ash content by dry weight and wet weight of each physical composition in four samples (October, November 2013)

No	Composition	Ash by dry weight (%)			Ash by wet weight (%) Calculated		
		Average	Min	Max	Average	Min	Max
1	Food waste	22.7	17.7	25.6	3.9	2.5	5.1
2	Paper	17.6	14.4	22.3	0.3	0.1	0.4
3	Diaper	10.5	6.7	12.7	0.1	0.1	0.2
4	Plastic	12.4	8.2	15.2	1.7	1.1	2.4
5	Textile	9.7	7.5	11.5	0.3	0.3	0.4
6	Wood	11.0	6.1	20.6	0.1	0.0	0.2
7	Rubber and leather	19.5	6.3	27.3	0.1	0.0	0.2
8	Metal	100	100	100	0.1	0.1	0.1
9	Inorganic matter	100	100	100	2.2	0.9	3.0
10	Shell - Bone	100	100	100	0.5	0.2	0.8
11	Others	63.5	27	100	0.2	0.1	0.3

The average values of ash content and VS by dry weight and wet weight are shown in Figure 16 - Figure 19.

- As shown in Figure 16, the average VS value of 8 out of 11 compositions (excluding metal, inorganic matter and shell-bone) are high in range of 77.3% – 90.3% and 36.5% for others.

- VS of wood fluctuates considerably from 79.4% (sample 1) to 93.6% (sample 4). In sample 1 there is a part of broken wood desk, very heavy and hard, but in sample 4, there is only plywood.

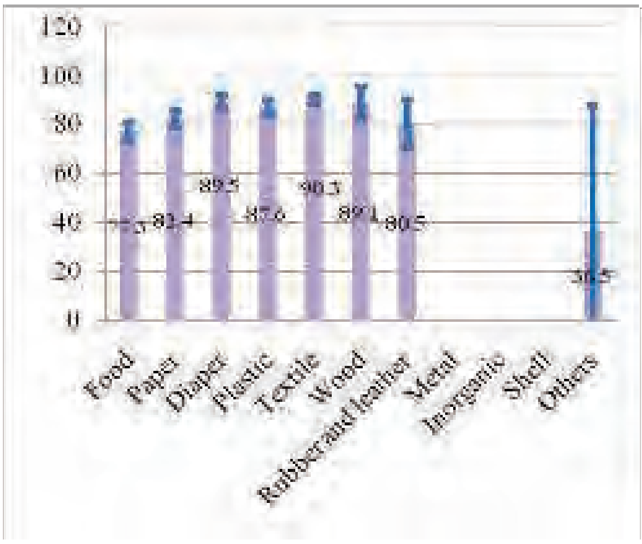


Figure 16 Average value of VS by dry weight of each physical composition

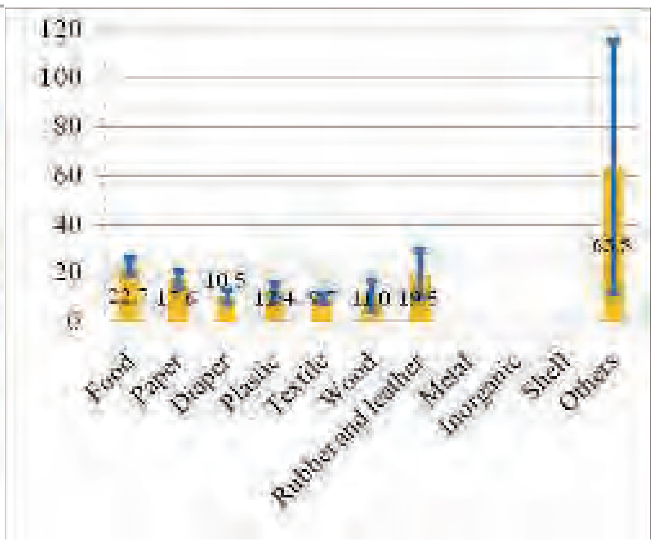


Figure 17 Average value of ash content by dry weight of each physical composition

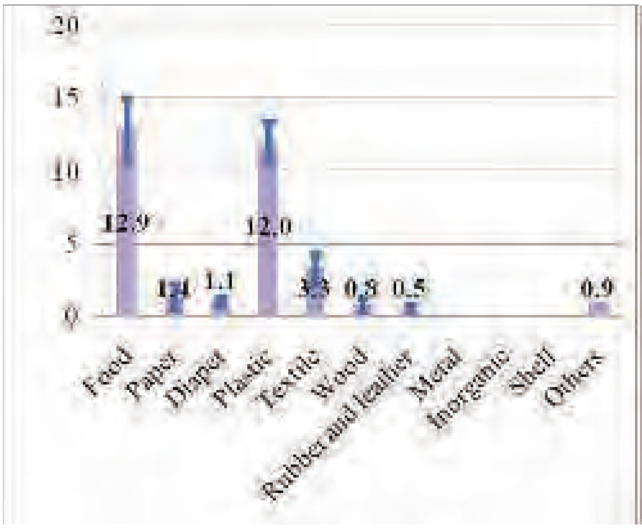


Figure 18 Average value of VS by wet weight of each physical composition

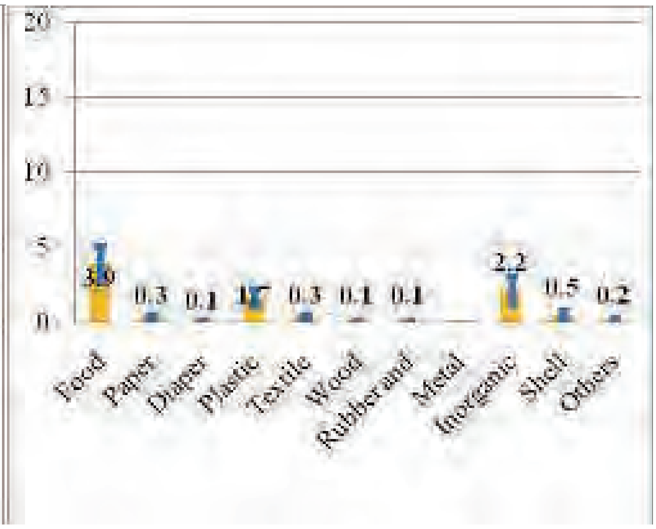


Figure 19 Average value of ash content by wet weight of each physical composition

4.4 Correlation of moisture content, VS and ash

4.4.1 Correlation of moisture content, VS and ash of each composition by wet weight.

The correlation of moisture content, VS and ash of each composition is shown in Figure 20 - Figure 23.

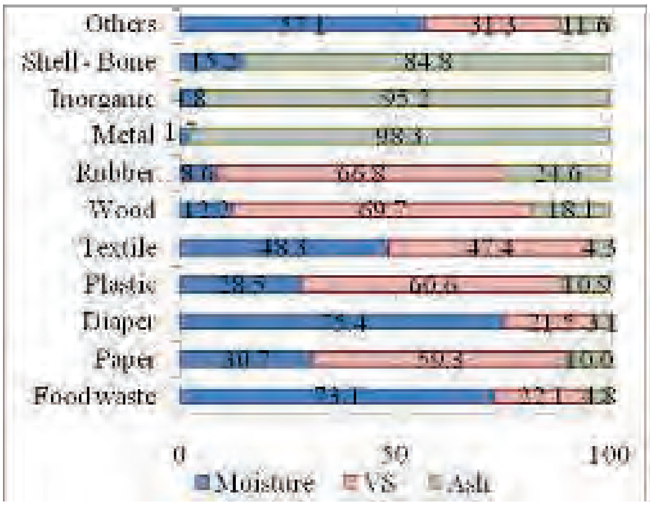


Figure 20 Correlation of moisture content, VS and ash of each physical composition in sample 1

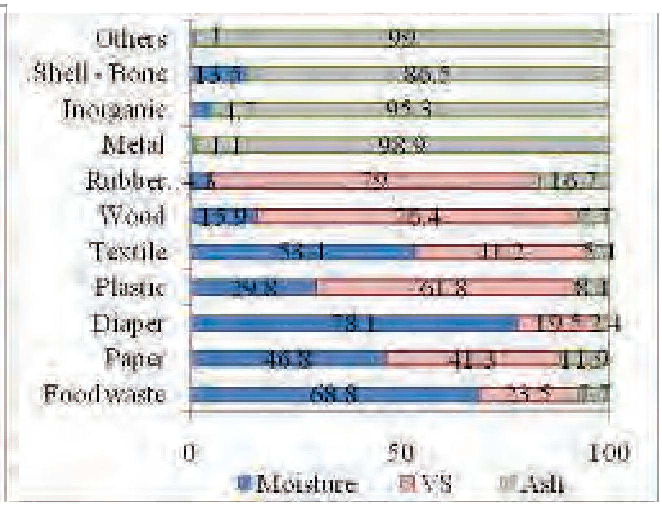


Figure 21 Correlation of moisture content, VS and ash of each physical composition in sample 2

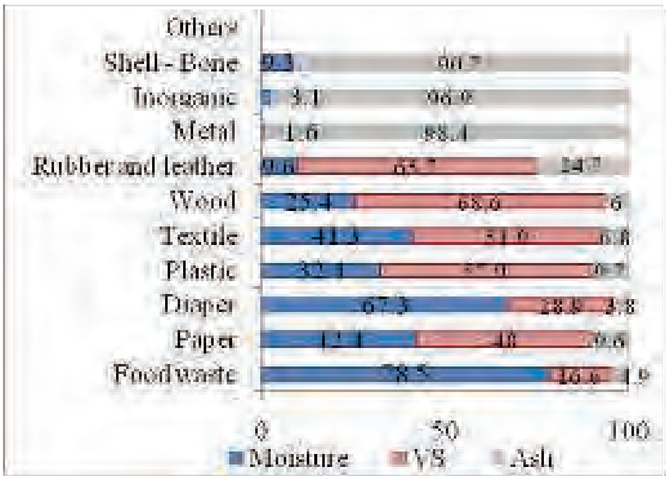


Figure 22 Correlation of moisture content, VS and ash of each physical composition in sample 3

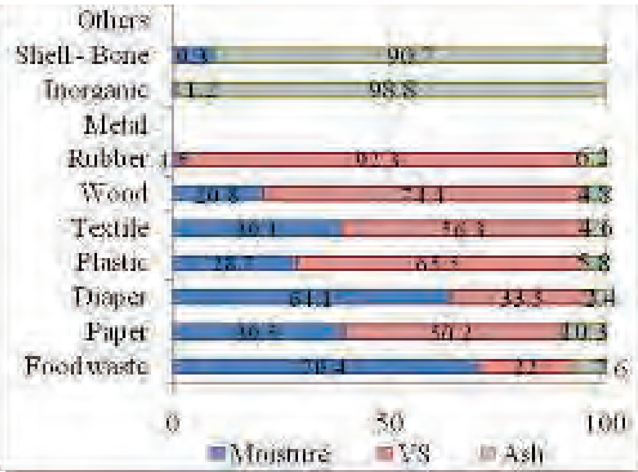


Figure 23 Correlation of moisture content, VS and ash of each physical composition in sample 4

As shown in above figures, the correlation of moisture content, VS and ash of each composition is based on its natural characteristics.

- Food waste has the highest percentage among physical compositions with moisture content of 68.8% -78.5%, VS of 16.6% - 23.5% and ash content of 4.8% - 7.7% by wet weight;

- After that, the second place is plastic with moisture content of 28.5% - 32.4%, VS of 57.9% - 65.5% and ash content of 5.8% - 9.7% by wet weight;

- The moisture content, VS and ash content of diaper is observed about 64.1 % - 78.1%, 19.5% - 28.9% and 3.4% - 2.4% respectively;

- The moisture and ash content of shell-bone is in range of 9.3% - 15.2% and 84.8% - 90.7% respectively;

- The moisture and ash content of metal is in range of 1.1% - 1.6% and 98.3% - 98.9% respectively. The moisture and ash content of inorganic matter is in range of 1.2% - 4.7%, 95.2% - 98.8% respectively.

4.4.2 Correlation of moisture content, VS and ash of each sample by wet weight

The percentage of moisture, VS and ash by wet weight in original sample is shown under bar chart in Figure 24 – Figure 27 below. Specifically, the moisture content, VS and ash content of this sample is in range of 55.1% - 64.7%, 27.9% - 34.6% and 7.4% - 10.3% by wet weight respectively.

As shown in Figures below, the moisture content, VS and ash values of sample 3 is significantly different from one of the other samples. Specifically, the moisture content of sample 1, 2, 4 fluctuates from 55% to 58% while one of sample 3 is approximately 65%. Furthermore, the ash content is observed with the lowest value of 7% in sample 3 and nearly 10% in the other samples.

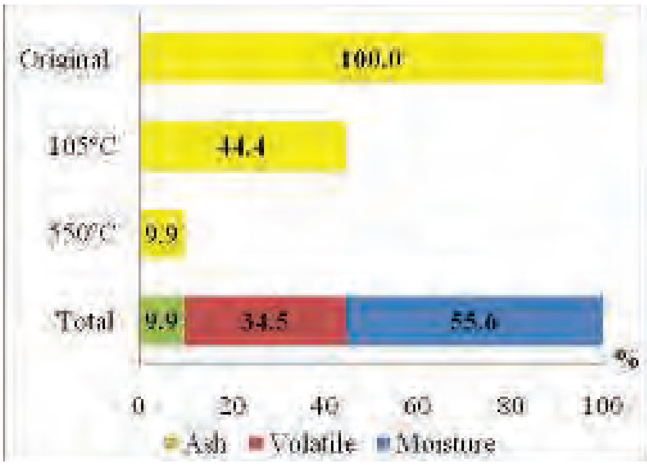


Figure 24 Correlation of moisture content, VS and ash values by wet weight in sample 1

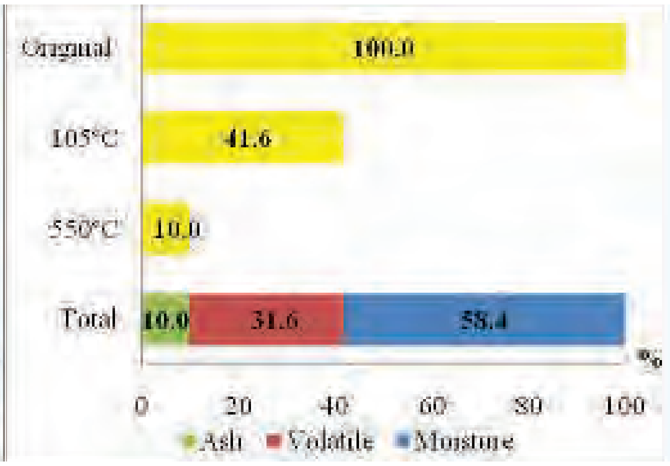


Figure 25 Correlation of moisture content, VS and ash values by wet weight in sample 2

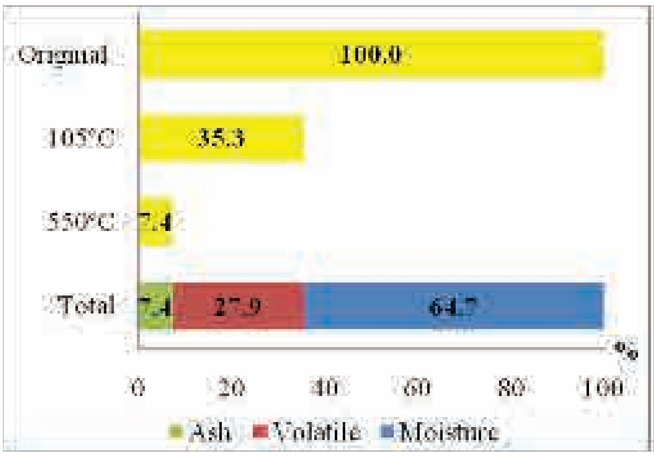


Figure 26 Correlation of moisture content, VS and ash values by wet weight in sample 3

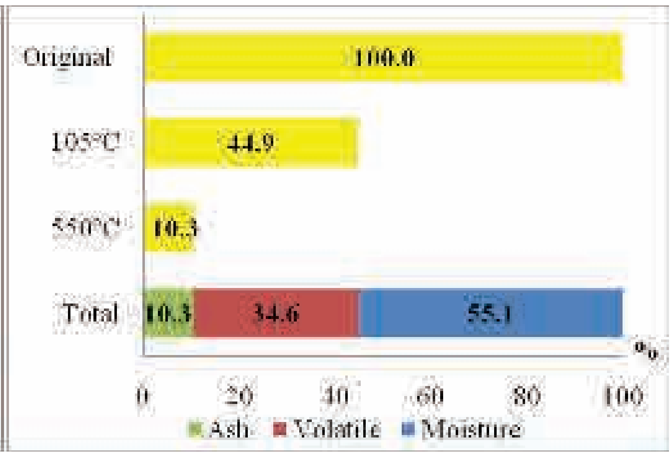


Figure 27 Correlation moisture content, VS and ash values by wet weight in sample 4

4.5 GROSS CALORIFIC VALUE

The gross calorific values of general samples are presented in Table 13, Figure 28 and 29.

Table 13 Gross calorific values by dry weight of each physical composition in four samples (October, November 2013)

No.	Composition	Gross Calorific Value (Cal/g)						
		Sample 1	Sample 2	Sample 3	Sample 4	Average	Min	Max
1	Food waste	4,222	3,549	4,033	3,656	3,865	3,549	4,222
2	Paper	4,466	4,479	5,156	3,592	4,423	3,592	5,156
3	Diaper	4,889	4,504	4,320	4,616	4,582	4,320	4,889
4	Plastic	7,633	7,930	8,259	8,980	8,201	7,633	8,980
5	Textile	5,301	4,898	4,445	4,985	4,907	4,445	5,301
6	Wood	4,607	4,056	-	3,798	4,154	-	4,607
7	Rubber and leather	-	7,325	4,825	-	6,075	-	7,325
8	Metal	-	-	-	-	-	-	-
9	Inorganic	-	-	-	-	-	-	-
10	Shell - Bone	-	-	-	-	-	-	-
11	Others	3,917	-	-	-	3,917	3,917	3,917

- Food waste, wood, plastic have a significant fluctuation of gross calorific value. Specifically, food waste has gross calorific value in range of 3,549 cal/g to over 4,200 cal/g.

- Plastic is observed with the highest gross calorific value ranging from 7,633 cal/g (sample 1) to 8,980cal/g (sample 4). The plastic in sample 1 is mostly hard plastic, but in sample 4 is color plastic. The gross calorific value of hard plastic is lower than one of colored plastic bag.

- The gross calorific value of paper, diaper and textile is in range of 3,592 – 5,156 cal/g; 4,320 – 4,889 cal/g; 4,445 to 5,301 Cal/g respectively.

- For others in sample 1 (mainly garden waste including leaves, braches, grass, etc.), the gross calorific value is 3,917 cal/g.

- As calculated results of HCV and LCV, the HCV and LCV of four samples fluctuates in range of 1,978 cal/g - 2,318 cal/g and 1,629 cal/g – 2,018 cal/g respectively.

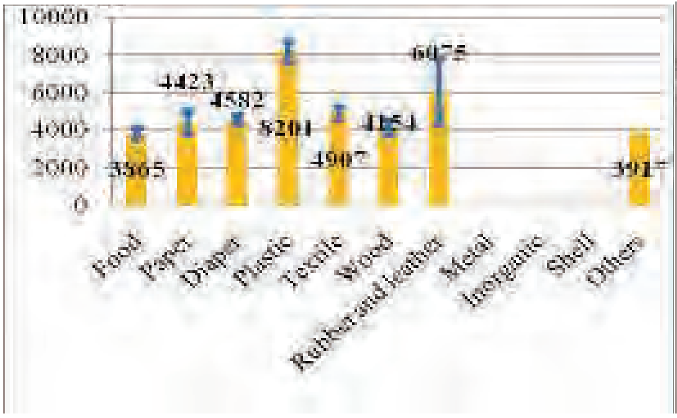


Figure 28 Average gross calorific value of each physical composition

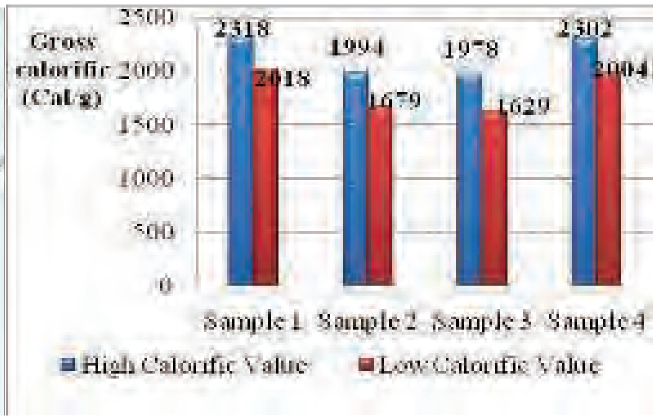


Figure 29 Gross calorific values (HCV and LCV) of four samples

APPENDIX 1

FORMULA

1. Correlation of moisture, VS and ash by wet weight of each composition:

Moisture content of each composition (%) + Ash (% ww) + Volatile (% ww) = 100

Ash (% ww) $= \frac{(100 - \text{MCEC } (\%)) \times \text{ash } (\% \text{ dw})}{100}$

Volatile (% ww)$= \frac{(100 - \text{MCEC } (\%)) \times \text{volatile } (\% \text{ dw})}{100}$

2. Correlation of moisture, VS and ash by wet weight of each sample:

Moisture content (%) + Ash (% ww) + Volatile (% ww) = 100

Moisture content (%) $= \Sigma \frac{\text{PCEC } (\% \text{ ww basis}) \times \text{MCEC } (\%)}{100}$

Ash(% ww) $= \Sigma \frac{\text{SFEC } (\%) \times \text{ash } (\% \text{ dw})}{100}$

Volatile(% ww) $= \Sigma \frac{\text{SFEC } (\%) \times \text{volatile } (\% \text{ dw})}{100}$

3. High calorific value – HCV and Low calorific value – LCV of each sample:

HCV (cal/g) $= \Sigma \frac{\text{Gross Calorific of composition} \times \text{SFEC } (\%)}{100}$

LCV (cal/g) = HCV (cal/g) – $\frac{540 \times \text{Moisture content } (\%)}{100}$

Conversion formula: 1 cal/g = 4.187 J/g

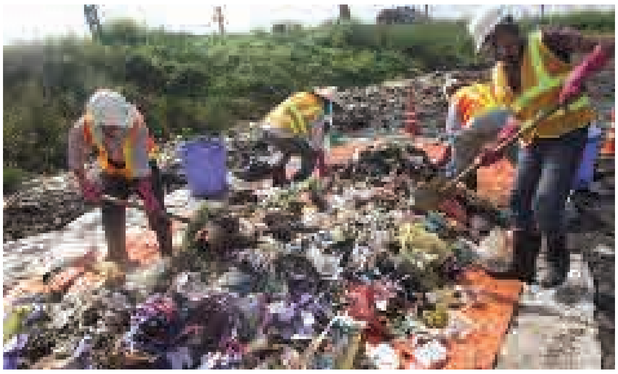
Solid fraction of each composition (%) $= \Sigma \frac{\text{PCEC } (\% \text{ ww basis}) \times (100 - \text{MCEC } (\%))}{100}$

❖ ***Note:***

- *MCEC: Moisture content of each composition*
- *PCEC: Physical composition of each composition*
- *SFEC: Solid fraction of each composition*

APPENDIX 2

FIGURE OF SAMPLING AND CLASSIFICATION MSW AT TRANSFERRING FLOOR OF PHUOC HIEP LANDFILL



PRETREATMENT MSW SAMPLE FOR ANALYSIS AT ETM CENTER

APPENDIX 3

FIGURE OF MSW SAMPLE BEFORE MOISTURE ANALYSIS

Sample 1

Sample 2

Sample 3

Sample 4

APPENDIX 4

FIGURE OF MSW SAMPLE AFTER MOISTURE ANALYSIS (DRIED AT 105°C)

Sample 1 **Sample 2**

Sample 3 **Sample 4**

APENDIX 5

FIGURE OF PHUOC HIEP SAMPLE AFTER ANALYSIS VOLATILE AND ASH (IGNITED AT 550°C)

Sample 1

Sample 2

Sample 3

Sample 4

APPENDIX 6- THE RAW DATA

Sample 1

No.	Composition	Analyzing result						Calculated result				
		Bulk density (kg/l)	Physical composition (% ww)	Physical composition (% dw)	Moisture content (%)	Ash, at 550^{o}C (%)	Gross Calorific (Cal/g) (% dw)	Moisture content (%)	Total Ash (% ww)	Toal VS (% ww)	High Gross Calorific Value (Cal/g) (% ww)	Low Gross Calorific Value (Cal/g) (% ww)
1	Food waste	0.33	51.6	31.2	73.1	17.7	4222	37.7	2.5	11.4	586	382
2	Paper		4.0	6.2	30.7	14.4	4466	1.2	0.4	2.4	124	117
3	Diaper		4.7	2.6	75.4	12.7	4889	3.5	0.1	1.0	57	37
4	Plastic		21.9	35.3	28.5	15.2	7633	6.2	2.4	13.3	1195	1162
5	Textile		9.7	11.3	48.3	8.4	5301	4.7	0.4	4.6	266	241
6	Wood		1.0	2.0	12.2	20.6	4607	0.1	0.2	0.7	40	40
7	Rubber and leather		0.4	0.8	8.6	26.9	-	-	0.1	0.3	-	-
8	Metal		0.1	0.2	1.7	-	-	-	0.1	-	-	-
9	Inorganic (Brick,coal ash, broken cup)		2.7	5.8	4.8	-	-	0.1	2.6	-	-	-
10	Shell-Bone		0.9	1.7	15.2	-	-	0.1	0.8	-	-	-
11	Others (garden waste: grass, branch, leaves)		3.0	2.9	57.1	27.0	3917	1.7	0.3	0.9	50	41

Sample 2

No.	Composition	Analyzing result						Calculated result				
		Bulk density (kg/l)	Physical composition (% ww)	Physical composition (% dw)	Moisture content (%)	Ash, at 550^{o}C (%)	Gross Calorific (Cal/g) (% dw)	Moisture content (%)	Total Ash (% ww)	Toal VS (% ww)	High Gross Calorific Value (Cal/g) (% ww)	Low Gross Calorific Value (Cal/g) (% ww)
1	Food waste	0.33	66.5	50.0	68.8	24.6	3549	45.8	5.1	15.6	736	490
2	Paper		0.7	0.9	46.8	22.3	4479	0.3	0.1	0.3	17	15
3	Diaper		4.1	2.2	78.1	10.9	4504	3.2	0.1	0.8	40	23
4	Plastic		16.6	28.1	29.8	12.0	7930	4.9	1.4	10.3	924	897
5	Textile		7.1	7.9	53.4	11.5	4898	3.8	0.4	2.9	162	142
6	Wood		1.1	2.2	15.9	9.1	4056	0.2	0.1	0.8	38	37
7	Rubber and leather		1.1	2.6	4.3	17.5	7325	-	0.2	0.9	77	77
8	Metal		0.1	0.1	1.1	-	-	-	0.1	-	-	-
9	Inorganic (Brick,coal ash, broken cup)		2.4	5.4	4.7	-	-	0.1	2.3	-	-	-
10	Shell-Bone		0.2	0.5	13.5	-	-	-	0.2	-	-	-
11	Others (garden waste: grass, branch, leaves)		0.1	0.1	1.0	-	-	0.0	0.1	-	-	-

Sample 3

No.	Composition	Analyzing result						Calculated result				
		Bulk density (kg/l)	Physical composition (% ww)	Physical composition (% dw)	Moisture content (%)	Ash, at 550^oC (%)	Gross Calorific (Cal/g) (% dw)	Moisture content (%)	Total Ash (% ww)	Toal VS (% ww)	High Gross Calorific Value (Cal/g) (% ww)	Low Gross Calorific Value (Cal/g) (% ww)
1	Food waste	0.35	66.1	40.2	78.5	23.0	4033	51.9	3.3	10.9	573	293
2	Paper		2.3	3.8	42.4	16.7	5156	1.0	0.2	1.1	68	63
3	Diaper		5.1	4.7	67.3	11.6	4320	3.4	0.2	1.5	72	54
4	Plastic		20.2	38.6	32.4	14.3	8259	6.5	2.0	11.7	1128	1092
5	Textile		3.9	6.5	41.3	11.5	4445	1.6	0.3	2.0	102	93
6	Wood		0.3	0.7	25.4	8.0	-	0.1	0.0	0.2	-	-
7	Rubber and leather		0.8	2	9.6	27.3	4825	0.1	0.2	0.5	35	35
8	Metal		0.1	0.1	1.6	-	-	0.0	0.1	-	-	-
9	Inorganic (Brick,coal ash, broken cup)		0.9	2.6	3.1	-	-	0.0	0.9	-	-	-
10	Shell-Bone		0.3	0.8	9.3	-	-	0.0	0.3	-	-	-
11	Others (garden waste: grass, branch, leaves)		-	-	-	-	-	-	-	-	-	-

Sample 4

No.	Composition	Analyzing result						Calculated result				
		Bulk density (kg/l)	Physical composition (% ww)	Physical composition (% dw)	Moisture content (%)	Ash, at 550°C (%)	Gross Calorific (Cal/g) (% dw)	Moisture content (%)	Total Ash (% ww)	Toal VS (% ww)	High Gross Calorific Value (Cal/g) (% ww)	Low Gross Calorific Value (Cal/g) (% ww)
1	Food waste	0.31	61.2	40.4	70.4	25.6	3656	43.1	4.6	13.5	662	430
2	Paper		3.7	5.0	39.5	17.0	3592	1.5	0.4	1.9	80	73
3	Diaper		3.0	2.5	64.1	6.7	4616	1.9	0.1	1.0	50	39
4	Plastic		19.6	31.2	28.7	8.2	8980	5.6	1.1	12.8	1255	1225
5	Textile		6.7	9.1	39.1	7.5	4985	2.6	0.3	3.8	203	189
6	Wood		1.7	3.0	20.8	6.1	3798	0.4	0.1	1.3	51	49
7	Rubber and leather		0.3	0.6	1.5	6.3	-	0.0	0.0	0.3	-	-
8	Metal		-	-	-	-	-	-	-	-	-	-
9	Inorganic (Brick,coal ash, broken cup)		3.0	6.7	1.2	-	-	0.0	3.0	-	-	-
10	Shell-Bone		0.8	1.5	9.3	-	-	0.1	0.7	-	-	-
11	Others (garden waste: grass, branch, leaves)		-	-	-	-	-	-	-	-	-	-

CALCULATED SAMPLE RESULT OF MOISTURE, ASH, GROSS CALORIFIC, HIGH GROSS CALORIFIC AND LOW GROSS CALORIFIC

No.Sample	1	2	3	4
Total Moisture	55.6	58.4	64.7	55.2
Total Ash (%ww)	9.9	10.0	7.4	10.3
Total VS (%ww)	34.6	31.6	28.0	34.5
High Gross Calorific	2318	2018	2318	2018
Low Gross Calorific	1994	1679	1994	1679

No	Composition	Total moisture (%)				Total Ash (%ww)				Total VS (%ww)			
		1	2	3	4	1	2	3	4	1	2	3	4
1	Food waste	37.7	45.8	51.9	43.1	2.5	5.1	3.3	4.6	11.4	15.6	10.9	13.5
2	Paper	1.2	0.3	1.0	1.5	0.4	0.1	0.2	0.4	2.4	0.3	1.1	1.9
3	Diaper	3.5	3.2	3.4	1.9	0.1	0.1	0.2	0.1	1.0	0.8	1.5	1.0
4	Plastic	6.2	4.9	6.5	5.6	2.4	1.4	2.0	1.1	13.3	10.3	11.7	12.8
5	Textile	4.7	3.8	1.6	2.6	0.4	0.4	0.3	0.3	4.6	2.9	2.0	3.8
6	Wood	0.1	0.2	0.1	0.4	0.2	0.1	0.0	0.1	0.7	0.8	0.2	1.3
7	Rubber and leather	0.0	0.0	0.1	0.0	0.1	0.2	0.2	0.0	0.3	0.9	0.5	0.3
8	Metal	0.0	0.0	0.0	-	0.1	0.1	0.1	-	-	-	-	-
9	Inorganic	0.1	0.1	0.0	0.0	2.6	2.3	0.9	3.0	-	-	-	-
10	Shell - Bone	0.1	0.0	0.0	0.1	0.8	0.2	0.3	0.7	-	-	-	-
11	Others	1.7	0.0	0.0	-	0.3	0.1	-	-	0.9	-	-	-
Total		**55.6**	**58.4**	**64.7**	**55.2**	**9.9**	**10.0**	**7.4**	**10.3**	**34.6**	**31.6**	**28.0**	**34.5**

APPENDIX 7

DIAGRAM OF PHUOC HIEP LANDFILL