2-3 IDENTIFICATION OF SOURCES OF SOLID WASTE SUITABLE FOR INCINERATION AND VIABLE AMOUNTS OF MUNICIPAL SOLID WASTE FOR PHUOC HIEP LANDFILL, GO CAT LANDFILL AND DONG THANH LANDFILL

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Report 1

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APHA	American Public Health Association
B.O.D	Board of directors
BTNMT	Department of natural Resources and Environment
DONRE	Department of natural Resources and Environment
DPIWMF	Da Phuoc Integrated Waste Management Facility
DW	Dry weight
EM	Effective Microganisms
EPA	Environmental Protect Agency
ETM	Center for Environmental Technology and Management
GHV	Gross heating value
HCMC	Ho Chi Minh City
HDPE	High Density Polyethylene
HHV	Higher heating value
HW	hazardous waste
ISWTZ	Integrated Solid Waste Treatment Zone
LFG	Landfill gas
LHV	Lower heating value
MSW	Municipal solid waste
SW	Solid waste
TCVN	Vietnam Standards
VS	Volatile solid
WW	Wet weight

1. GENERAL INTRODUCTION

1.1 Phuoc Hiep Landfill

1.1.1 Location

The Phuoc Hiep Landfill that is located in the Integrated Solid Waste Treatment Zone (hereinafter called as ISWTZ) in Northwest of HCMC in Tam Tan Hamlet, Phuoc Hiep Commune, Cu Chi District is about 50km far from the central City in the Northwest and about 5km far from the central Cu Chi District in the Southwest. This area that has relatively flat terrain in the low-lying area of Cu Chi district, has many artificial and natural canals. The Phuoc Hiep Landfill has the landmarks as follows:

- In the East and North: border on the planned areas in the ISWTZ in Northwest of HCMC and existing melaleuca forest;
- In the Northwest: border on canal No. 16;
- In the Southwest: border on Thay Cai canal;
- In the Southeast: border on canal No. 15.

The area around the landfill has a thin population density that is mainly concentrated along the asphalt road run parallel with Thay Cai canal (towards the Provincial Road No. 8).

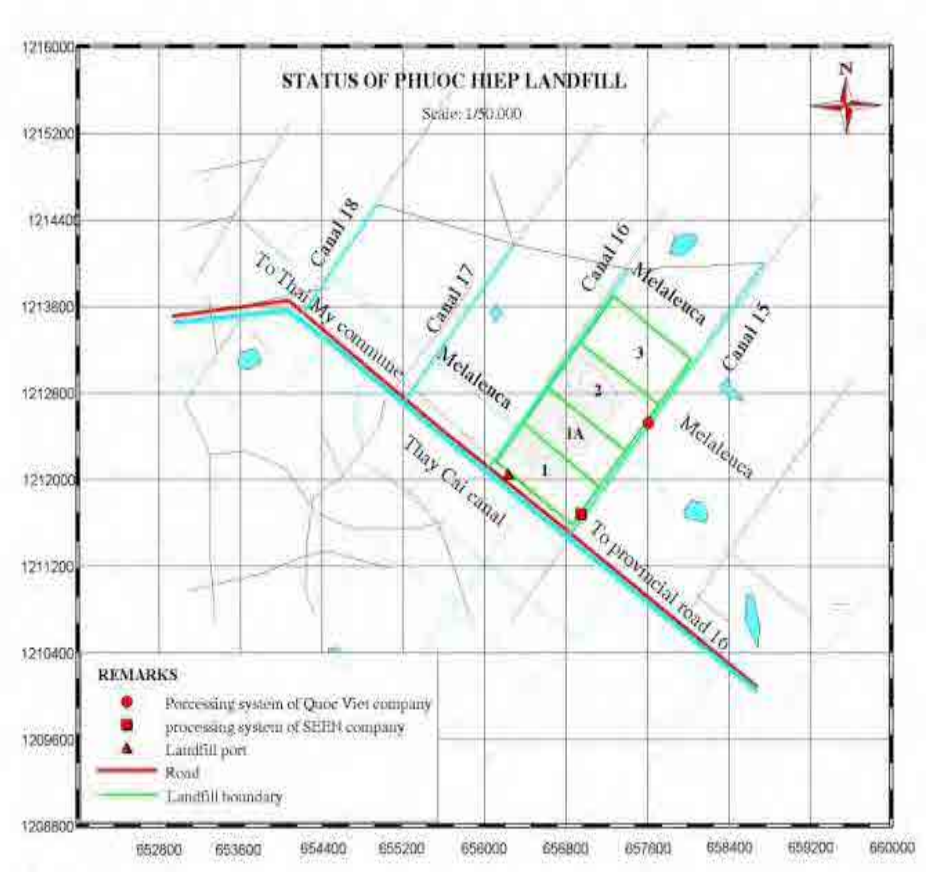

Figure 1. Current master layout of Phuoc Hiep Landfill. (**Source**: ETM, 2012)

1.1.2 Scale

The Phuoc Hiep Landfill consists of the landfills as follows:

- Phuoc Hiep Landfill No. 1, No. 1A and Landfill No. 2: they are currently stopped their operation;
- Phuoc Hiep Landfill No. 3 has just been both constructing and receiving the MSW and is going to be closured.

The Phuoc Hiep Landfill No. 1 had been officially operated from January 2003 to at the end of 2007 with a total area of landfill cells of about 18.993ha and an average receiving capacity of about 3,000 tons/day.

The Phuoc Hiep Landfill No. 1A had been operated from February 2007 to February 2008 with a total area of landfill cells of about 9.75ha and a design capacity of about 3,000 tons/day.

The Phuoc Hiep Landfill No. 2 had been operated since February 2008 with a total area of landfill cells of about 19.5ha and a receiving capacity of about 3,500 tons/day. The Phuoc Hiep Landfill No. 2 is connected with the Phuoc Hiep Landfill No. 1A to utilize the enclosure wall of the Phuoc Hiep Landfill No. 1A. A part of the Phuoc Hiep Landfill No. 2 that borders on the Phuoc Hiep Landfill No. 1A will be utilized to bury the MSW in order to increase the receiving capacity. The Phuoc Hiep Landfill No. 2 had been operated until at the end of 2013, then it has stopped to receive the MSW. At this time, the MSW had so been buried in the landfill No. 3. The leachate that is generated from the Phuoc Hiep Landfill is now partly stored in reservoirs and partly treated by the Quoc Viet Environmental Protection and Technological Science Company (with a treatment capacity of 1,000 m^3/day) and the SEEN Technologies Corporation (with a treatment capacity of 800 m^3/day).

The Phuoc Hiep Landfill No. 3 is designed in a total area of 15ha with a design capacity of 2,000 – 2,500 tons/day. At present, the HCMC's PC gave a notice in writing No. 475/TB-VP dated 17/6/2014 about the closure of the Phuoc Hiep Landfill No. 3. Accordingly, the CITENCO is responsible for making the plan of closuring the Phuoc Hiep No. 3. After the Landfill No. 3 is stopped its operation, the total amount of MSW received by the Landfill No. 3 will be transferred to the Da Phuoc Integrated Waste Management Facility (DPIWMF).

The general information of the scale and current master layout of the Phuoc Hiep Landfill is presented in **Table 1** and **Figure 1** respectively.

Table 1. Summary of the Phuoc Hiep Landfill scale

No.	Information	Phuoc Hiep Landfill No. 1	Phuoc Hiep Landfill No. 1A	Phuoc Hiep Landfill No. 2	Phuoc Hiep Landfill No. 3
1	Operation time	1/2003 – 5/2006	2/2007 – 2/2008	2/2008 – at the end of 2013	10/2003 - now
2	Area of each landfill (ha)	18.993	9.75	19.5	15
3	Design capacity (tons/day)	3,000	3,000	1,500 – 2,500	2,000 – 2,500
4	Practically average receiving capacity (tons/day)	3,000	3,000	2,500 – 3,000	-
5	Landfill method	Sanitary	Sanitary	Sanitary	Sanitary
6	Height of landfill cell (m)	25	15 - 17	36	-
7	Depth of landfill bottom (m)	-7	-7	-7	-10

Source: HCMC's DONRE, 2010, 2013.

1.1.3 Operation procedure

The MSW landfill technology in the Phuoc Hiep Landfill is the sanitary landfill technology with full environmental protection works, HDPE (High Density Polyethylene) liner, LFG collection system, leachate collection and treatment system, storm-water collection system. In addition, there are the auxiliary works namely weighing station, vehicle washing floor, dike, other works catering for the management task, etc. The Phuoc Hiep Landfill is operated by the procedure as shown in Figure 2.

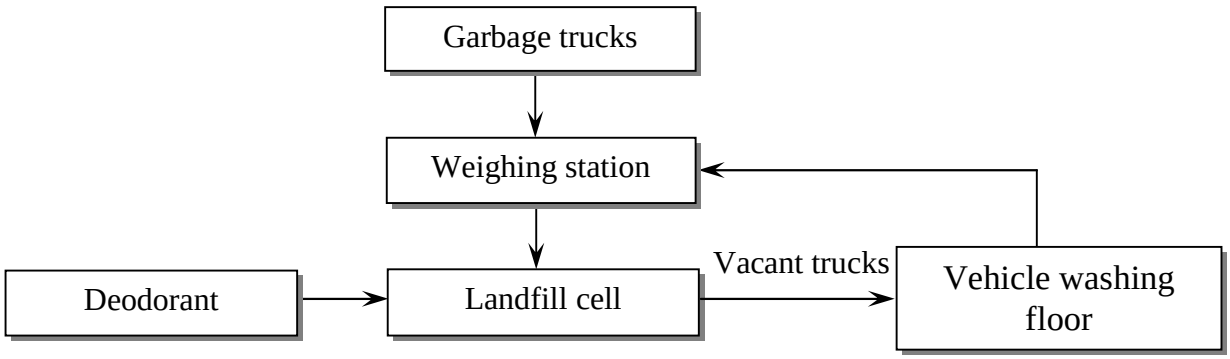

Figure 2. Operation procedure of Phuoc Hiep Landfill. (**Souce**: ETM, 2012)

Phuoc Hiep Landfill No. 1

The Phuoc Hiep Landfill No. 1 has a total landfill area of about 18.996ha that is divided into four cells with 4.74ha/each cell. The maximum height of each cell is 25m. The MSW that is buried into ten layers in each cell with 2.2m/layer (the MSW is smoothly bulldozed by bulldozers and carefully compacted). Each layer is separated by intermediate layer with a thickness of 20cm. The topcoat is a bentonite geotextile waterproofing membrane and a soil layer with a thickness of 30cm below.

The depth of MSW landfill is -7 m below the ground. The liners from the top to the bottom include as follows:

- MSW layer: 10;
- HDPE: 2.2 mm;
- Sand layer: 0.2 m;
- Macadam layer: 2x3 (a thickness of 0.3 m).

The Phuoc Hiep Landfill No. 1A and No. 2 is built with the same liner and topcoat compared to the Phuoc Hiep Landfill No. 1.

Phuoc Hiep Landfill No. 1A

The sanitary landfill technology that is applied in the Phuoc Hiep Landfill No. 1A is similar to the Phuoc Hiep Landfill No. 1. However, the most different point between the Phuoc Hiep Lanfill No. 1A and the other landfills is the design of pile wall. Specifically, the Phuoc Hiep Landfill No. 1A is built with the prestressed piles surrounding the landfill to prevent the subsidence and landslide incidents. The basic parameters of the Phuoc Hiep Landfill No. 1A include as follows:

- Total area of landfill: 9.75ha;
- Number of landfill cells: 2 cells;
- Number of layers in each cell: 7 layers;
- Thickness of daily coat: 0.15 – 0.20m;
- Thickness of coat at the end of day: 0.5 – 0.6m (it could be replaced by canvas);
- Heigh of MSW layer: 2.0 – 2.2 m (or 2.4 – 3.6 m);
- Total height of 7 layers: 15.0 – 17.0m.

Phuoc Hiep Landfill No. 2

When the Phuoc Hiep Landfill No. 2 reaches the intended height, it wiil be connected with the Phuoc Hiep Landfill No. 1A to utilize the enclosure wall of the Phuoc Hiep Landfill No. 1A. A part of the Phuoc Hiep Landfill No. 2 that borders on the Phuoc Hiep

Landfill No. 1A will be utilized to bury the MSW in order to increase the receiving capacity. The basic parameters of the Phuoc Hiep Landfill No. 2 include as follows:

- Total area of landfill: 19.5ha;
- Number of landfill cells: 4 cells;
- Number of layers in each cell: 15 layers;
- Thickness of daily coat: 0.15 – 0.20m;
- Thickness of coat at the end of day: 0.5 – 0.6m (it could be replaced by canvas);
- Heigh of MSW layer: 2.0 – 2.2 m;
- Total height of 15 layers: 36.0 m.

Phuoc Hiep Landfill No. 3

As discussed information and site monitoring, it showed that the Lanfill No. 3 has been operated since October 2013 and has been constructing more some works by the Korean Contractor.

1.2 Go Cat Landfill

1.2.1 Location

The Go Cat Landfill that is built in the land located in Binh Hung Hoa A Commune, Binh Tan District that borders on Hoc Mon District and Binh Tan District. It is about 15km far from the central City in the Northeast. The Go Cat Landfill is located in the highly topographical area to the Northeast of Binh Tan District.

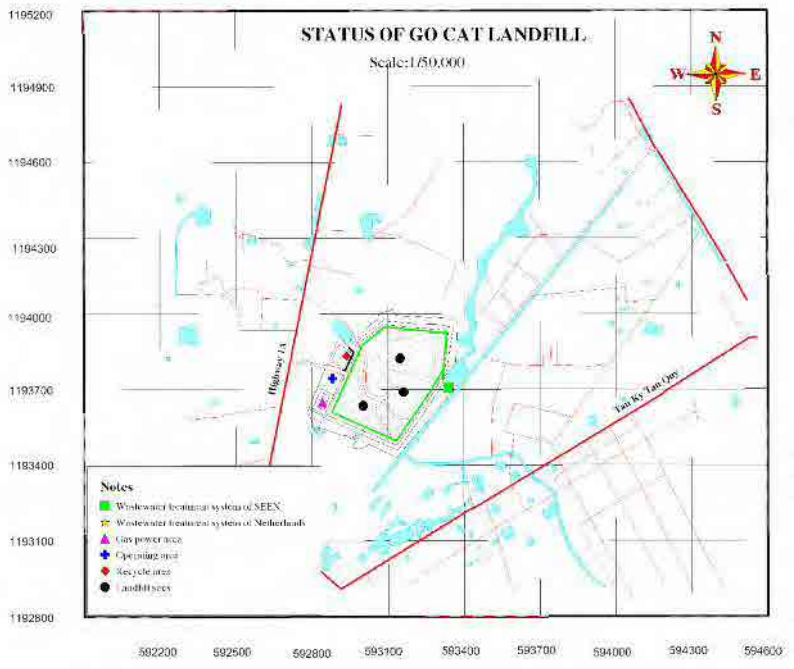

Figure 3. Current master layout of Go Cat Landfill. **(Source:** ETM, 2012)

1.2.2 Scale

The Go Cat Landfill is designed and completely built by the Netherlands modern technique and technology with the waterproofing liner, soil coat and canvas, LFG and leachate collection and treatment system that is firstly installed in this landfill in Vietnam. Total surface area of the Go Cat landfill is 25ha (17.5ha for landfill). As initial design, the Go Cat Landfill had been operated in 2001 and closured in 2005 with a toal treatment capacity of about 2,000 tons/day and design capacity of about 3.65 tons from the beginning to the end of operation (HCMC's DONRE, 2010).

In fact, the Go Cat Landfill had been officially operated on 19/01/2002 and officially closured on 01/08/2007 with a total receiving capacity of 3,000 tons/day and total amount of MSW buried of about 5,000,000 tons (HCMC's DONRE, 2010 and ETM, 2012). The amount of leachate that is generated from the Go Cat Landfill is currently collected and treated by the SEEN Technologies Corporation with a total treatment capacity of 200 m^3/day (a design capacity of 400 m^3/day).

Table 2. Summary of Go Cat Landfill scale

No.	Information	Scale
1	Operation time	19/01/2002 – 01/08/2007
2	Total surface area of Go Cat Landfill	25 ha
3	Total area of landfill	17.5ha
4	Practically receiving capacity	3,000 tons/day
5	Total amount of MSW received in practical	5,000,000 tons
6	Number of landfill cells	5 landfill cells (total area of 17.5ha)
	- Area of landfill cell 1	3.58ha
	- Area of landfill cell 2	3.43ha
	- Area of landfill cell 3	3.58ha
	- Area of landfill cell 4	3.54ha
	- Area of landfill cell 5	3.37ha
7	Height of landfill surface now (above the ground)	In range of +16m - +18.9m(*)
8	Depth of landfill bottom	-7m
9	Leachate reservoir	L x B x H = 20 x 7 x 3.3 (m)
10	Leachate treatment capacity (SEEN)	200 m^3/day

Source: HCMC's DONRE (2010) and ETM (2012).

(*) Practical monitoring result dated 01/10/2014, see **Annex**.

1.2.3 Operation procedure

The Go Cat Landfill is issued with the Invesment Policy that is sponsored in terms of the finance and technology by the Netherlands Government. The Go Cat Landfill is the first

landfill in Vietnam that applied the sanitary landfill technology. The main works that are invested include HDPE liner, wastewater collection and treatment system, biogas collection system to produce the power energy, transfer floor for dedicated equipment, weighing bridge and washing station, a boundary walls in a height of 6m and other works.

The MSW is buried in landfill cell at a depth of -7m below the ground and filled into 9 layers (each layer with a thickness of 2.2m). The intermediate soil layers (8 layers) with a thickness of 0.15m for each layer are filled between the MSW layers. The topcoat with a thickness of 1.3m and the bottom liner with a thickness of 0.5m are also installed. The total height of final landfill cell is about 23m (from 16m to 18.9m higher than the ground, excluding the subsidence in the decomposition process of SW). The topcoat and bottom liner of one landfill cell are structured as follows:

The topcoat has a thickness of 1.3 m including:

- Sand protective layer: 0.25m
- Waterproofing layer: 1.5mm
- Sand layer for water adsorption: 0.25m
- Soil layer: 0.8m.

The bottom liner has a thickness of 0.5m including:

- HDPE waterproofing geomembrane: 2.2mm
- Sand layer: 0.2m
- Leachate collection system
- Macadam layer 2x3, a thickness of 0.3m.

The Go Cat Landfill is operated by the following procedure as shown in **Figure 4**.

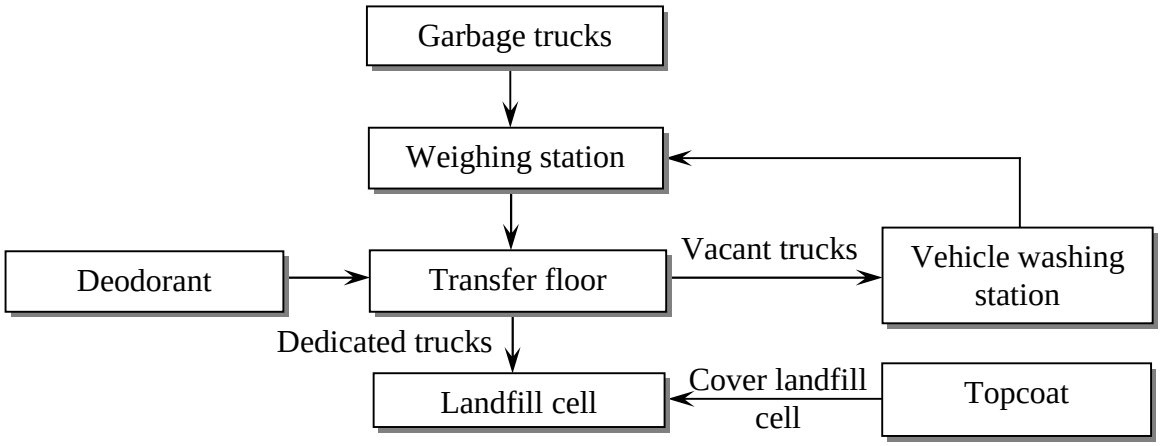

Figure 4 Operation procedure of Go Cat Landfill. **(Source:** ETM, 2012)

The MSW landfill technology in Go Cat Landfill is the sanitary landfill technology with HDPE liner, leachate collection and treatment systeme. Since 2007, Go Cat Landfill has

stopped receving SW, only remaining the activities of SW recycling system, leachate collection and treatment system, biogas collection system to produce the power energy.

1.3 Dong Thanh Lanfill

1.3.1 Location

The Dong Thanh Landfill that is located Hamlet 3, Dong Thanh Commune, Hoc Mon District, HCMC is about 9km far from the central City as the crow flies to the South of Dong Thanh Commune, Hoc Mon District.

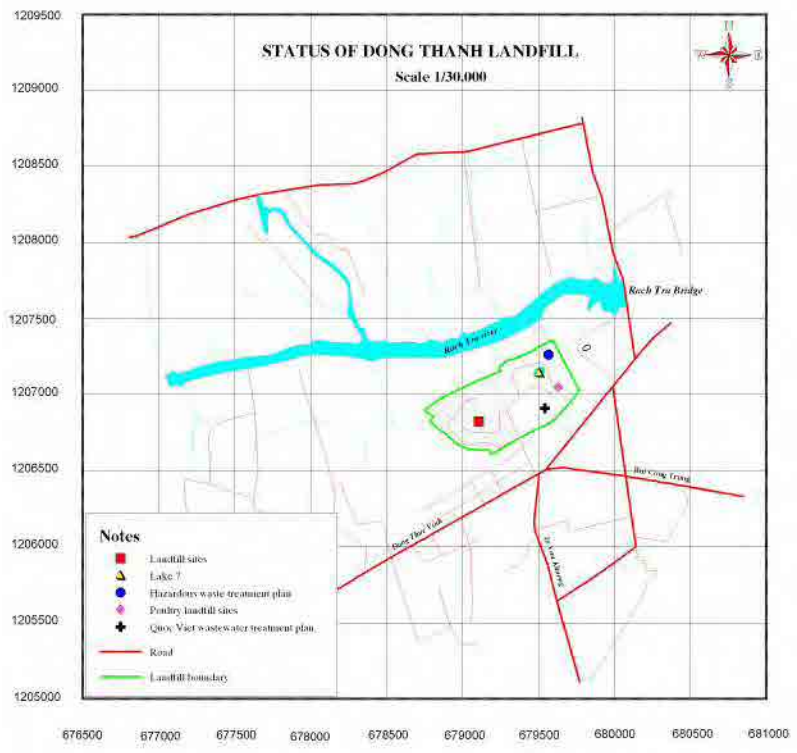

Figure 5. Current master layout of Dong Thanh Landfill. **(Source:** ETM, 2012)

1.3.2 Scale

The Dong Thanh Landfill had started to spontaneously bury the MSW in 1989 (the former area is soil pits exploited). In 1991, the Dong Thanh Lanfill had officially becomed the Dong Thanh waste disposal site with a total initial area of 10 ha. At present, the total area of the Dong Thanh waste disposal site is 43 ha. The MSW receiving capacity of the Dong Thanh Landfill is 3,000 tons/day in average. From 31/12/2002 onwards, the Landfill has stopped receiving the MSW. From 1991 to 2002, the total amount of the MSW that is received in the Dong Thanh Landfill is 10,800,000 tons in practical.

From 2002 to 2006, the Dong Thanh Landfill received the construction SW (debris) with a capacity of 1,000 tons/day. Until 2014, the Dong Thanh Landfill has stopped receving this waste.

In addition, from 2003 to 2004, the Dong Thanh also received the flu poultry delivered by the City Animal Health Department with a capacity of about 100 - 800 tons/day (about 4 days/week).

On the other hand, during the period of the Hoa Binh Septic Tank Treatment Company temporarily stopped its operation to move to the DPIWMF (12/2006 – 03/2008), the Dong Thanh landfill also received the amount of septic tank from the districts with a capacity of about 1,000 – 4,000 tons/day. As site monitoring and discussed with the B.O.D of the Landfill, until 2014, the Dong Thanh Landfill receives no longer the septic tank.

Beside receiving the debris and animal organs, the hazardous waste (HW) treatment plant in HCMC with a total area of 2.7ha that was built in the Dong Thanh Landfill came into the operation with a design capacity of 21 tons/day.

Because the Dong Thanh Landfill is a former spontaneous landfill, it was not installed with a bottom liner, LFG collection and treatment system and leachate collection and treatment system either. Until 2003, the leachate that is generated from the Dong Thanh Landfill was concerned and collected and treated. At the monitoring time (October 2014), the leachate in the Dong Thanh Landfill is collected by the Quoc Viet Environmental Protection and Technological Science Company (hereinafter briefly called as Quoc Viet Company) for treatment (a total area of treatment zone is about 7ha) with a treatment capacity of about 500 - 600 m^3/day (a design capacity of 900 m^3/day).

The scale of the Dong Thanh Landfill is briefly presented in **Table 3**.

Table 3. Summary of Dong Thanh Landfill scale

No.	Information	Scale
1	Operation time	1991-2002
2	Total area of Dong Thanh Landfill	43 ha
3	Receiving capacity of MSW (1991-2002)	3,000 tons/day
4	Total amount of SW received	10,800,000 tons
5	Receiving capacity of debris (2002-2006)	1,000 tons/day
6	Receiving capacity of debris (2006 - now)	100-500 tons/day
7	Receiving capacity of flu poultry (2003-2004)	100-800 tons/day
8	Receiving capacity of animal organs (2004-now)	100 tons/day
9	Receiving capacity of septic tank (received no longer)	1,000 – 4,000 tons/day

No.	Information	Scale
10	Design capacity of HW treatment plant in HCMC	21 tons/day
11	Leachate reservoir	
	Area (ha)	2.4
	Depth of reservoir (m)	25
	Depth of water level (m)	15
12	Treatment capacity of leachate	500 – 600 m^3/day

Source: HCMC's DONRE, 2010 and monitoring result in Dong Thanh Landfill, 2010, 2014.

1.3.3 Operation procedure

The Dong Thanh Landfill that is operated by a traditional method is semi-submersible landfill. It is continously operated and lasted in many years (1991 – 2002) and is mostly used for MSW landfill. The previously spontaneous landfill process made a high slope and very different altitudes in the Dong Thanh Landfill. The MSW landfill cells in the Dong Thanh Landfill are presented in **Table 4**.

Table 4. Summary of landfill cells in Dong Thanh Landfill

Article	Landfill cell 1	Landfill cell 2	Landfill cell 3
Total area (ha)	21.4	9.7	3.78
Receiving capacity (tons /day)	3.000		
Height of landfill cell (m)(above the ground)	+ 32	+ 17.5	+ 11
Depth of landfill cell bottom (m)(below the ground)	- 23	-	-
Bottom liner	No	No	No

Note: *- No information.*
Source: CENTEMA, 2003 and ETM, 2012.

✓ ***MSW landfill procedure***

The MSW is filled and smoothly bulldozed into each layer with a width of 0.6m and compacted by bulldozers before disposing other MSW layer. Each MSW layer with a width of 4m is covered by a clay layer with a width of 0.3m. During the landfill operation process, the deodorant EM (Effective Microganisms) is spayed over the surface of the covering layer at the end of the day to reduce the offensive odors diffused into the ambient air. The leachate is collected by open ditches installed around the landfill cells, then stored in the reservoir at the end of landfill.

✓ ***Debris landfill procedure***

The debris in HCMC is daily collected and transferred to the Dong Thanh Landfill by dedicated trucks. After weighing bridge, the debris is disposed and smoothly bulldozed

under the guidance of the site instructor. As site monitoring dated 05/03/2010, the Dong Thanh Landfill received daily about 100 – 500 tons/day and the debris is diposed above the old MSW layer in the Dong Thanh Landfill.

The debris bulldozing process is based on the status of the area that is selected for debris disposal as follows:

- If the debris is disposed in the subsidence pits due to MSW decomposition, the debris will be filled into each layer in the landfill cells by bulldozer;
- If the debris is disposed in the mud area, the excavator will be used for excavating a little amount of debris pushed away to support the bulldozer;
- If the debris is pile up, the high-capacity bulldozer and excavator will be made the debris piled up.

✓ ***Diseased livestock, poultry landfill procedure***

The Dong Thanh Landfill have two landfill areas for diseased livestock and poultry (ETM, 2012). The landfill procedure of diseased livestock, poultry in the Dong Thanh Landfill is presented in **Figure 8**.

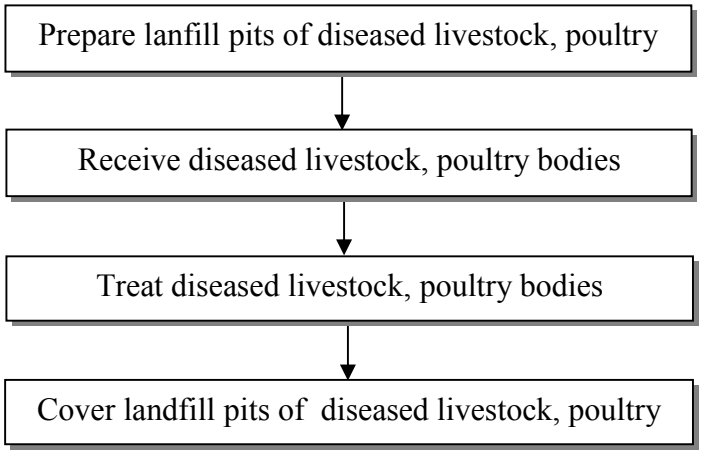

Figure 6. Landfill procedure of livestock and poultry bodies in Dong Thanh Landfill. **(Source:** ETM, 2012)

The preparation of the landfill cells of diseased livestock and poultry bodies in the Dong Thanh Landfill is implemented by the following steps:

- Landfill cells are excavated at a depth of 2.5m, a width of cell bottom of 2m, a width of cell mouth of 3.5 – 4m and a length unlimited (based on the length of HDPE bottom liner);
- Cover powder lime layer at the bottom of the cell with a thickness of at least 5cm and spread around the edge of the cell;
- Cover PE waterproofing sheet around the edge and the bottom of the cell;

- Spread lime above the bottom liner.

The treatment and landfill procedure for diseased livestock and poultry bodies in the Dong Thanh Landfill is implement by the major steps as follows:

- Shred the carcase sacks with a length of at least 0.2 m before discharging into the landfill cells. The operator must wear the protective gloves and clothing;
- Spread lime into each layer between carcase sacks;
- After completely treating the diseased carcase sacks, cover more lime layer above with a thickness of at least 5cm;
- Install vertically the venting pipe with its holes into the landfill cells (each pipe is installed at a distance of about 0.3cm along the length of the landfill cell). The specifications of venting pipe are as follows:
  + Diameter of venting pipe: 42 – 60 mm;
  + Diameter of hole around the venting pipe: 10 – 15 mm;
  + Total area of holes: 15 - 20% (of total pipe surface area);
  + Minimum length of the venting pipe: 1m.

The covering task in the landfill cells of diseased carcases in the Dong Thanh Landfill is implemented by the following steps:

- Cover the soil layer with a width of at least 0.6. The soil layer could be decomposed compost mixed with husk ash or wood ash, rice husk, straw. EM-Bokashi is mixed with husk ash or wood ash, rice husk, straw. The amount of EM Bokashi is used about 10% of the amount of soil layer;
- Cover the soil layer with straw of dried coconut leaves above with a thickness of at least 0.2m. When it starts to rain, the canvas is covered to prevent the storm-water runoff into the cells. The subsidence in the landfill cells is daily controlled. If the subsidence of the topsoil layer is over 0.2 m, the soil must be added with a thickness as same as the initial thickness.
- Cover the edge of the cells with a thickness of at least 0.2m to prevent the storm-water runoff. The soil is added with a ratio of horizontal slope and vertical slope = 3 : 1.

✓ **Septic tank treatment procedure**

The septic tank is treated in the area of 0.096 ha that includes 24 cells with an area of 96 m^3 for each cell (length x width x depth = 10m x 4m x 2.4m). The septic tank landfill cell is structured by the layers from the bottom to the top namely stone layer 4 x 6 and leachate collection pipe with a diameter of Φ60 installed, stone layer 1 x 2, sand layer and geomembrane.

2. IDENTIFICATION OF COMBUSTIBLE SOLID WASTE

2.1 Overview of SW treatment technology by incineration method

The SW is treated by thermal method where the SW is transformed from solid state to gaseous, liquid and ash state by using the heat as well as the energy is released as heat.

The incineration technology is the treatment process where the solid or liquid organic wastes will be transformed into gaseous state. The gaseous wastes will be heated through combustion net to reach a certain temperature so that the organic compounds are decomposed into the elements. The elements will combine with the oxygen into the persistent gases that will be released into the ambient air after emission treatment system.

By the incineration technology, the volume of SW is significantly reduced about 80 – 90%. The incineration process could produce the energy by heat exchange of gases produced at high temperature.

The incineration process is operated by the following principle:

- Temperature: it is necessary to ensure that the temperature is enough high for the reaction happend more quickly and completely without dioxin produced and maximum treatment efficiency reached (expected temperature for MSW > 900 °C). If the temperature is too high, the gas flow-rate is generated too much affecting the gas retention time in the secondary chamber. It means that the contact between the gases and the air is reduced and a large amount of of black smoke and the high concentration pollutants such as CO, THC are also observed in the emissions. If the temperature is not high enough, the reaction will not be completely occurred, so the black smoke is also observed in the emissions.
- Mixture: in orde to strengthen the efficiency of contacting between the burned SW and oxidants, the shield is installed the chamber with a suitable slope between the air flow and spray nozzle to enhance the mixing. The mixture could be assessed by the mixed factors.
- Time: the combustion retention time is long enough for the reaction to be thoroughly happened. The time must be made sure so that the SW could be thoroughly burned depending on the burned SW and combustion temperature.

The products after combustion are slag and ash containing the hazardous wastes in the SW components. The percentage of the SW residue after combustion is based on each SW type (including incombustible and combustible components) and a design of the incinerator (a heating capacity of each incinerator). In addition, the emissions generated

from the incinerator that are the above-mentioned emissions could cause harm to the environment and public health (EPA, 2004).

Status of applying the incineration technology for SW treatment

For SW treatment, the landfill technology has mainly been applied. The technology has some advantages such as simple operation, not high low investment and operation cost, etc. but there are many potential risks to the surrounding environment. In addition, the shortcomings of the landfill management task is also a reason causing the environmental pollution (soil, surface water, groundwater, air), the landfill technology also wastes the natural soil resource, etc. Some other treatment technologies that were researched and applied are SW incineration, SW compression, building material production, microbiological fertilizer production, SW reuse and recycling.

In foreign countries

The MSW treatment methods are mainly landfill, microbiological fertilizer production, energy recycling, reuse and recovery. In comparison with other treatment methods, the incineration method is applied with high recovery of the energy as well as a little amount of soil resources wasted, so this method is applied to many foreign countries, especially the soil and energy resources are more and more reduced. In the Europe and Japan, the MSW is basically treated by incineration method that is currently becoming a new trend of MSW treatment in China.

In 2010, there were up to 77% of MSW in China that were treated by landfill method, 20% by incineration method and only 3% by composting method. As "The National Plan for the Construction of facilities for Treatment of Urban Household Waste in a Non-hazardous Way under the 12th Five-Year Plan of China", it showed that China will increase up to 35% the amount of SW treated by incineration method, up to 6% the amount of SW treated by composting method. It means that the amount of SW that is treated by landfill method is reduced to 59%[1].

As S.Kusch et al. 2011, in the European countries, the application of incineration method for SW treatment is tending to be increased together with the method of reuse, recycling and compost production while the landfill method is gradually reduced. In particular, the total amount of MSW treated by the incineration method that occupied about 15 – 17% and tended to be increased from 1997 to 2009, treated by the landfill method that was reduced from 65% in 1997 to about 40% in 2009 and kept reducing in the following years. The countries namely Denmark, France, Germany, Sweden and Switzerland have

[1] The National Plan for the Construction of facilities for Treatment of Urban Household Waste in a Non-hazardous Way under the 12th Five-Year Plan of China

applied the incineration method for SW treatment in combination with the energy recovery that will be also the forthcoming trend of SW treatment in these countries. Specifically, in Germany, from 2007 to 2009, the MSW landfill method had been absolutely removed, the incineration method in combination with the energy recovery for the SW treatment had been increased from 20% in 1997 to over 30% in the period of 2006 – 2009. Until 2009, there were totally 449 factories of SW treatment by the incineration method that has been operated in over 20 western and central European countries (excluding the HW treatment factories) (Department for Environment Food & Rural Affairs, 2013).

The trend of SW treatment by incineration method was also applied in the United Kingdom with about 15.1% of total amount of MSW treated by incineration method in 2011, or 3.98 million tons/year. Especially in the UK, until March 2010, there were totally 73 factories that were licensed for the SW incineration (Department for Environment Food & Rural Affairs, 2013)

Japan is the country that has the limited soil resource, so from the 1990s, the country had selected the incineration method that is a main method for the SW treatment. The amount of SW that were burned from 1994 to 2003 in Japan were about 350 million tons/year, occupied over 70% of total amount of SW generated. Until 2003, there were totally 995 factories applying the incineration method for SW treatment and 401 factories applying other methods for SW treatment (Katsuya Kawamoto, 2006).

In Vietnam

In Vietnam, the MSW treatment technology that is mainly applied at present is a landfill technology. The incineration method has not been popularly applied to treat the MSW, but is popularly applied to treat the industrial waste, especially hazardous waste (HW). The SW in Vietnam is burned by two methods namely combined incineration in available incinerators (industrial boiler; brick, ceramic furnace; clinker furnace, etc.) or one-level or two-level industrial incinerators with a low capacity, static furnace, manual electric furnace.

However, the initial results show that the domestic technologies have not been completed and reached the comprehensive efficiency while the foreign technologies and equipment have not been suitable for the SW properties in Vietnam (unseparated at source, high moisture content, high percentage of food compared to other components). In practical, the incineration technology had been applied in some local areas for SW treatment in small scale, has not been much applied in large scale. Some applications are presented as follows:

First, there was "MSW incinerator BD-ANPHA" of the Polytechnic University (Hanoi) and Duc Minh One Member Co., Ltd. This technology that consisted of automatic separation equipment, rotary drying machine, hydraulic loading machine is the versatile incineration machine for SW with a capacity of 250 – 750 kg/h. The incinerator was designed to burn both MSW and industrial SW, the heat from the incinerator will be reused for some purposes namely heat the boiler, dry agricultural products, provide hot water, provide hot wind, drying, etc. As site monitoring result, it showed that the concentration of the wastes that were generated from the incinerator were all lower than QCVN 30:2012/BTNMT[2]. This technology were applied in some cities and provinces namely Khanh Hoa, Hai Phong, Thanh Hoa, Nam Dinh, Binh Duong, Soc Trang, Quang Ninh, Bac Can, Da Nang, etc.

Since January 2004, the pilot incinerator with Model NFI – 120, a capacity of 150 - 500 kg/h has been applied in Lim Town, Tien Du District, Bac Ninh Province. As trial operation, the amount of MSW were treated approximately 6 – 8 tons/day, the incinerator was stably operated and the amount of smoke and slag was insignificantly generated without offensive odors[3]. One another town in Bac Can Province has also applied the pilot incinerator for SW treatment in Ba Be Town, Ba Be District that was made by Vietnam Mineral Resources, Power and Environment Corporation (VMPEC) since July 2014[4].

In addition, some other incineration technologies for MSW treatment were applied such as small-scale incinerator Model ĐM-LSH-500 with a capacity of 500 kg/h (made by Duc Minh One Member Co., Ltd.); incinerator Model NFi-05 with a capacity of 450 kg/day; plasma incinerator with a high capacity (about 50 – 3,000 tons/day) Model Plasma JMI, ENSERCO incineration technology with a capacity of 450 tons/day (made by Thang Long Environmental Services J.S. Company), etc.

In general, the application of the incineration technology for MSW treatment in Vietnam is not popular, so this technology is currenty applied with small capacity and scale. The practical applications show that the emission treatment efficiency of this technology is rather high and the emissions after treatment meet the National Technical Regulations and have not caused the negative impacts on the surrounding environment. In the future, the application of the incineration technology for SW treatment in combination with energy recovery in Vietnam is widely deployed together with the recycling technology and compost processing technology to access to gradually reduce the application of landfill technology and to contribute to the environmental protection. Although the

[2] http://www.ducminhmtv.com.vn/tin-tuc/cong-nghe/bao-cao-cong-nghe-lo-dot-chat-thai-ran-sinh-hoat-bdnanpha
[3] http://baobacninh.com.vn/news_detail/81040/tien-du-thi-diem-lo-dot-chat-thai-ran-sinh-hoat.html
[4] http://vmpec.com.vn/20449-vmpec-trien-khai-du-an-lo-dot-rac-thai-sinh-hoat-tai-huyen-ba-be-tinh-bac-can-07-2014.html

incineration technology requires rather high investment and operation cost (the total investment capital for one SW incineration factory with a capacity of 300 tons/day is estimated approximately 20 - 30 million USD[5]) together with rather high cost of relevant equipment maintenance, it will significantly contribute to solve the energy problem and the environment hygiene in the urban area.

Overview of the heating value of SW

The heating value includes higher heating value (HHV) and lower heating value (LHV). In which, the HHV or GHV is a heating value of SW mixture and the LHV is a net heating value.

The MSW consists of many components including many combustible components that could significantly create the energy (the heating value) for the power generation. As Tchobanoglous, 1993, the heating value of the MSW components is presented in **Table 5** below.

Table 5. Heating value of MSW components

No.	Component	Heating value (KJ/kg)		Heating value (Cal/g)	
		Range	Specific value	Range	Specific value
1	Food	3,489 – 6,978	4,652	837 – 1,675	1,116
2	Paper	11,630 – 18,608	16,747	2,791 – 4,466	4,019
3	Carton	13,956 – 17,445	16,282	3,349 – 4,187	3,908
4	Plastic	27,912 – 37,216	32,564	6,699 – 8,932	7,815
5	Textile	15,119 – 18,608	17,445	3,629 – 4,466	4,187
6	Rubber	20,934 – 27,912	23,260	5,024 – 6,699	5,582
7	Leather	15,119 – 19,771	17,445	3,629 – 4,745	4,187
8	Garden waste	2,326 – 18,608	6,513	558 – 4,466	1,563
9	Wood	17,445 – 19,771	18,608	4,187 – 4,745	4,466
10	Glass	116 – 223	140	28 – 54	34
11	Tin can	233 – 1163	689	56 – 279	165
12	Other metals	233 – 1163	689	56 - 279	165
13	Dust, ash, etc.	2,326 – 11,630	6978	558 – 2,791	1,675
14	MSW (mixture)	9,304 – 13,956	11,630	2,233 – 3,349	2,791

Source: Tchobanoglous et al., 1993.

As mentioned in Table 1, the plastic has the highest heating value with a specific value of 7,815 Cal/g. The components that have the HHV include paper (4,019 Cal/g), carton (3,908 Cal/g), textile (4,187 Cal/g), rubber (5,582 Cal/g), leather (4,187 Cal/g) and wood

[5] Tuan Luong, MSW: which treatment technology do you apply?, http://www.epe.edu.vn/?nid=478, 2014

(4,466 Cal/g). The other components namely food, metal, glass, garden waste, dust, ash, etc. have the LHV of below 1,500 Cal/g. The heating values of the components namely glass, tin can or metal as mentioned in Table 1 are not their own heating values, but are the heating values of their external coats, labels and materials attached. Therefore, these components could be considered as incombustible components that could not form the heat if they burned.

As M.F.Seelig et al. (2012), the HHV of MSW is approximately 9.98 MJ/kg (≈ 2,395 Cal/g) and the LHV of MSW is approximately 4.77 MJ/kg (≈ 1,145 Cal/g). In similar, as Amrehn (2014), the GHV of MSW in Vietnam is about 10 MJ/kg (or 2,400 Cal/g). In which, the components that have the HHV of over > 20 MJ/Kg (or > 4,800 Cal/g) are paper and plastic. In addition, the analytical result of the SW components in the Phuoc Hiep Landfill, HCMC made by ETM, 2014, the HHV and LHV of the MSW fluctuate about 1,600 – 2,300 Cal/g and 980 – 2,000 Cal/g respectively.

The MSW in Vietnam in general and in HCMC in particular could be separated into 11 major components such as (1) food (meat, fish, vegetables, rice, bread, fruits, etc.); (2) paper; (3) diaper; (4) plastic; (5) textile; (6) wood; (7) Rubber-leather; (8) metal; (9) inorganic components (coal ash, brick, glass, etc.); (10) shell-bone and (11) others (the components that have too small sizes or could not be visually separated are soil, stone, hair, cigarette butts, etc.). Among these components, the plastic has the high combustible possibility and the most energy generation with the HHV of about 7,000 – 9,000 Cal/g; the HHV of paper, diaper, textile, wood, rubber-leather fluctuates about 3,000 – 6,000 Cal/g. Otherwise, the food that has the lowest heating value fluctuates about 3,000 – 4,000 Cal/g (ETM, 2014).

In conclusion, the SW components namely plastic, rubber-leather, diaper, textile, garden waste, wood, paper or food that have all the HHV of over 1,500 Cal/g have high combustible possibility to produce the energy for the power generation (as Ph.D Kosuke Kawai, 2012).

2.2 Combustible possibility of the SW components in Phuoc Hiep Landfill, Dong Thanh Landfill and Go Cat Landfill

ETM has implemented the sampling programs at Phuoc Hiep, Go Cat and Dong Thanh Landfills to assessing the combustible possibility of waste, along with full chemical and physical analyses of MSW, through which, to assessing the possibility of using the incineration technology for MSW treatment. For Phuoc Hiep Landfill has received MSW, ETM has analysed the new MSW, not buried. For Go Cat and Dong Thanh Landfills had been stopped receiving and landfilling the SW, the SW samples are taken in the landfill cells by the drilling method or cranes according to the depth of the sample taken.

The Go Cat Landfill and Dong Thanh Landfill had been stopped operating for a long time. The Dong Thanh Landfill had been stopped operating since 2002 and the Go Cat Landfill had been stopped operating since 2007. In these landfills, the SW had been buried seven years ago for new SW and over 23 years for old SW (the SW had been buried in the Dong Thanh Landfill since 1991). Thus, the current properties of SW are changed compared to the initial properties due to the organic matters decomposed by time together with leachate generation, storm-water infiltration into the surface water and groundwater sources in local areas for a long time. Meanwhile, the Phuoc Hiep Landfill has received the SW before official closure, so the SW components are new and many organic components has not been decomposed.

In order to assess the combustible possibility of SW, ETM took the SW samples in the landfill cells in the Dong Thanh Landfill, Go Cat Landfill and the SW from the MSW collection vehicles at Phuoc Hiep Landfill. As the analytical result of the GHVs of the SW components in these landfills, the combustible components that could be burned to highly produce the energy could be determined. The analytical result of the GHV of the SW components is mentioned hereinafter.

2.2.1 Combustible possibility of the SW components in Phuoc Hiep Landfill

For Phuoc Hiep Landfill, ETM has analysed the new MSW, not buried. In comparison with the Dong Thanh Landfill and Go Cat Landfill, the SW components in the Phuoc Hiep Landfill is rather new and many other components have not been decomposed. In the Phuoc Hiep Landfill, the food that has a rather high percentage compared to other components is about 66.2%. Additionally, the percentage of the other components are about 17.0% for plastic mainly nylon; about 5.8% for textile, about 3.5% for diaper, 3.1% for paper, 1.6% for inorganic components and about 1.0% for shell-bone. The rest components namely rubber-leather, metal and others that are insignificantly fluctuate about 0.2 – 0.7%. The SW components in the Phuoc Hiep Landfill are showned in **Figure 7**.

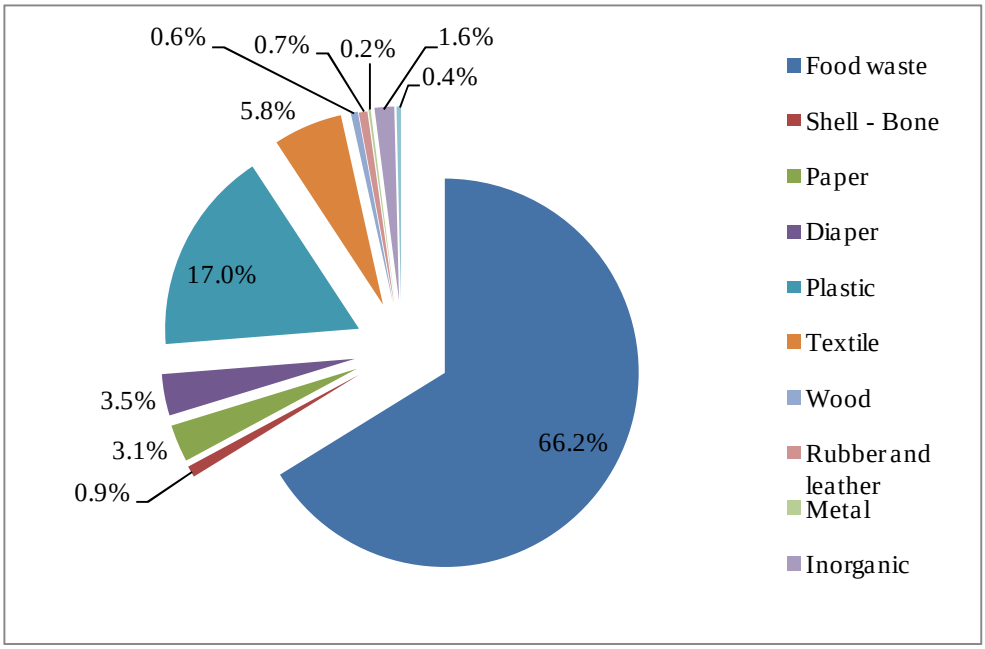

Figure 7. SW components in Phuoc Hiep Landfill.

Because the SW is newly buried in the Phuoc Hiep Landfill, there are many combustible components namely food, paper, diaper, plastic, textile, wood and rubber-leather that could be burned to highly produce the energy. The GHV of these components fluctuate in wide range of 3,700 – 8,400 Cal/g in which the plastic has the highest heating value and the food has the lowest heating value. The analytical result of the GHV of the SW components in the Phuoc Hiep Landfill is shown in **Figure 8** below.

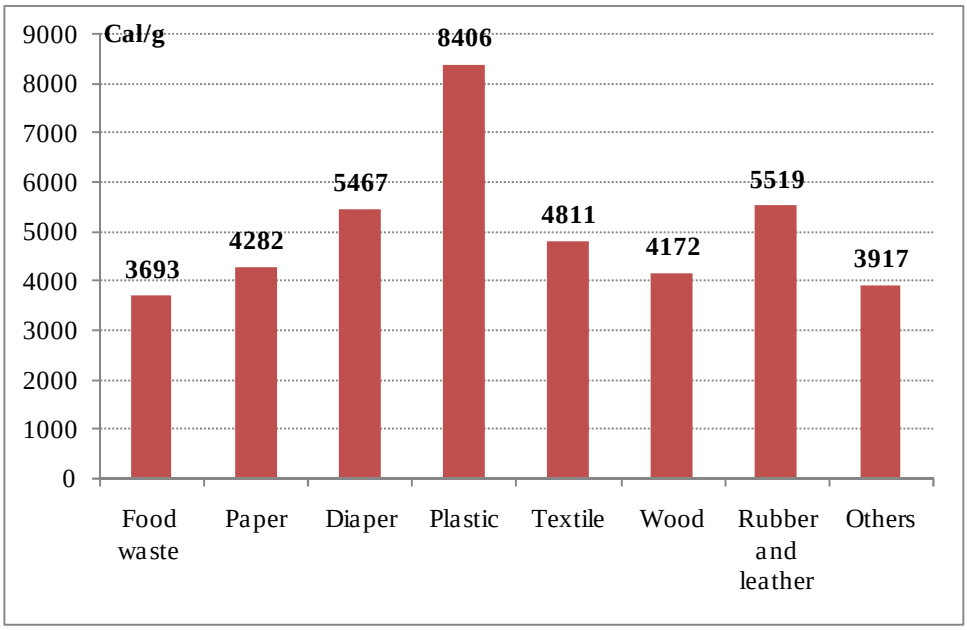

Figure 8. GHV of the SW components in Phuoc Hiep Landfill**.**

The plastic has the highest heating value of about 8,406 Cal/g compared to the other components in the SW in the Phuoc Hiep Landfill that were analyzed. This is the

component that has the highest percentage in SW in the Phuoc Hiep in general and in MSW in Vietnam in particular.

The components namely paper, diaper, textile, wood, rubber-leather have all the average heating value in range of about 4,000 – 5,000 Cal/g.

Others and food have the lowest heating values that are 3,917 Cal/g and 3,693 Cal/g.

In conclusion, the SW components in the Phuoc Hiep Landfill have all the HHVs and could be burned to produce the energy for the power generation, even the components that have high moisture content (about 70%) and diaper (approximately 80%). The other components namely shell-bone, metal and inorganic components (ceramic, glass) could not be burned.

2.2.2 Combustible possibility of the SW components in Dong Thanh Landfill

The SW in the landfill cells in the Dong Thanh Landfill is taken at different depth of about 3 - 22m and then analyzed with its components, the SW samples in the landfill cells in the Dong Thanh Landfill, Go Cat Landfill were landfilling over a period of 5 – 7 years. The samling and analyzing procedure of the SW components in the Dong Thanh Landfill are shown in **Figure 9**.

a. Crane used for excavating and taking SW in landfill cell

b. SW in landfill cell

c. SW excavated and piled up

d. SW separation

e. SW before and after separation

f. Some components separated

g. Nylon, plastic

h. Shell-bone

i. Textile

j. Rubber

Figure 9. Sampling and analyzing procedure of the SW components in Dong Thanh Landfill (**Source**: HCMc 's DONRE, 2007).

As analytical result, the SW components left in the landfill cells in the Dong Thanh Landfill include mud (0 – 50%), plastic (including mainly nylon) (20.7 – 62.7%), bamboo-straw-leaves (11.4 – 20.7%), papers (including carton, plastic coated paper) (0 – 2.1%), wood (0 – 5.3%), leather (0 – 1.1%), color metal (0 – 2.4%), iron (0 – 0.5%) and other components namely stone, ceramic, shell-bone, textile, rubber and sacks, hair, etc. The average percentage of the SW components in the Dong Thanh Landfill is shown in **Figure 10**.

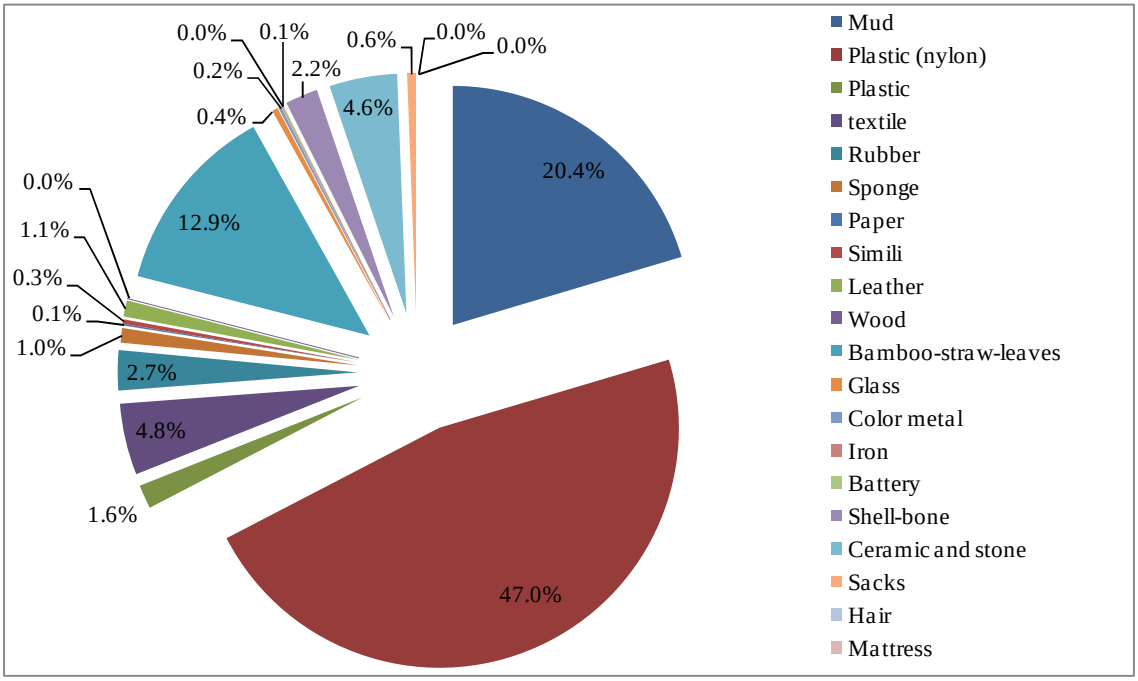

Figure 10. SW components in Dong Thanh Landfill (**Source**: HCMc 's DONRE, 2007).

In conclusion, beside mud (not or completely decomposed), there are paper, wood and some organic components with a low combustible possibility that could be degradable to produce the gas or be burned for the power generation.

As analytical result, the combustible components in MSW that could be burned to highly produce the energy include plastic, rubber, leather, diaper, textile, garden waste, wood, papers (carton, plastic coated paper) and food; these components are mostly observed in the SW buried in the Dong Thanh Landfill except food (decomposed) and diaper (is not observed in the SW components at the sampling time due to the low demand of using this component).

The GHV of the SW components is estimated depending on the analytical result of the SW elements namely C, H, O, N, S (as specifically presented in the ***Report 2:*** *Analysis of the physical and chemical properties of the SW in Phuoc Hiep Landfill, Dong Thanh Landfill and Go Cat Landfill*). The GHV is presented in **Table 6** and shown in **Figure 11** below.

Table 6. GHV of the SW components is estimated depending on the analytical result of the SW elements namely C, H, O, N, S in Dong Thanh Landfill (under Tchobanoglous et al. 1993)

No.	**Component**	**GHV** (Btu/lb)	**GHV** (Cal/g)
1	Paper	6,616	3,693
2	Textile	9,668	5,397
3	Rubber	17,430	9,730
4	Leather	12,796	7,143
5	Wood	7,584	4,233

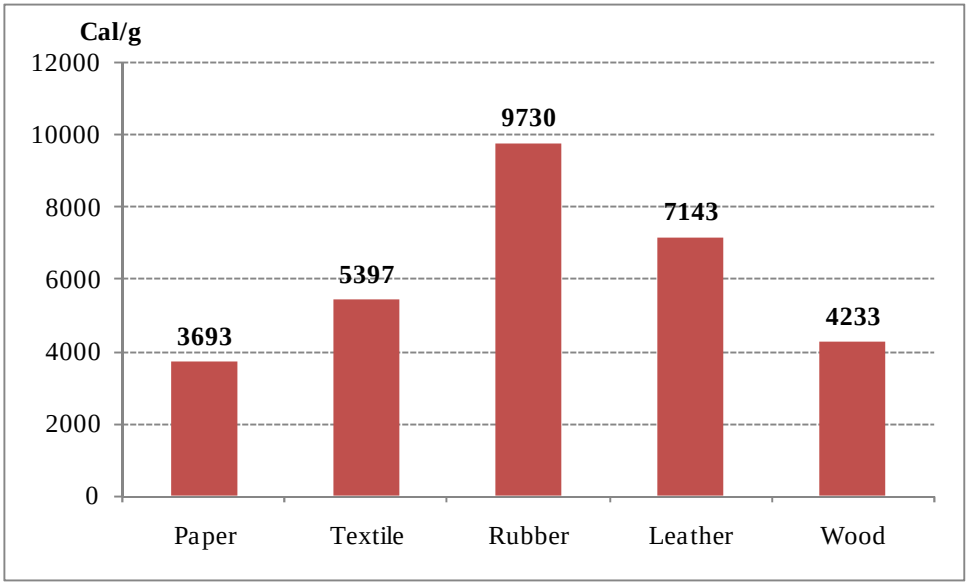

Figure 11. GHV of the SW components in Dong Thanh Landfill.

The GHV of the SW components in the Dong Thanh Landfill is rather high and equivalent to the GHV of the SW components in the Phuoc Hiep Landfill. In which, the rubber and leather component in the Dong Thanh Landfill is separately analyzed with its GHV, so the GHV in the Dong Thanh landfill is higher than one in case of general analysis of two components in the Phuoc Hiep Landfill. Particularly, the GHVs of rubber and leather are 9,730 Cal/g and 7,143 Cal/g respectively while the general GHV of rubber and leather is about 5, 519 Cal/g in average. As some analytical results under the programs on SW separation at source in Binh Thanh District and District 1, HCMC in 2013, the general GHV of rubber and leather is not as high as the separate GHVs of rubber and leather. The general GHVs of rubber and leather in Binh Thanh District and District 1 are 4,673 Cal/g and 6,277 Cal/g.

The GHVs of paper and wood that are similar to the specific GHVs recorded from the different researches is approximately 4,000 Cal/g. Similarly, the textile is approximately 5,000 Cal/g.

The analysis of the elements namely C, H, O, N, S is not applied to the plastic, so the GHV of this component could not be estimated. However, as the percentage of plastic and nylon in the SW components in the Dong Thanh Landfill and the GHV of the plastic in range of 7,000 – 9,000 Cal/g recorded from other researches, it showed that the plastic is one of combustible components to highly produce the energy in the Dong Thanh Landfill.

The above-mentioned components that have all the HHV of over 1,500 Cal/g could be burned to highly produce the energy. Beside these components, some other components in the SW buried that could be also burned to highly produce the energy include simili, porous foam, bamboo, leaves, sacks, mattresses.

2.2.3 Combustible possibility of the components of the SW in Go Cat Landfill

The SW samples are taken in the Go Cat Landfill at a depth of 1 – 5.5m by the cranes. The SW sampling process in the Go Cat Landfill is shown in Figure 12 below.

a. Crane to excavate and take SW

b. SW piled up

c. Excavated pit for taking SW

d. Sampling activity

e. SW before separation

f. Some SW components after separation

g. Wood

h. Paper

i. Plastic

j. Rubber

Figure 12. Sampling process in Go Cat Landfill.

Similar to the SW components in the Dong Thanh Landfill, the SW components are manily mud, soil and stone, hair (other components could be visually separated), inorganic components and low biodegradable components. In which, there about 35.8% – 54.0% for others; 24.6 – 51.9% for plastic, mainly nylon; 1.8 – 13.4% for textile; 0.6 – 2.3% for paper; 0 – 1.9% for shell-bone, wood, glass, metal and rubber.

The components such as plastic, textile, wood, rubber that have HHV are observed in the SW components in the Go Cat Landfill. As analytical results, the GHV of these components are high, so they could be treated by incineration method with the energy produced. The average HV of the components of the SW in the Go Cat Landfill is presented in **Table 7** and shown in **Figure 13**.

Table 7. Average heating value of the SW components in Go Cat Landfill

No.	Component	Average heating value (Cal/g)
1	Plastic	8,852
2	Textile	4,139
3	Wood	3,484
4	Shell-bone	1,112
5	Paper	3,591
6	Rubber	5,555
7	Persistent biodegradable components	2,441
8	Others	1,597

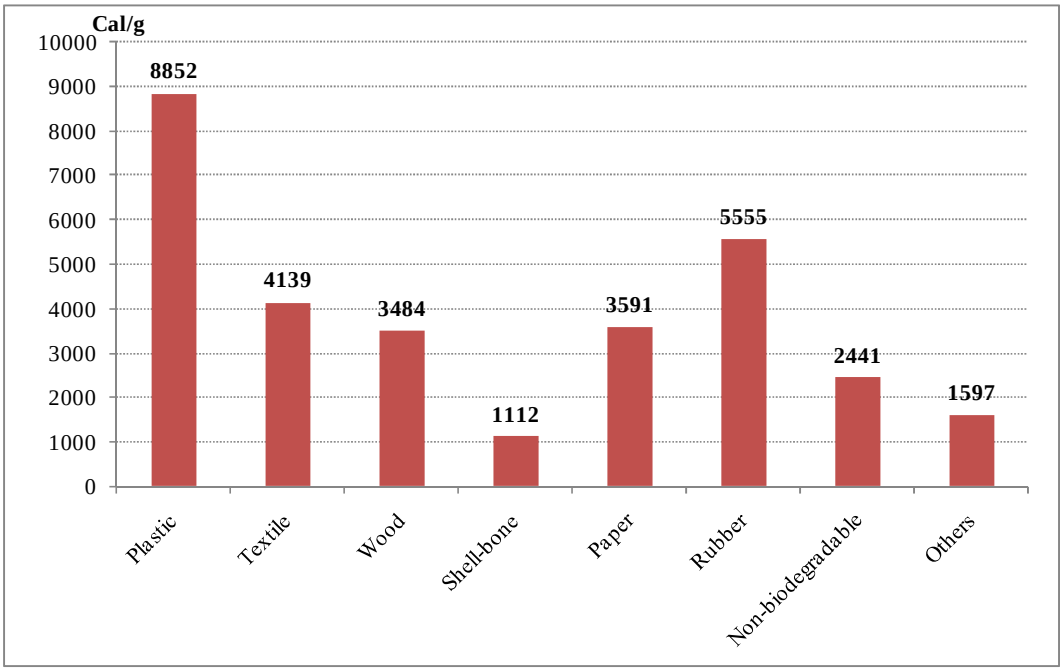

Figure 13. Average heating value of the SW components in Go Cat Landfill.

The plastic has the highest heating value compared to the other components. The average heating value of the SW in the Go Cat Landfill is about 8,852 Cal/g that is equivalent to the average heating value of the SW before landfill in the Phuoc Hiep Landfill (about 8,400 Cal/g) and one of the SW in Binh Thanh District and District 1 under the programs on SW separation at source (approximately 9,000 Cal/g) (ETM, 2014).

The GHV of rubber is equivalent to the GHVs in the Phuoc Hiep Landfill, District 1 and Binh Thanh District that were analyzed. The GHV of SW in the Go Cat Landfill is 5,555 Cal/g while the GHVs of the SW types in the other places fluctuate about 4,600 – 6,200 Cal/g. However, these values are rather different to ones in the Dong Thanh Landfill that are approximately 4,000 Cal/g lower than the others.

The GHV of textile of the SW in the Go Cat landfill is about 4,139 Cal/g that is lower than one in the Phuoc Hiep Landfill (4,811 Cal/g), in the Dong Thanh Landfill (5,397 Cal/g), in Binh Thanh District and District 1 (5,201 and 5,352 Cal/g respectively) but a insignificant difference.

The GHVs of wood, paper are similar, approximately 3,500 Cal/g. The components could generate the HHV in the Go Cat Landfill. The GHVs are lower than ones in the other places (in rang of 3,500 – 4,500 Cal/g).

The persistent biodegradable components (the wastes containing cellulose such as coconut fibers, mango seeds, etc.) as well as the LHV components compared to the above-mentioned components that could be burned to produce the energy for the power generation have the average heating values of 2,441 Cal/g và 1,597 Cal/g respectively.

The shell-bones that are the low combustible components could be treated by incinceration method (HHV > 800 Cal/g) but they could not be burned to produce the energy (HHV > 800 Cal/g). The average heating value is low, only 1,112 Cal/g.

Excep the inorganic components namely metal, glass and hazardous components (e.g. batteries, syringes) are incombustible to produce the energy, most of the other components that are highly combustible could be burned to produce the energy for the power generation (except shell-bones).

3. CONCLUSION

Both Dong Thanh Landfill and Go Cat Landfill stopped receiving and landfilling the SW. At present, the landfills collect and treat the leachate and biogas for generator. The SW in the Dong Thanh Landfill is deeply buried in the landfill cells and covered by debris layer with a width of 3-5m at the top of landfill cells. There are not many environmental problems namely offensive odors, leachate or LFG arised within the Dong Thanh Landfill. The Go Cat Landfill has the time of stopped operation that is less than the Dong Thanh Landfill, so there are many environmental problems left in the Go Cat Landfill such as leachate or LFG, topcoat in the landfill cells with small height of about 20 – 50cm (as site monitoring catering for taking the SW samples). The Phuoc Hiep Landfill among three above-mentioned landfills is the only one landfill that had still received the SW until 2003[6] as planned. The environmental problems in this landfill are mainly offensive odors and leachate generated.

The SW components in both Dong Thanh Landfill and Go Cat Landfill that are similar include mud, soil, stone, nylon, textile, paper, rubber, leather, wood and other components namely metal, ceramics, glass, etc. In which, the components that have high combustible possibility with HHV of over 1,500 Cal/g (in range of 1,500 – 9,000 Cal/g) are plastic, textile, paper, rubber, leather, wood, coconut fiber, mango seeds. So, these components could be burned to produce the energy for the power generation.

The Phuoc Hiep Landfill has still been operated, so the SW components in this landfill are different from the components of the old SW in the Go Cat Landfill and Dong Thanh Landfill. The SW in the Phuoc Hiep Landfill has the HHV components namely plastic, textile, paper, rubber-leather, wood that are similar to the SW components in two other landfills, except that some components namely food unburied and new diaper are additionally generated in recent years due to the demand of customers. The components have all the HHV of over 1,500 Cal/g (in range of 3,500 – 8,500 Cal/g) that could be burned to produce the energy for the power generation.

[6]Official Letter No. 475/TB-VP issued by the HCMC's PC dated 17/6/2014 regarding the closure of the Phuoc Hiep Landfill No. 3.

2-4 ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF THE SOLID WASTE BURIED IN DONG THANH LANDFILL GO CAT LANDFILL

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REPORT 2

ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF THE SOLID WASTE BURIED IN DONG THANH LANDFILL GO CAT LANDFILL AND PHUOC HIEP LANDFILL

October 2014

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APHA	American Public Health Association
B.O.D	Board of directors
BTNMT	Department of natural Resources and Environment
DONRE	Department of natural Resources and Environment
DPIWMF	Da Phuoc Integrated Waste Management Facility
DW	Dry weight
EM	Effective Microganisms
EPA	Environmental Protect Agency
ETM	Center for Environmental Technology and Management
GHV	Gross heating value
HCMC	Ho Chi Minh City
HDPE	High Density Polyethylene
HHV	Higher heating value
HW	hazardous waste
ISWTZ	Integrated Solid Waste Treatment Zone
LFG	Landfill gas
LHV	Lower heating value
MSW	Municipal solid waste
SW	Solid waste
TCVN	Vietnam Standards
VS	Volatile solid
WW	Wet weight

1. OVERVIEW OF MUNICIPAL SOLID WASTE IN HO CHI MINH CITY (HCMC)

In the recent 5-10 years, the situation of MSW generation in Vietnam in general and in HCMC in particular has had a rapid increase of volume and the changes of the SW composition and properties. This is the inevitable changes together with the population growth and the process of urbanization, industrialization in recent years. The process of rapid population growth has resulted in the gradually increased demand of housing, domestic activities, education, training, health care, transportation, etc. that has directly affected the natural environment and social environment. The amount of waste, especially SW from the domestic activities in urban area has constantly increased and has still tended to be more and more increased in the future. Besides, the quality of people's lives is also better, so the demand of the consumers is also increased. Accordingly, the amount of wastes will be generated more with more many different components such as diapers, electrical and electronic utensils, etc.

As *the National Environment Report 2011 – Solid Waste* of the MONRE, the input MSW components in the landfills in some local Cities/Provinces namely Hanoi, Hai Phong, Hue, Da Nang, HCMC and Bac Ninh in the period of 2009 – 2010 showed that the amount of food wastes is significant in range of 53.81 – 77.1%, followed by the plastic in range of 8.35 – 15.96%, the paper in range of 1.92 – 8.17% and the other components such as textile , wood, rubber-leather, metal, glass, ceramics, soil and sand, coal slag, hazardous wastes (HW), sludge and others in range of 0 – 6% as mentioned in **Table 1** below.

Table 1 Percentage of input MSW in landfills in some Cities/Provinces in the period of 2009 – 2010

No.	Component	Hanoi (Nam Son)	Hanoi (Xuan Son)	Hai Phong (Trang Cat)	Hai Phong (Dinh Vu)	Hue (Thuy Phuong)	Da Nang (Hoa Khanh)	HCMC (Da Phuoc)	HCMC (Phuoc Hiep)	Bac Ninh (Ho Town)
1	Organic SW	53.81	60.79	55.18	57.56	77.10	68.47	64.50	62.83	56,90
2	Paper	6.53	5.38	4.54	5.42	1.92	5.07	8.17	6.05	3,73
3	Textile	5.82	1.76	4.57	5.12	2.89	1.55	3.88	2.09	1,07
4	Wood	2.51	6.63	4.93	3.70	0.59	2.79	4.59	4.18	-
5	Plastic	13.57	8.35	14.34	11.28	12.47	11.36	12.42	15.96	9,65
6	Rubber-leather	0.15	0.22	1.05	1.90	0.28	0.23	0.44	0.93	0,20
7	Metal	0.87	0.25	0.47	0.25	0.40	1.45	0.36	0.59	-
8	Glass	1.87	5.07	1.69	1.35	0.39	0.14	0.40	0.86	0,58
9	Ceramic	0.39	1.26	1.27	0.44	0.79	0.79	0.24	1.27	-
10	Soil and sand	6.29	5.44	3.08	2.96	1.70	6.75	1.39	2.28	27,85
11	Coal slag	3.10	2.34	5.70	6.06	-	0.00	0.44	0.39	-
12	Hazardous coomponents	0.17	0.82	0.05	0.05	-	0.02	0.12	0.05	0,07

No.	Component	Hanoi (Nam Son)	Hanoi (Xuan Son)	Hai Phong (Trang Cat)	Hai Phong (Dinh Vu)	Hue (Thuy Phuong)	Da Nang (Hoa Khanh)	HCMC (Da Phuoc)	HCMC (Phuoc Hiep)	Bac Ninh (Ho Town)
13	Sludge	4.34	1.63	2.29	2.75	1.46	1.35	2.92	1.89	-
14	Others	0.58	0.05	1.46	1.14	-	0.03	0.14	0.04	-
Total		**100**	**100**	**100**		**100**	**100**	**100**	**100**	

Source: The National Environment Report 2011, MONRE.

In HCMC, the MSW is mainly generated from households, officies, commercial centers, trading enterprises and street wastes. The MSW components are rather various with two major components namely food and plastic, the other components are little namely paper, diaper, textile , wood, rubber-leather, metal, garden waste, inorganic components and others. The SW components in HCMC (Dong Thanh, Go Cat, Phuoc Hiep Landfill) has been changed in the period of 1996 – 2013 as shown in **Figure 1**.

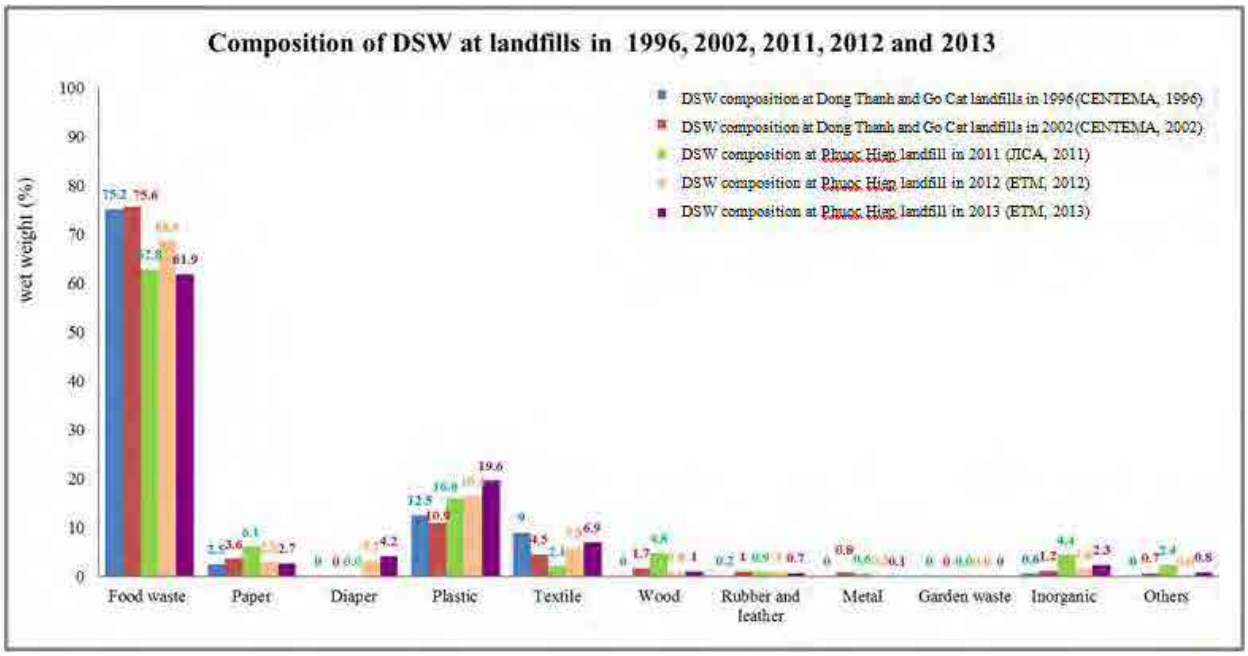


Figure 1 Fluctuation of MSW components in the landfills in HCMC in 1996, 2002, 2011, 2012 và 2013.

As shown in **Figure 1**, from 1996 to 2013, the percentage of the food tends to be reduced but is rather high, in range of 61.9 – 75.6%. Otherwise, the components that tend to be increased include plastic (10.9 – 19.6%) and diaper (0 – 4.2%) due to the demand of consuming these components increased. The other components are not much and could be insignificantly changed by time.

The MSW in Vietnam contains mainly the food with high moisture content, so the MSW moisture content is also rather high. For the SW in the Phuoc Hiep, Dong Thanh and Go Cat Landfill in HCMC, it contains the food of 60 – 70% that has rather high moisture

content in range of 60 – 75%) leading to the SW moisture content increased (in range of 50 – 70%). In addition, the high moisture content of MSW is also resulted from many various factors such as storm-water infiltration from the process of SW storage at source to the process of SW collection and transportation to the landfill. Because the components namely paper, textile , especially diaper have moisture content absorption, the storm-water will be retained inside these components leading to the SW moisture content increased.

The VS of MSW in the landfills in HCMC occupies about 30% while the ash content occupies approximately 10%. Almost SW components have good combustible possibility at 550^{o}C such as food, paper, plastic, diaper, textile , wood, rubber-leather, etc. while the other components namely inorganic components, shell-bone or metal, etc. are mostly unchanged after combustion.

As Amrehn (2014), the HHV of the MSW in Vietnam is about 10 MJ/kg (≈ 2,400 Cal/g). In which, the components that have the HHVs of over 20 MJ/Kg (≈ > 4,800 Cal/g) include paper and plastic. For the MSW in HCMC, as the analytical results of the SW components in the Phuoc Hiep, Go Cat and Dong Thanh Landfill carried out by ETM, the plastic have the most combustible possibility for the energy generation with the HHV in range of 7,000 – 9,000 Cal/g; the components namely paper, diaper, textile , wood, rubber-leather have the HHV in range of 3,000 – 6,000 Cal/g. Otherwise, the food has the lowest heating value in range of 3,000 – 4,000 Cal/g. The HHV and LHV of the MSW is about 2,000 Cal/g and 1,500 Cal/g respectively (ETM, 2014).

In summary, due to the SW unseparated at source, the SW that is transported to the landfills in HCMC is mixed wastes including the components possibly separated namely food (the highest percentage), plastic, paper, textile , wood, rubber-leather, shell-bone, metal, inorganic components and some components that could not be visually sorted are called as others. The SW has rather high moisture content and almost SW components have good combustible possibility at 550^{o}C, the ash content after combustion is rather little, occupied only 10%ww. The heating value of the SW is rather high, so the SW could be burned for the energy recovery (LHV > 1,500 Cal/g).

The analyis, assessment of the input SW properties known as the SW unburied in the landfills in HCMC are mentioned hereinbefore. The SW after landfill will be decomposed and reduced with its volume, especially after 5 – 10 years, the biodegradable components namely food, paper or garden waste were mostly decomposed. The SW components were left mainly wood, textile , plastic, glass and metal. The organic components after decomposition will generate the leachate together with the amount of storm-water and surface-water infiltrated into the landfill cells, so the buried SW layer

has high moisture content, the deeper SW layers will have higher moisture content due to the vertical infiltration of leachate inside the landfill cells.

The SW properties after landfill will be changed by year, the fluctuation of the SW components is mainly based on the biological decomposition of the SW components inside the landfill cells. The longer landfill time will result in the more decreased amount of the SW leading to the subsidence, landslide occurred in the landfill cells due to the volume of the SW reduced in the landfill cells by time. The analytical result of the physical and chemical properties of the SW buried 5 – 10 years ago in the Go Cat and Dong Thanh Landfill are presented hereinafter in this report.

2. METHOD OF SAMPLING AND ANALYZING THE SW COMPONENTS

ETM has implemented the sampling programs at Phuoc Hiep, Go Cat and Dong Thanh Landfills to analyzing the chemical and physical components of MSW. For Phuoc Hiep Landfill has received MSW, ETM has analysed the unburied MSW. For Go Cat and Dong Thanh Landfills had been stopped receiving and landfilling the SW, the SW samples are taken in the landfill cells by the drilling method or cranes according to the depth of the sample taken. The sampling and analytical methods is presented as follow.

2.1 Sampling method

2.1.1 Sampling

The sampling location is mainly based on the safety and the specific property of the SW samples. The SW samples are taken by excavating or drilling the landfill cells in each layer or from the MSW collection vehicles. The sampling method in each landfill is presented as follows:

In Phuoc Hiep Landfill

The SW sampling that is catering for analyzing the components and properties of the MSW in the Phuoc Hiep Landfill is from the collection trucks to the landfill as follows:

- Sampling locations are based on the safety and the specific property of the SW samples taken;
- The SW is taken from the collection trucks with a frequency of every ten trucks;
- The SW is taken in the transfer station where the trucks will deliver the SW to the landfill cells. In each pile of SW, the SW samples are taken at four random points with 20kg/each point. Thus, the total amount of the SW from each truck fluctuates 75 – 80kg.
- The sampling process will be carried out four times, so the total amount of the SW is taken about 300 – 320 kg.

In Dong Thanh Landfill

The Dong Thanh Landfill that began to spontaneously bury the MSW in 1989 without bottom liner was designed under the technical standard for hygienic landfill. Until 2002, the Dong Thanh Landfill had stopped receiving the MSW. The program on drilling to take the SW samples in the Dong Thanh Landfill is carried out to cater for analyzing the SW components in this landfill after being buried for a long time.

In order to monitor the SW components, the researching team took the SW samples at three different locations. Because the SW is dumped around from the bottom to the top, the SW components and properties in different locations are almost similar. The researching team selected three highest locations with the least amount of debris dumped that are drilled to take the SW samples to determine the composition and properties of the SW left in the landfill cells. The sampling locations are shown in **Figure 2**.

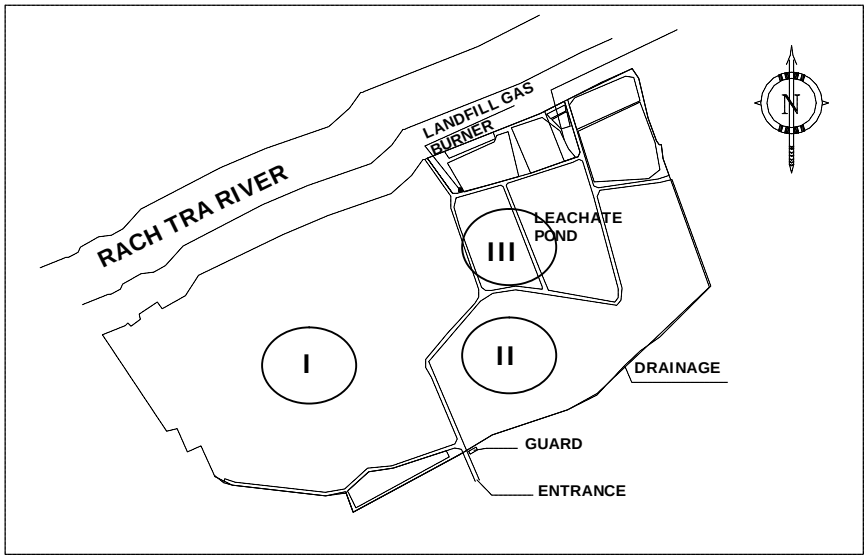


Figure 2. Sampling locations in Dong Thanh Landfill.

In case, the samples that are taken at a depth of 3 – 17 m will be taken by cranes. The samples that are taken at a depth of 17m and above will be taken by crane together with the driller. In theory, in order to precisely determine the analytical result, the amount of each SW sample is taken about 200 lb, or 98kg. However, the sampling devices must be improved in conformity with the property of the SW decomposed in the landfill, so the amount of the SW samples that are different fluctuates about 70-95 kg/sample. The symbols of the SW samples and sampling locations are presented in **Table 2** below.

Table 2. Symbol of the SW samples and sampling locations in Dong Thanh Landfill

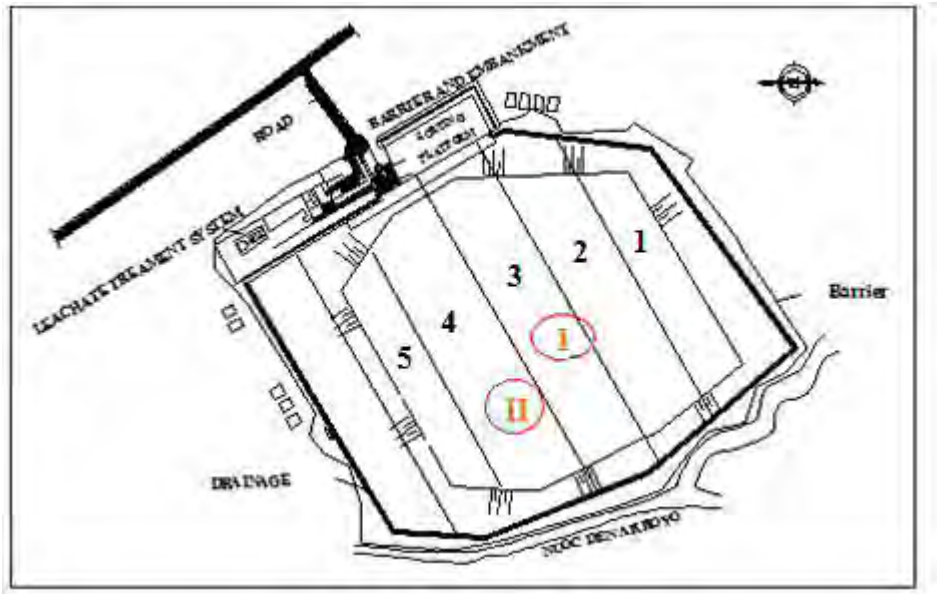
Symbol	Depth (m)	Sampling device	Quantity (kg)
I3	3	Crane	87.5
I6	6	Crane	88.2

Symbol	Depth (m)	Sampling device	Quantity (kg)
I9	9	Crane	83.8
I12	12	Crane	75.7
I18	18	Driller	85.1
II3	3	Crane	86.5
II6	6	Crane	87.1
II9	9	Crane	90.5
II12	12	Crane	91.7
II17	17	Crane	64.3
II20	20	Driller	70.5
II22	22	Driller	81.4
III3	3	Driller	95.7
III6	6	Driller	83.2
III9	9	Driller	91.4
III16	16	Driller	92.7
III19	19	Driller	84.8

Note: I, II, III are symbols corresponding to the drilling hole 1, 2 and 3
Source: DONRE, 2007

In Go Cat Landfill

The Go Cat Landfill had been operated from 2002 to 2007, the SW sample was taken on 01/10/2014 after the landfill had stopped its operation 7 years ago. The sampling method is similar to the Dong Thanh Landfill. Unlike the sampling program in the Dong Thanh Landfill, the sampling program in the Go Cat Landfill was made only at a depth of 1 - 5 m by only crane. The sampling locations are shown in **Figure 3**.



Note: I: Location 1, landfill cell 3, near landfill cell 2
II: Location 2, landfill cell 4

Figure 3. Sampling locations in Go Cat Landfill.

The SW sampling procedure is carried out by the folowing steps:

- The crane is used for excavating and shovelling the SW from the landfill cells into a pile according to each layer with a depth of 1 – 5m. The SW samples are taken at depth of 1m and 5m.
- At each depth, the SW sample is separately piled up and then taken by plastic buckets with a volume of 80L. The amount of the SW sample that is equivalent to a filled 80-liter bucket fluctuates 50 – 60 kg.
- The total amount of the SW sample that is equivalent to four filled 80-liter buckets fluctuates 200 – 240 kg.

2.1.2 Sample treatment

The sample treatment procedure is conformed to the following steps:

- After sampling, the SW sample is spread into a canvas on the ground, then cut into smaller pieces with a size of about 15cm by knives and scissors. The large-size components such as carton, tree branches, etc. will be cut into smaller pieces with a size of less 15cm. Each SW sample will be thoroughly mixed by manual method via portable shovels to reach the thorough mixing of the SW sample.
- After that, the mixed sample is divided into four equal parts that will take two parts to reach the smaller amount of the sample. This sampling process is done 2 times. Finally, the amount of the SW sample that is analyzed is one-quarter of the initial amount. The sample treatment process is shown in **Figure 4** below.

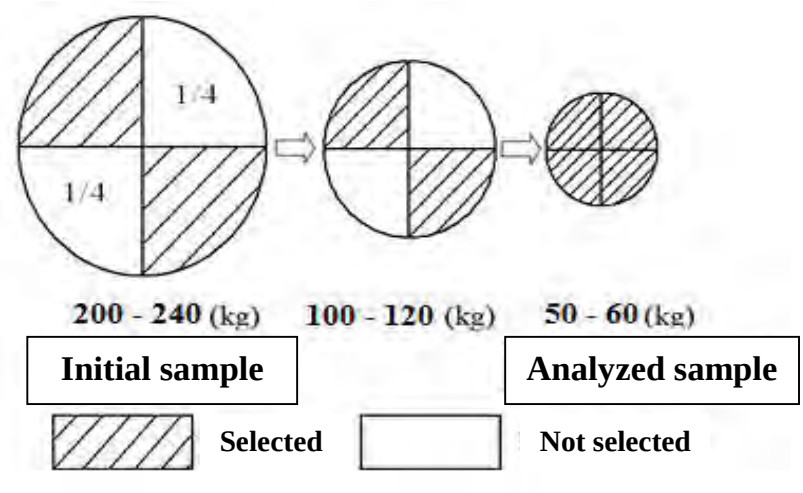


Figure 4. Sampling method.

2.2 Analytical method

2.2.1 Density

a. Use 80-liter plastic barrels with full information such as volume (V_0) and weight (W_0) of empty barrel written down.
b. The SW sample is stored in these barrels, prevent too filled barrels.
c. Lift vertically the barrels to a height of about 30 cm from the ground to reduce the SW porosity. When the porosity is decreased, the volume of SW in the barrels is also reduced. Accordingly, the SW could be added more into the barrels like step b until the barrels are suitably filled.
d. Perform the step c three times, then determine the quantity of the SW barrels (including the amount of both SW and barrel) (W_1).
e. Density of the SW sample is determined by the following formula:

$$\text{Density } (\text{kg/L} = \text{T/m}^3) = \frac{W_1(\text{kg}) - W_0(\text{kg})}{V_0} \quad (1)$$

2.2.2 Physical components

a. The SW sample is spread into a canvas on the ground to be separated into each component.
b. The initial sample is separated into 11 components namely 1-Food (meat, fish, vegetables, rice, bread, fruits, etc.); 2-Paper; 3-Diaper, 4-Plastic; 5-Textile ; 6-Wood; 7-Rubber, leather; 8-Metal, 9-Inorganic components (coal ash, brick, glass, etc.); 10-Shell-bone; 11-others (including too small components so that they could not be visually separated).
c. Weigh each SW component (X_i), total amount of SW sample estimated by total amount of all SW components. Each physical component of the SW sample is estimated by the following formula:

$$\textbf{Physical component } (X_i) \textbf{ (\% WW)} = \frac{X_i \text{ (kg WW)}}{X \text{ (kg WW)}} \times 100$$

$$\textbf{Physical component } (X'_i) \textbf{ (\% DW)} = \frac{X'_i \text{ (kg DW)}}{X' \text{ (kg DW)}} \times 100$$

2.2.3 Analysis of moisture content, ash content, VS and HHV

Moisture content

a. The moisture content of each SW component is separately determined under APHA 2540G (2012).
b. Each SW component is cut into smaller pieces with a size of 2 – 3 cm, then put into a metal dish with a diameter of 20 cm. The height of SW sample in the dish should be less 10cm if any.
c. After that, the SW sample is dried at 105^{o}C in 4 – 5 days until the amount of this sample could not be changed.
d. Finally, the moisture content of each SW component is estimated by the difference between the DW and WW of the sample.

VS, ash content and HHV

The SW components are cut into small pieces with a size of less 1cm before being analyzed to determine the VS and ash content. After that, the SW samples will be burned at 550^{o}C under APHA 2540 G (2012).

Similar to the analysis of the VS and ash content, the SW samples are cut into small pieces with a size of less 1cm, then ground into the pieces with a size of 2mm, finally analyzed to determine the HHV under TCVN 200-2007 (ISO 1928:2009).

The method of analyzing the SW samples is presented in **Table 3** below.

Table 3. Analytical method of the SW samples

No.	Parameter	Analytical method	Analytical device
1	Moisture content	APHA 2540 G	WTB Binder, Germany, Metter Toledo MS204 balance, Switzerland
2	VS and ash content	APHA 2540 G	Nabertherm oven, Metter Toledo MS204 balance, Switzerland
3	HHV	TCVN 200-2011 (ISO 1928:2009)	IKA calorimeter C 4000

3 ANALYSIS OF PHYSICAL AND CHEMICAL PROPERTIES OF THE SW IN PHUOC HIEP, GO CAT, DONG THANH LANDFILL

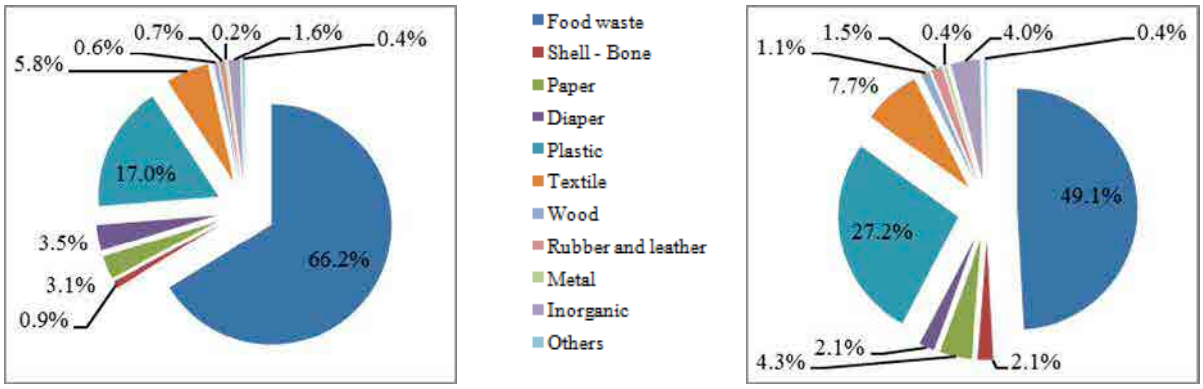
3.1 SW properties in Phuoc Hiep Landfill

Phuoc Hiep Landfill has received the SW before closure, ETM has analysed the unburied MSW. So the SW components are new and many organic components has not been

decomposed. Besides, in 2012 – 2014, ETM has carried out many programs of sampling and analysis the MSW at Phuoc Hiep Landfill. The results of chemical and physical analyses are presented as follows:

3.1.1 SW components in Phuoc Hiep Landfill

The SW components that are mainly observed in the SW samples in the Phuoc Hiep Landfill consist of firstly food, secondly plastic including mainly nylon. The components that have the average and stable proportion compared to the other components are paper, textile, diaper and shell-bone. The components that have low proportion are wood, rubber-leather, metal, inorganic components and others. The SW components (by DW and WW) are shown in **Figure 5** below.



Physical composition (%ww) of MSW **Physical composition (%dw) of MSW**

Figure 5. SW components in Phuoc Hiep Landfill.

The MSW in the Phuoc Hiep Landfill in the sampling periods (from 2012 to 2014) is separated into 11 components namely (1) Food, (2) Shell-bone, (3) Paper, (4) Diaper, (5) Plastic, (6) Textile, (7) Wood, (8) Rubber-leather, (9) Metal, (10) Inorganic components, (11) Others. The analytical result of the SW components in the Phuoc Hiep Landfill is presented as follows:

- The food has the percentage that is much higher than the other components. The total amount of the other components is always lower than the amount of the food by WW, or equivalent to the amount of the food by DW. The percentage of the food fluctuates 61.3 – 70.1%ww and 40.5 – 55.2%dw.

- After the food, the plastic have the second percentage, occupied 16.1 – 19.6%ww and 23.7 – 33.3%dw.

- The components such as textile , diaper, paper, inorganic components and shell-bone have the average proportion of 61.3 – 70.1%ww and 40.5 – 55.2%dw.

- The components namely rubber-leather, wood, others and metal have the average proportion of 0 – 1.4%ww and 0 – 3.2%dw.

3.1.2 Physical, chemical properties in Phuoc Hiep Landfill

Density

The analysis results of Phuoc Hiep MSW from 2012 to 2014 shows that, the density of the SW in the Phuoc Hiep Landfill fluctuates 0.30 – 0.40 kg/l, reached 0.36 kg/l in average.

Moisture content

The average moisture content of the SW components in the Phuoc Hiep Landfill is shown in **Figure 6** below.

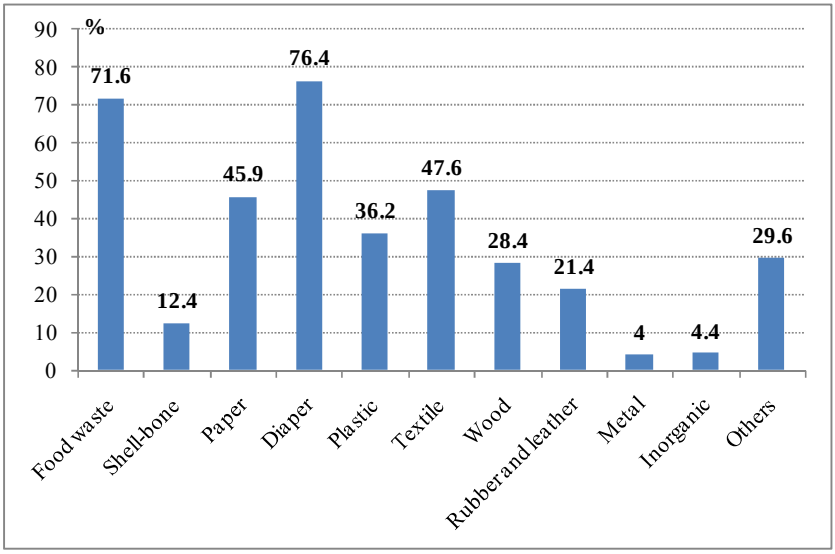


Figure 6. Average moisture content of the SW components in Phuoc Hiep Landfill.

- The food that are mainly vegetables, meat, fish, residual food, etc. and additionally little of sand, mud, soil unseparated has rather high moisture content, about 71.6% in average. The average moisture content values of the SW components in the sampling periods fluctuate 67.6 – 74.3%.

- The paper has the average moisture content of 45.9% in range of 38.7 – 53.8%.

- Together with the social development, the demand of using the diapers is also more and more increased due to their usefulness and diversity. The diaper has the highest moisture content, approximately 82,7% that is about 10% higher than the lowest moisture content of 71.2%, the anverage moisture content of diaper is about 76.4%. The diaper is a type of good water absorbent, but is easily affected by the moisture

content of the SW mixture and leachate. This is a main cause to make the moisture content of this component in the highest concentration compared to the other components, even the food.

- Similar to the paper, the textile is a good water absorbent, thus this component has also rather high moisture content in range of 38.7 – 53.8%, about 47.6% in average.

- With respect to the property, the plastic could not absorbed the moisture content, howeverm the moisture content of the plastic fluctates 29.9 – 44.0% and about 36.2% in average. The leachate from the SW mixture could be absorbed on the surface of the packings causing rather high moisture content.

- The moisture content of the rubber fluctuates in widely range of 6.0 – 38.6% and about 21.4% in average.

- The moisture content of the components namely wood, metal and inorganic components fluctuates in range of 17.4 – 34.4%, 1.5 – 7.6% and 3.5 – 6.7% respectively.
- The other components have the moisture content in range of 8.9 - 29.1%. The moisture content is not similar between the SW components in different analysis periods due to the different components of the SW samples taken. The SW sample that has mainly others namely garden waste, soil, etc. has higher moisture content compared to the SW samples containing a lot of hair, batteries, etc.

- The shell-bone has a difference of the moisture content between the analysis periods due to the different components of the SW samples taken. The SW samples containing a lot of mango seeds, corn cores, etc. will has higher moisture content compared to the SW samples containing a lot of shell-bone, etc. The shell-bone has the moisture content in range of 7.4 – 18.6%.

VS and ash content

The combustible possibility of the SW components in the Phuoc Hiep Landfill is shown by ash content and VS in **Figure 7**.

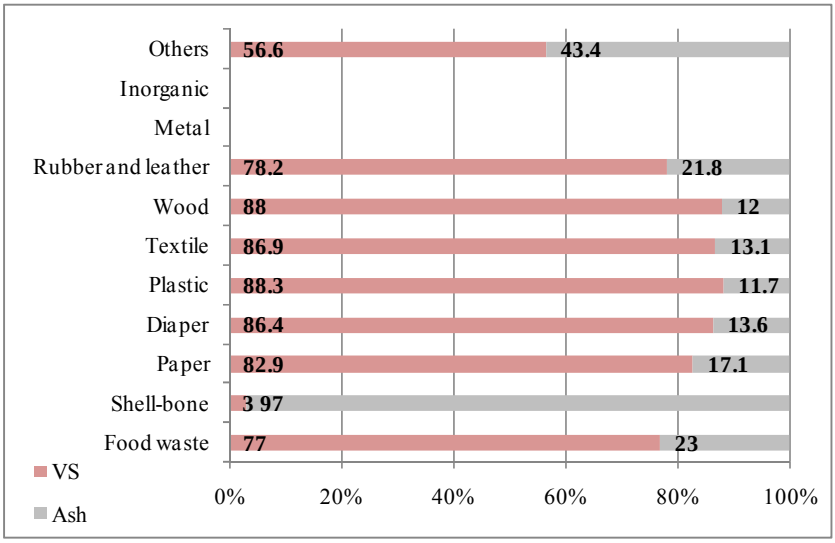


Figure 7. VS and ash content of the SW components in Phuoc Hiep Landfill.

- **For ash content:**

  + The average ash content of the shell-bone is rather high, approximately 97.0%.

  + The components that have the average ash content of over 20% include about 43.4% for others, about 23% for food and about 21.8% for rubber-leather. The ash content of the food and rubber-leather is similar, insignificantly different between the analysis periods. The ash content values of the other components between the analysis periods are similar to the assessment of the moisture content values. Specifically, the ash content and VS of the other components are different due to the different components of the SW samples taken. The SW samples containing garden waste, hair, etc. have the higher combustible possibility and lower ash content compared to the SW samples containing soil, etc.

  + The rest components that have the ash content of less 20% include 17.1% for paper, 13.6% for diaper, 11.7% for plastic, 13.1% for textile , 12.0% for wood.

- **For VS:**

  + The components that have the average ash content of less 20% will have the highest average VS, over 80% including 82.9% for paper, 86.4% for diaper, 88.3% for plastic, 86.9% for textile , 88.0% for wood.

  + The components that have the average ash content in range of 50 – 80% include 56.6% for others, 77.0% for food and 78.2% for rubber-leather.

  + The shell-bone has high ash but the lowest VS of only 3.0%.

Relation between moisture content, ash content and VS

The relation between the moisture content, ash content and VS of each SW component in the Phuoc Hiep Landfill is shown in **Figure 8**.

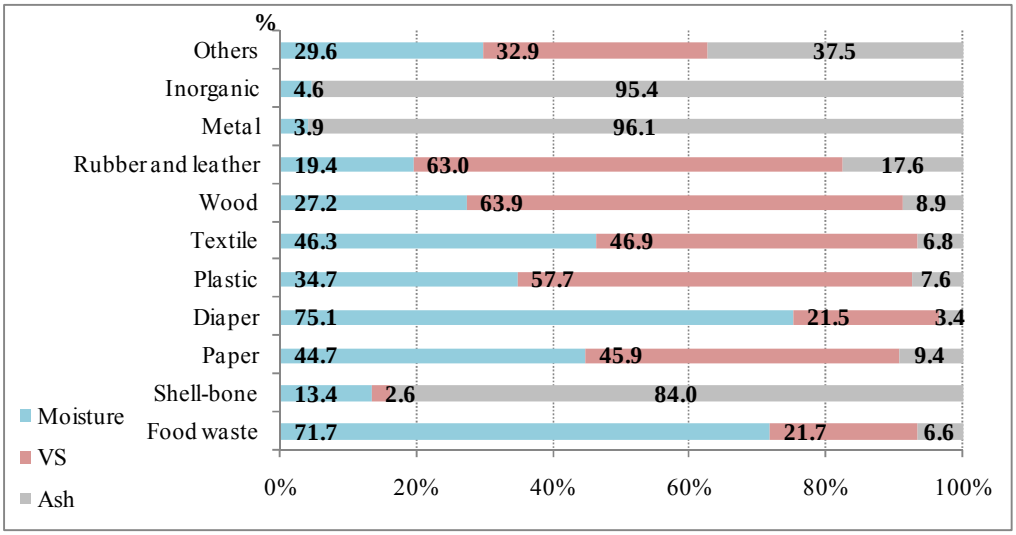


Figure 8. Relation between moisture content, ash content and VS of each SW components in Phuoc Hiep Landfill.

- The food has the highest proporation by weight compared to the other components and also rather high moisture content (67.6 – 74.3%). The food contains mainly organic matters, so it has good combustible possibility at 550^{o}C. As a result, the VS and ash content of this component is about 20.1 - 24.1% and 4.4 – 9.1% respectively.

- As above-mentioned, the diaper has the highest moisture content compared to the other components (in range of 71.2 – 80.8%). This component is made by organic, flammable matters such as cotton, paper, etc., so its VS and ash content are about 16.0 – 25.8% and 2.7 – 5.0% respectively.

- The paper has the moisture content in range of 38.7 – 53.8%; rather high VS in range of 37.5 – 50.0% that is approximately the moisture content; ash content of only 7.4 – 11.3%.

- The other components such as plastic, textile , wood, rubber – leather have the average moisture content (6.0 – 54.0%), high VS (40.9 – 75.9%) and low ash content (5.9 – 22.2%).

Moisture content, ash content and VS of mixed sample

The mixed sample in the Phuoc Hiep Lanfill that is new SW has rather high moisture content in range of 55.4 – 70.9%. Almost combustible components at 550^{o}C are oberved

in the SW in the Phuoc Hiep Landfill, so the VS of this mixed sample is rather high, occupied 23.7 – 32.2% while the incombustible inert components is rather low, approximately 10%, in range of 5.4 – 12.4%.

HHV

Almost SW components in the Phuoc Hiep Landfill have all the HHV in range of 3,700 – 8,400 Cal/g. The analytical result of the HHV of the SW components in the Phuoc Hiep Landfill is shown in **Figure 9**.

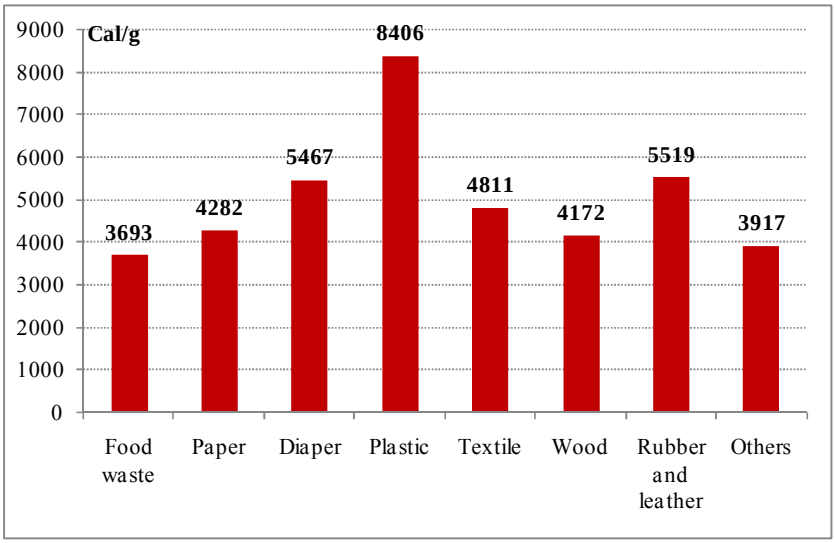


Figure 9. HHV of the SW components in Phuoc Hiep Landfill.

The plastic has the highest heating value compared to the other components, reached 8,406 Cal/g in average. This component occupies significantly in the SW components in the Phuoc Hiep Landfill in particular and in the MSW in Vietnam in general.

The components such as paper, diaper, textile , wood, rubber-leather have all the average heating value in range of 4,000 – 5,000 Cal/g.

Others and food that have the LHVs are 3,917 Cal/g and 3,693 Cal/g respectively.

In conclusion, the heating values of the separate components of the SW in the Phuoc Hiep Landfill are rather high, so these components could be burned to produce the energy (> 1,500 Cal/g). The heating values of the mixed sample in the Phuoc Hiep landfill fluctutates 1,370 – 2,297 Cal/g (HHV) and 987 – 2,001 Cal/g (LHV). These values are suitable for being burned to produce the energy. However, these components could be treated by the incineration method (> 800 Cal/g).

3.2 SW properties in Dong Thanh Landfill

3.2.1 SW components in Dong Thanh Landfill

The analytical result of the SW components left in the Dong Thanh Landfill is presented in **Table 4** and shown in **Figure 10**.

As analytical result of the SW components, the mud that is left in the SW samples fluctuates 0.0 - 50.2%. The SW samples that are taken in the drilled hole No. 1 have the mud with the highest concentration (among three drilled locations) in range of 26.7% - 50.2%. The SW samples that are taken at deeper locations have the lower concentration of mud. The SW samples that are taken in the drilled hole No. 2 have the lower concentration of mud compared to the SW samples taken in the drilled hole No. 1. Except two samples at a depth of 17m and 20m, they have a little of mud while the other samples (at a depth of 3m, 6m, 9m, 12m) have the mud concentration in range of 23.3 - 27.7%. the SW samples that are taken in the drilled hole No. 3 have the lowest concentration of mud in range of 9.1% - 14.7%.

Among 18 components of the SW samples taken in the Dong Thanh Landfill, plastic (mainly nylon) has the highest percentage (20.7% - 62.7%). The SW samples that have low concentration of mud often contain a lot of nylon. Five SW samples that are taken in the drilled hole No. 3 have the concentration of nylon in range of 43.4% - 54.3%. The SW samples that are taken in the drilled hole No. 1 have the lower concentration of nylon in range of 20.7% -41.8%. The high concentration of nylon left in the SW components in the Dong Thanh Landfill is one of causes affecting the decomposition rate of organic matters, LFG recovering possibility as well as leachate removal.

After plastic and mud, the bamboo-straw-leaves that are also observed with a large amount in the SW samples analyzed occupy 11.4% - 20.7%. Although the components namely stone-ceramic; shell-bone; textile ; rubber have the lower proportion, they are all observed in the SW samples analyzed. Especially, some samples could contain sacks with the percentage of up to 11.6%.

The components that have very low proportion include paper (0-2.1%), wood (0-5.3%), leather (0-1.1%), color metal (0-2.4%), iron (0-0.5%). Some samples are observed with hair, occupied 0,6%.

Therefore, beside mud (completely decomposed and not decomposed), there are paper, wood and some low degradable organic components in the Dong Thanh Landfill that could be decomposed to produre the gases or be burned to produce the energy.

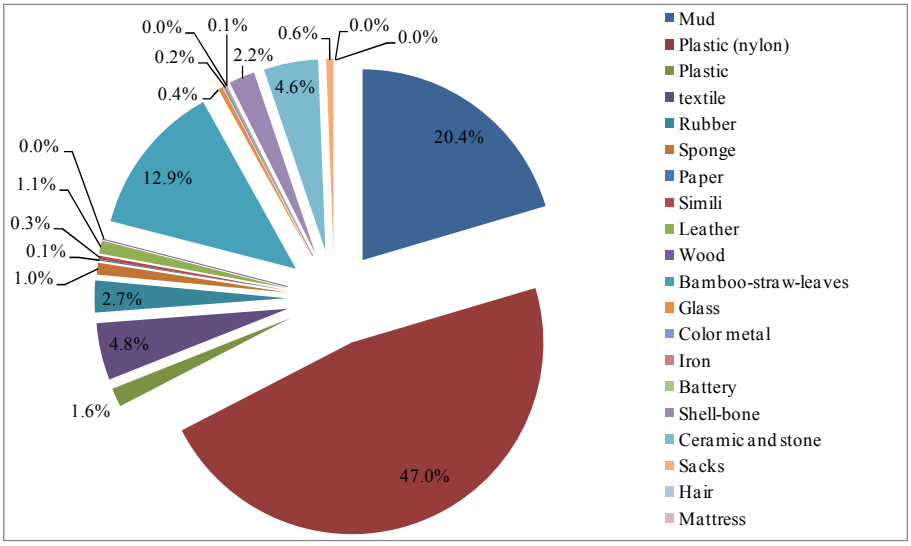


Figure 10.SW components in Dong Thanh Landfill (%ww).

3.2.2 Physical, chemical properties in Dong Thanh Landfill

The analytical result of moisture content, ash content, VS, Total organic carbon (TOC) of the SW sample taken in the Dong Thanh Landfill is briefly presented in **Table 5** and shown in **Figure 11**, **Figure 12** as follows:

Moisture content

The moisture content of the SW samples taken in the Dong Thanh Landfill fluctuates about 50.0 - 68.0%. In which, almost SW samples have the moisture content in range of 50 - 60% that is lower than the moisture content of the SW buried (normally in range of 75.0 – 85.0%). The moisture content of the SW samples taken in same drilling hole, at various depth is different about 0.8 - 14%. The SW samples that are taken at deeper points have normally the higher moisture content. It shows that the leachate is flowed towards the bottom of the landfill cell. However, the SW samples that are taken in different points at same depth have significantly different moisture content. For example, the SW samples taken at a depth of 6m have the moisture content such as about 50.8% for I6, 56.9% for II6 and 61.0% for III6. The moisture content distribution is different inside the landfill that is resulted from many causes namely the different moisture content of the SW components buried, level of different compression in various landfill locations, different landfill time and movement of leachate inside the landfill. In which, the last one is a main cause for the different distribution of the SW moisture content inside the landfill.

Ash content and VS

The ash content and VS of the SW samples in the Dong Thanh Landfilln fluctuate about 12.0 – 40.0%ww and 10 – 28%ww respectively.

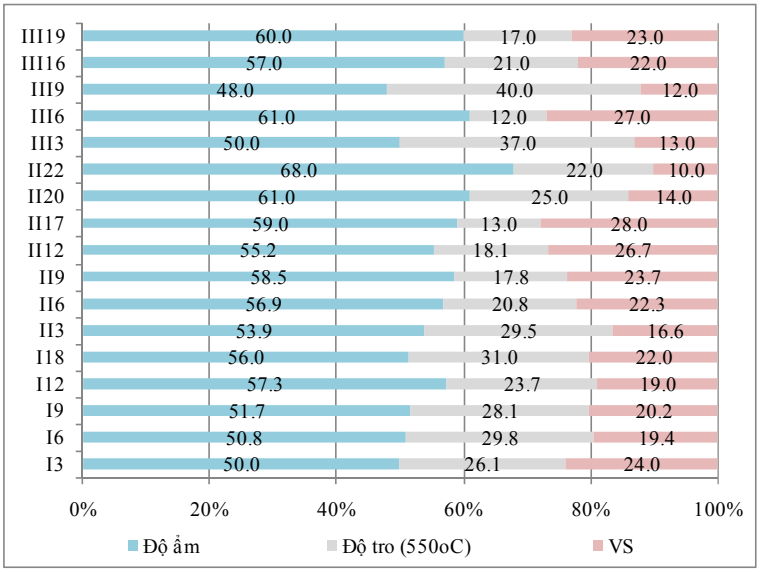


Figure 11. Relation between moisture content, ash content and VS of the SW samples in Dong Thanh Landfill.

TOC

As the analytical result of the chemical properties of the SW samples taken in the Dong Thanh Landfill, it shows that the TOC significantly fluctuates depending on the locations and depth of the SW samples taken (3.3 – 23.8%), in which:

- Up to 35% of SW samples have TOC < 10%, mostly of samples from drill hole No.I and No.II at shallow depth from 3 to 12m.
- 47% of samples have TOC ranging from 10% to 20%, mostly of samples from drill hole No.III.
- Yet only 18% of samples have TOC > 20%.

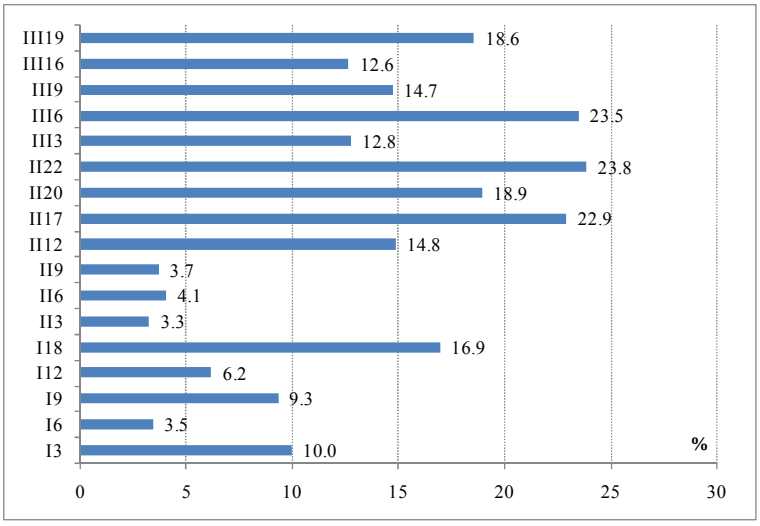


Figure 12.TOC of the SW samples in Dong Thanh Landfill.

Table 4.SW components in Dong Thanh Landfill

Component	Percentage (%)																	
	Mixed sample	I3	I6	I9	I12	I18	II3	II6	II9	II12	II17	II20	II22	III3	III6	III9	III16	III19
Mud	20.4	36.6	39.7	43.2	50.2	26.7	27.7	24.1	24.9	23.3	0	0	14.7	13.0	9.1	12.7	12.2	12.4
Nylon	47.0	24.0	27.4	22.0	20.7	41.8	25.9	34.4	26.7	47.2	58.2	62.7	51.1	43.6	54.3	43.4	48.3	53.3
Plastic	1.6	1.3	0.7	0.7	1.2	3.1	1.6	1.7	1.7	2.7	2.5	2.0	1.8	2.6	2.0	1.8	3.5	1.9
Textile	4.8	14.9	6.1	1.9	2.8	2.9	6.5	0.6	3.9	1.2	1.6	6.4	4.4	5.5	1.9	2.3	2.7	2.0
Rubber	2.7	3.1	2.7	1.3	2.4	0.6	4.0	1.8	0.6	0.4	2.3	0.7	1.4	2.2	2.2	1.6	1.3	2.1
Sponge	1.0	0.7	0.1	1.1	0	0	0.8	0.6	2.8	0.5	0	0.6	0.6	0.6	0.8	0	1.5	1.3
Paper	0.1	0	0.6	2.0	0	0	2.1	1.4	1.5	0.4	0	0.1	0	0	0	0	0	0
Simili	0.3	1.1	0.5	3.7	0.5	0.7	1.8	0	0	1.9	3.1	1.8	1.6	1.5	0.6	0.8	1.6	1.7
Leather	1.1	0.3	0.3	0	0	0	0.5	0	0	0	0.6	0.3	0.6	0.3	0	0.7	0	0
Wood	0	5.3	3.3	1.6	0.4	0	0	1.1	0.3	0	0	0	0	0.8	0	0.5	0	1.4
Bamboo, straw, leaves	12.9	8.2	11.7	19.3	18.5	13.5	17.3	20.7	13.0	16.6	17.9	17.0	16.5	14.8	12.5	15.8	15.7	11.4
Glass	0.4	1.0	0.2	0	0.3	0.5	0	0.3	0.6	0.5	0.8	0.1	0.2	0.2	0.6	1.3	0.2	0.4
Color metal	0.2	0.1	0.2	0	0	0.1	0	0	0	0	0.9	0.7	0.7	0.9	1.9	1.5	1.0	2.4
Iron	0	0	0	0	0	0.2	0.1	0	0.1	0.5	0	0	0	0	0	0	0	0
Battery	0.1	0.1	0	0.1	0.1	0.1	0.1	0	0.2	0.1	0	0	0.1	0	0	0	0	0.1
Shell-bone	2.2	1.6	0.8	0.8	0.4	0.8	4.7	0.6	1.6	0.8	1.1	2.0	1.8	0.6	1.4	0.9	1.5	0.9
Stone and ceramic	4.6	1.1	5.8	2.4	2.5	6.0	3.7	1.7	10.6	1.6	10.1	5.1	3.2	9.5	9.5	15.3	8.7	5.8
Sack	0.6	0	0	0	0	3.1	2.0	5.2	11.6	2.1	0.9	0.4	1.1	3.8	3.0	1.4	1.7	2.9
Hair	0	0.6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Mattress	0	0	0	0	0	0	1.0	5.7	0	0	0	0	0	0	0	0	0	0
Total	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**

Source: DONRE, 2007

Table 5. Physical, chemical properties of the SW samples in Dong Thanh landfill

Property	Value																	
	Đơn vị	I3	I6	I9	I12	I18	II3	II6	II9	II12	II17	II20	II22	III3	III6	III9	III16	III19
Moisture content	%	50.0	50.8	51.7	57.3	56.0	53.9	56.9	58.5	55.2	59.0	61.0	68.0	50.0	61.0	48.0	57.0	60.0
Ash content (550^{o}C)	%ww	26.1	29.8	28.1	23.7	31.0	29.5	20.8	17.8	18.1	13.0	25.0	22.0	37.0	12.0	40.0	21.0	17.0
VS	%ww	24.0	19.4	20.2	19.0	22.0	16.6	22.3	23.7	26.7	28.0	14.0	10.0	13.0	27.0	12.0	22.0	23.0
TOC	% (DW)	9.95	3.46	9.34	6.20	16.94	3.29	4.07	3.72	14.84	22.90	18.92	23.84	12.75	23.47	14.70	12.64	18.55

Source: DONRE, 2007

HHV

The SW sampling in the Dong Thanh Landfill is not catered for analyzing the HHV of the SW. However, the HHV of each SW component could be estimated depending on the analytical result of the elements namely C, H, O, N, S and the following formula (Tchobanoglous et al. 1993):

$$HHV = 145 \times C + 610 \times \left(H_2 - \frac{1}{8}O_2\right) + 40 \times S + 10 \times N \text{ (Btu/lb)} \quad (2)$$

Where:

C: percentage of C (Carbon) by dry weight (DW)
H_2: percentage of H (Hydrogen) by DW
S: percentage of S (Sulfur) by DW
O_2: percentage of O (Oxygen) by DW
N: percentage of N (Nitrogen) by DW

The analytical result of C, H, O, N, S of each SW component and the estimated HHV of the SW components in the Dong Thanh Landfill are presented in **Table 6** and shown in **Figure 7** below.

Table 6. Analytical result of C, H, O, N, S of the SW components in the Dong Thanh Landfill

Component	DW (kg)	Weight of elements											
		C		H		O		N		H		Ash	
		%	Kg	%	Kg	%	Kg	%	Kg	%	Kg	%	Kg
Paper	0.44	43.50	0.19	6.00	0.03	44.00	0.19	0.30	0.00	0.20	0.00	6.00	0.03
Textile	3.25	55.00	1.79	6.60	0.21	31.20	1.01	4.60	0.15	0.15	0.00	2.50	0.08
Rubber	1.19	78.00	0.93	10.00	0.12		0.00	2.00	0.02		0.00	10.00	0.12
Leather	0.73	60.00	0.44	8.00	0.06	11.60	0.08	10.00	0.07	0.40	0.00	10.00	0.07
Wood	1.61	49.50	0.80	6.00	0.10	42.70	0.69	0.20	0.00	0.10	0.00	1.50	0.02

Source: DONRE, 2007

Table 7.HHV of the SW components in Dong Thanh Landfill under Tchobanoglous et al. 1993

No.	Component	**HHV** (Btu/lb)	**HHV** (Cal/g)
1	Paper	6,616	3,693
2	Textile	9,668	5,397
3	Rubber	17,430	9,730
4	Leather	12,796	7,143
5	Wood	7,584	4,233
6	Mixed sample	-	-

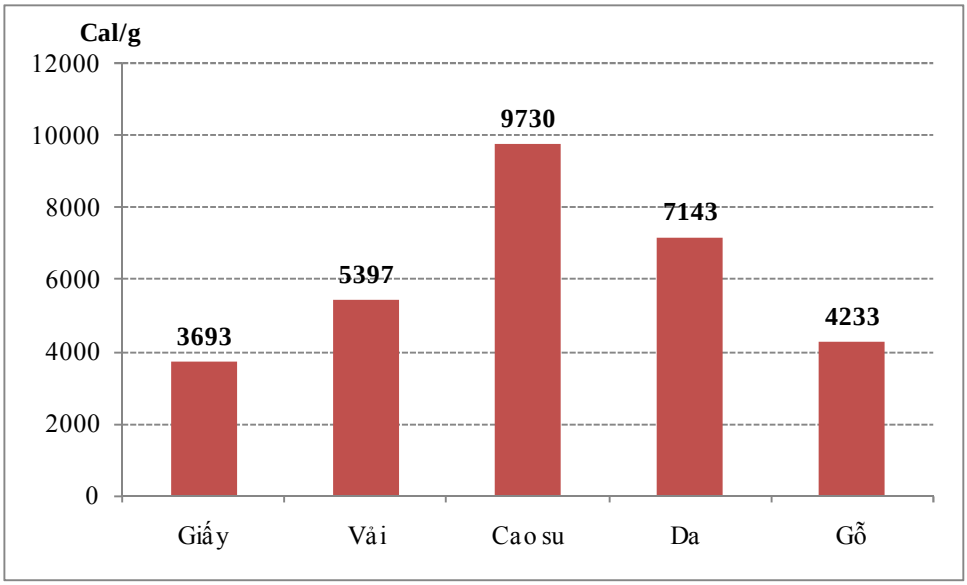


Figure 13. HHV of the SW components in Dong Thanh Landfill.

As mentioned in Table 7, the HHV of the separate components in the Dong Thanh Landfill is rather high. Thus, these components could be burned for the energy recovery. However, the heating value of mixed sample that is estimated depending on the HHV of each separate component (paper, textile , rubber – leather and wood) in the Dong Thanh Landfill is rather low, about 427 Cal/g (HHV).

3.3 SW properties in Go Cat Landfill

The SW that is taken at two points with a depth of 1m and 5 – 5.5m in the Dong Thanh Landfill caters for analyzing its components. The SW samples at different depth have some different properties namely density, components, moisture content, etc. but have a general property of SW buried by time. The analytical result of the SW components taken in the Go Cat Landfill dated October 2012 is presented hereinafter.

3.3.1 SW components in Go Cat Landfill

Similar to the SW samples in the Dong Thanh Landfill, the SW components after being buried in over 7 years in the Go Cat Landfill are mainly the persistent biodegradable components and inorganic components together with mud, soil and stone mixed in the SW. In addition, there are the components that could be separated consist of plastic, textile , wood, shell-bone, glass, metal, paper, leather and some hazardous components (battery, syringe), persistent biodegradable components (coconut fiber, mango seeds, etc.) and some components (e.g. hair, soil, stone; scrap textile , plastic, etc.) that could not be visually separated are called as “others”.

SW components by wet weight (%ww)

The SW components by WW that are taken in the Go Cat Landfill are presented in **Figure 14** below.

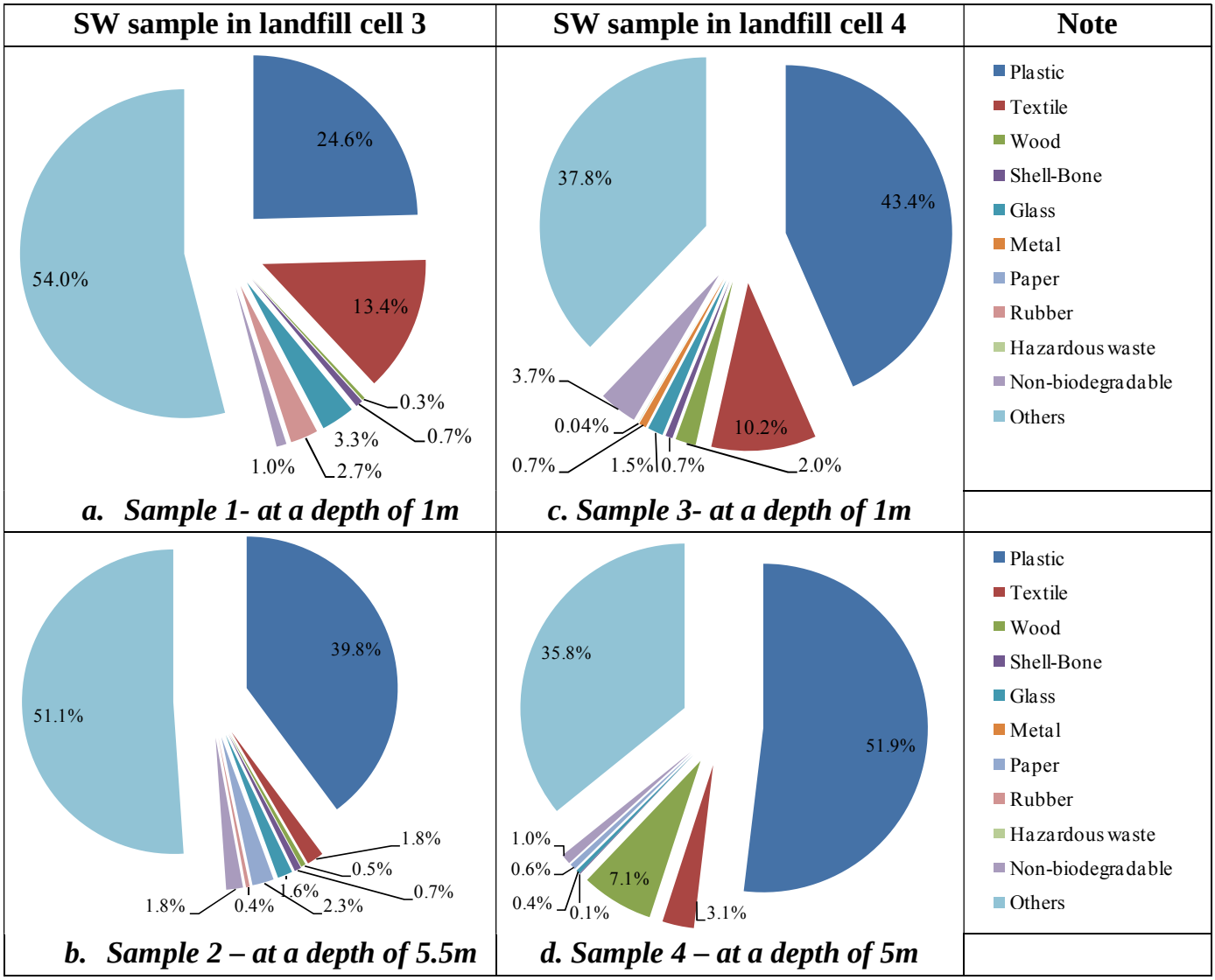


Figure 14. SW components in Go Cat Landfill by wet weight (%ww).

The plastic mainy nylon is a main component of the SW in the Go Cat Landfill, occupied about 24.6%ww – 51.9%ww according to the buried depth and location. This component has the high percentage in the SW due to its usefulness in daily life. Moreover, the component could be decomposed for a long time (40 – 100 years), thus it could not be decomposed in the period of 7 – 10 years, it has stayed mostly the same and not been decomposed. For that reason why it has the high percenatged in the SW.

In SW layers at a depth of about 1m, the textile has also the high percentage (10.2%ww and 13.4%ww while this component is not much at a depth of about 5 – 5m (3.1%ww and 1.8%ww).

As analytical result, the percentage of wood is not similar between the SW samples. Specifically, the wood is about 0,3 – 0,7%ww in the SW samples taken in the landfill cell 3 while the wood is up to 2,0 – 7,1%ww in the SW samples taken in the landfill cell 4.

The percentage of the other components is lower namely about 0.1 – 0.7%ww for shell-bone, 0.4 – 1.9%ww for glass. The metal has is rather low percentage and is only observed in the sample taken in the landfill cell 4 (about 0.7%ww).

The paper is a degradable component and easily rotted in flooded leachate condition in the landfill cells, the rest paper is mainly carton or plastic coated paper. There are only two among four samples that are observed with this component. Specifically, the paper is observed in the sample at a depth of 5.5m in the landfill cell 3 (2.3% ww) and in the sample at a depth of 5m in the landfill cell 4 (0.6% ww).

Similarly, the rubber has low percentage and is not similar between the samples. It is observed in the sample taken in the landfill cell 3, occupied about 1.6%ww (Sample 1, at a depth of 1m) and about 0.4%ww (Sample 2, at a depth of 5.5m).

The hazardous components such as battery, syringe are only observed in the Sample 3 at a depth of 1m in the landfill cell 4, occupied about 0.04%ww.

The persistent biodegradable components (e.g. coconut fiber, mango seeds, etc.) are rather uniformly distributed in the samples in the Go Cat Landfill, occupied about 1.0 – 3.7%ww.

Because the SW was buried for a long time with many components decomposed into scraps that could not be visually separated, “others” have the highest percentage, about 35.8 – 54.0%ww.

SW components by dry weight (%DW)

The SW components by DW that are taken in the Go Cat Landfill is presented in **Figure 15** below.

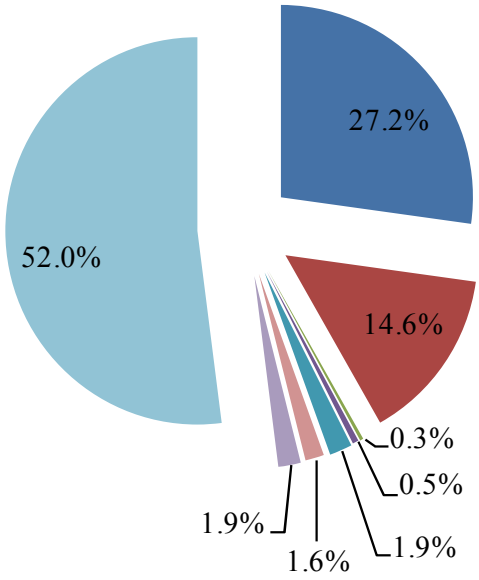
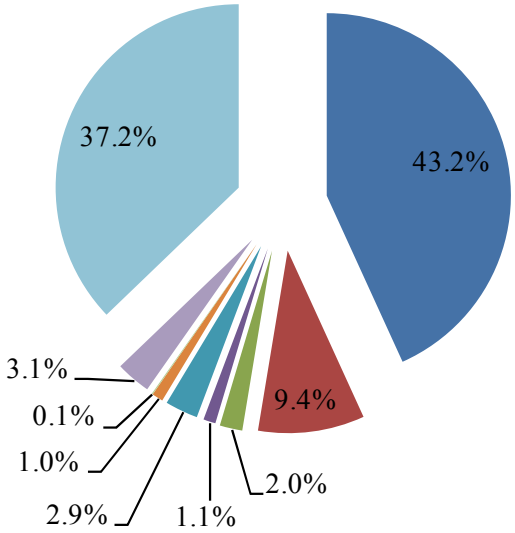
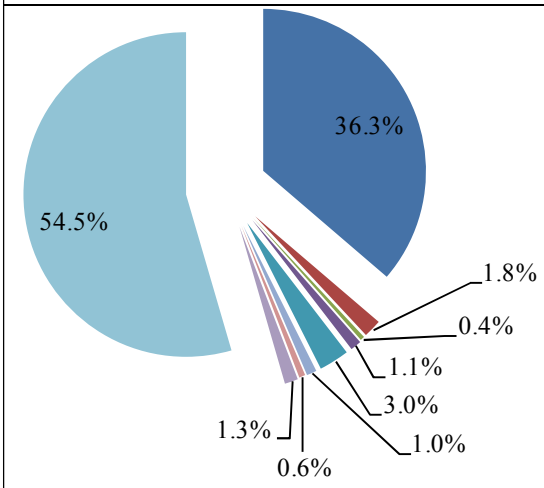
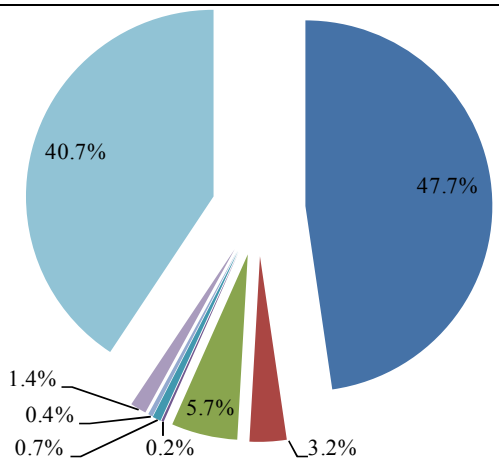
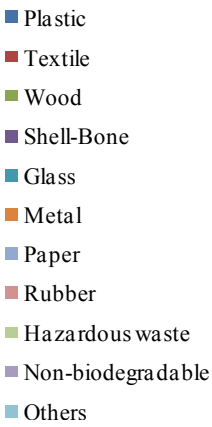
SW sample in landfill cell 3	SW sample in landfill cell 4	Note
		
Sample 1- at a depth of 1m	***Sample 3- at a depth of 1m***	
		
Sample 2 – at a depth of 5.5m	***Sample 4 – at a depth of 5m***	

Figure 15.SW components in Go Cat Landfill by DW (%dw).

As above-shown in Figure 15, the percentage of the SW components by DW is similar to one by WW. In which, the plastic (mainly nylon) are about 27.2 – 47.7%dw; the textile has a higher percentage in the samples at a depth of 1m in the landfill cell 3 and landfill cell 4 that is about 14.6%dw and 9.4%dw respectively and only 1.8%dw and 3.2%dw at a depth of 5 – 5.5m.

The other components such as wood, shell-bone, glass, metal, paper, rubber, hazardous components and persistent biodegradable components have rather low percentage, less 5%dw, occupied about 0.2 – 3.1%dw.

Similar to estimation by WW, others that are estimated by DW have rather high percentage, occupied about 37.2 – 52.0%dw.

3.3.2 Physical, chemical properties in Go Cat Landfill

Density

Because the SW were buried in the landfill cells and affected by leachate, so the SW density could be varied on the increase of the depth of the SW buried. As analytical result, it shows that the SW density in lower layers (5 – 5.5m) is higher than one in upper layers (1m) as presented in **Table 8**.

Table 8. SW density in Go Cat Landfill

No.	Sample	Density (kg/l)
1	Sample 1- landfill cell 3 – 1m	0.65
2	Sample 2 – landfill cell 3 – 5.5m	0.70
3	Sample 3 – landfill cell 4 – 1m	0.61
4	Sample 4 – landfill 4 – 5m	0.72

As mentioned in **Table 8**, the SW density at a depth of 1m that ranges 0.61 – 0.65 kg/l is lower than one at a depth of 5.0 – 5.5m, occupied about 0.70 - 0.72 kg/l.

Moisture content

The SW components in landfill cells has high moisture content due to the affect of leachate inside the landfill cells as follows:

The paper has the highest moisture content compared to the other components analyzed. It is resulted from the water absorption and retention, especially in flooded leachate condition like the landfill cells at a depth of 5 – 5.5m. The moisture content of the paper in the Sample 2 and Sample 4 is 79.8% and 74.3% respectively.

The components such as plastic, textile , wood and others have the moisture content of about 50%, specifically plastic (52.3 – 58.6%); textile (52.0 – 55.6%); wood (51.8 – 63.7%); others (45.6 – 52.8%).

The persistent biodegradable components namely coconut fiber, mango seeds have the moisture content in range of 60.4 – 72.0%. Especially, the Sample 4 is mainly mango seeds (low moisture content), so the moisture content of this sample that is about 36.4% is lower than one of the samples containing a lot of coconut fibers.
The rubber has the moisture content in range of 15.9 – 39.7%. The samples at a depth 5.5m has higher moisture content.

The shell-bone has stable and rather low moisture content, approximately 20% (in range of 21.1 – 24.9%). The moisture content of the glass fluctuates 8.2 – 22.8%. The moisture content of the metal is about 22.4% (Sample 3). The Sample 3 contains the hazardous components namely battery and syringe, so it has the lowest moisture content, occupied only 4.2%.

The moisture content of the SW components in the landfill cells is shown in **Figure 16**.

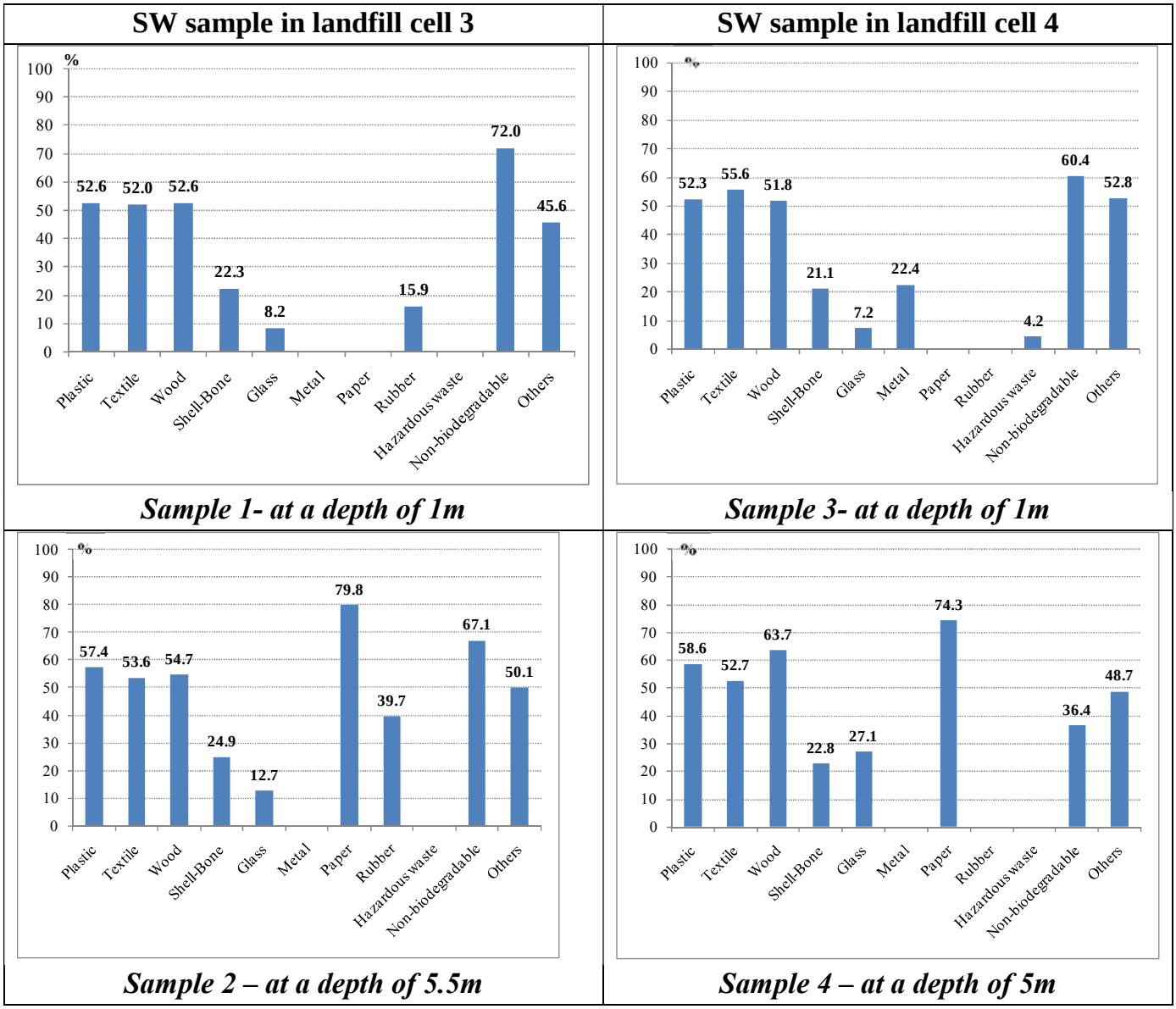


Figure 16. Moisture content of the SW components in Go Cat Landfill.

VS/ash content

The analytical result of VS/ash content by DW is shown in **Figure 17**.

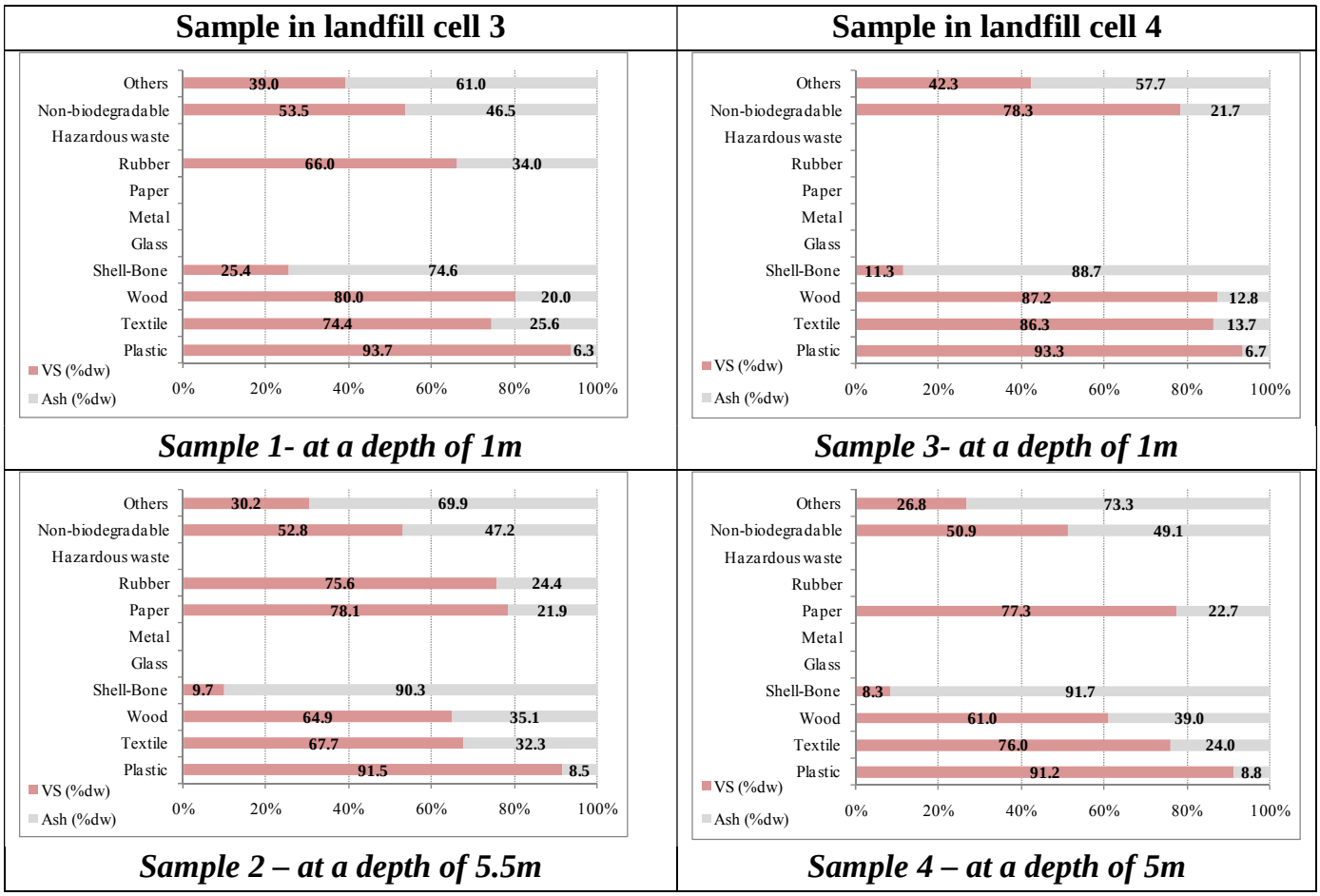


Figure 17.VS/ash content by DW of the SW samples in Go Cat Landfill.

The components that could be highly combustible at 550^{o}C include plastic (VS of about 91.2 -93.7%dw); textile (VS of about 67.7 – 86.3%dw); wood (VS of about 61.0 – 87.2%dw), rubber (VS of about 66.0 – 75.6%dw); paper (VS of about 78.1 and 77.3%); persistent biodegradable components (VS of about 50.9 – 78.3%dw).

Otherwise, "others" and shell-bone are two components that could not be highly combustible at 550^{o}C and the incombustible inert matters are left rather much. The ash content of two components is 57.7 – 73.3%dw and 74.6 – 91.7%dw respectively.

The components such as metal, glass and hazardous components are incombustible inorganic components, so the VS of these components is zero.

Relation between moisture content, ash content and VS

The relation between the moisture content, ash content and VS of each SW component in the Go Cat Landfill is shown in **Figure 18**.

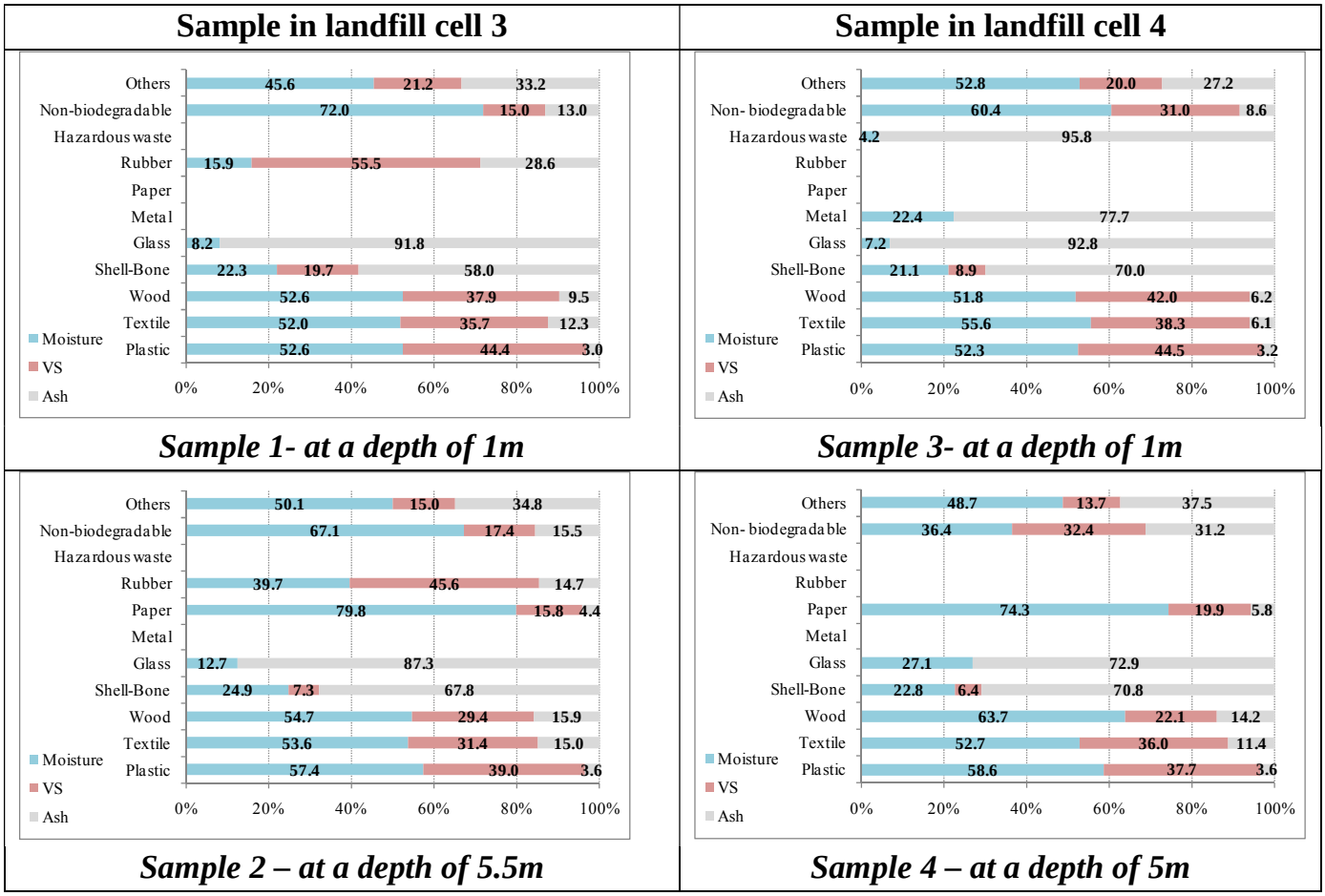


Figure 18. Relation between the moisture content, ash content and VS of each SW component in Go Cat Landfill.

According to the relation between the moisture content, ash content and VS of the SW components in the Go Cat Landfill, it shows that the moisture content is a high propotion in almost SW components, especially combustible components including:

- The plastic that has the moisture content in range of 50 – 60% is highly combustible component (VS: 35 – 45%ww) with rather low ash content of only 3%;
- Similarly, the textile and wood that has the moisture content in range of 50 – 60% is highly combustible component (VS: 35 – 45%ww) with ash content of approximately 10%.

- The persistent biodegradable components namely coconut fiber and mango seeds have also high moisture content (mainly coconut fiber) in range of 60 – 72%; average combustible possibility with similar VS and ash content.

In addition, some other components that have low moisture content and low combustible possibility include as follows:

- The shell-bone has low moisture content of about 20%, VS in range of 6.4 – 19.7%ww, ash content of about 58.0 – 70.8%ww.

- The glass, metal and hazardous components have low moisture content of approximately 10%, no VS and, high ash content of up to 90%.

Moisture content, ash content and VS of mixed sample

The moisture content, ash content and VS of mixed sample are presented in **Table 9** below.

Table 9. Moisture content, ash content and VS of mixed sample in Go Cat Landfill

No.	Sample	Moisture content (%ww)	Ash content (%ww)	VS (%ww)
1	Sample 1- Landfill cell 3 – 1m	47.7	22.6	29.7
2	Sample 2 – Landfill cell 3 – 5,5m	53.3	21.9	24.8
3	Sample 3 – Landfill cell 4 – 1m	52.0	15.2	32.8
4	Sample 4 – Landfill cell 4 – 5m	55.0	17.4	27.6

As mentioned in **Table 9**, the moisture content of the SW samples buried in the landfill cells in the Go Cat Landfill that is about 50% (in range of 47.7 – 55.3%) is similar to one in the Dong Thanh Landfill but lower than one unburied in the Phuoc Hiep Landfill (in range of 55.4 – 71% (ETM, 2014)).

The ash content and VS are similar and insignificantly different from the ash content and VS of the SW unburied. In which, the combustible components at 550^{o}C (VS in range of 24.8 – 32.8%) have always VS that is higher than VS of the incombustible components (ash content in range of 15.2 – 22.6%). The difference between two parameters in the Go Cat Landfill is about 1.0 – 2.0 times that is lower than one in the Phuoc Hiep Landfill (2.5 – 4.5 times). The VS of the SW buried is reduced in comparison with new SW that

could be clarified depending on the degradable possibility of the combustible components (e.g. organic wastes, paper, newspaper, leaves, etc.) buried under the ground in many years.

HHV

The HHV of each component of the SW samples in the Go Cat Landfill is shown in **Figure 19** below.

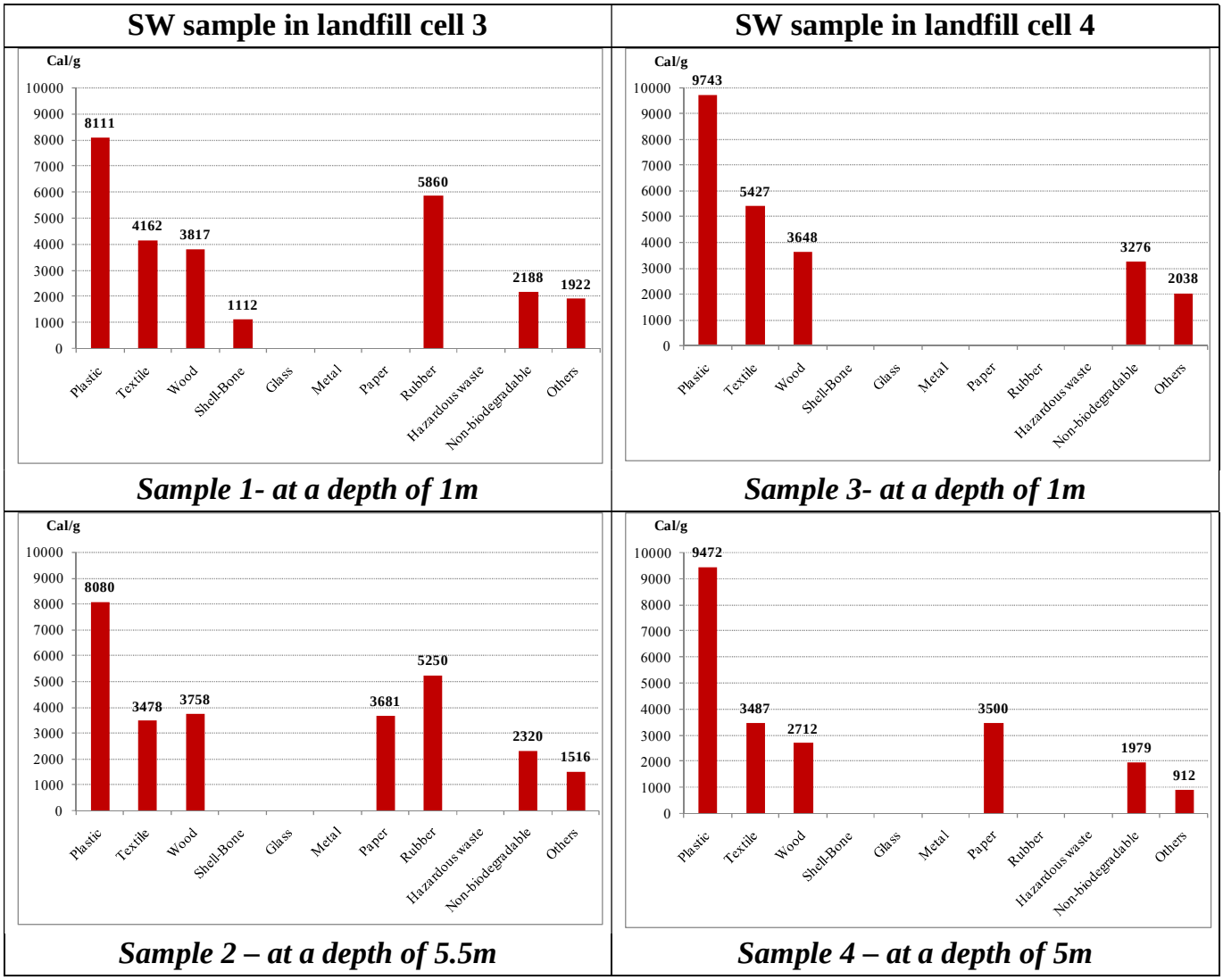


Figure 19. HHV of the SW components in Go Cat Landfill.

As shown in Figure 19, the persistent biodegradable components and others have the HHV in range of 2,000 – 10,000 Cal/g. These are the highly combustible components (high VS, low ash content) as follows:

- The plastic has HHV. The analytical result shows that the HHV of the plastic in the SW components in the Go Cat Landfill is similar to the HHVs that were

recorded from the national and international researches performed. The HHV of the plastic fluctuates 8,080 – 9,743 Cal/g.

- Next is the HHV of the rubber that are 5,860 Cal/g (Sample 1) and 5,250 Cal/g (Sample 2).

- The HHV of the paper fluctuates 3,487 – 5,427 Cal/g.

- The HHV of the wood that is similar to the one of the paper fluctuates 2,712 – 3,817 cal/g.

- The HHVs of the persistent biodegradable components and others that are lower than the HHVs of the rest components fluctuate 912 – 2,320 Cal/g.

HHV of mixed sample

The HHV of mixed sample in the Go Cat Landfill is rather high, in range of 1,980 – 2,709 Cal/g (HHV) and 1,724 – 2,429 Cal/g (LHV). The analytical result of the heating values of the SW samples in the Go Cat Landfill is shown in **Figure 20**.

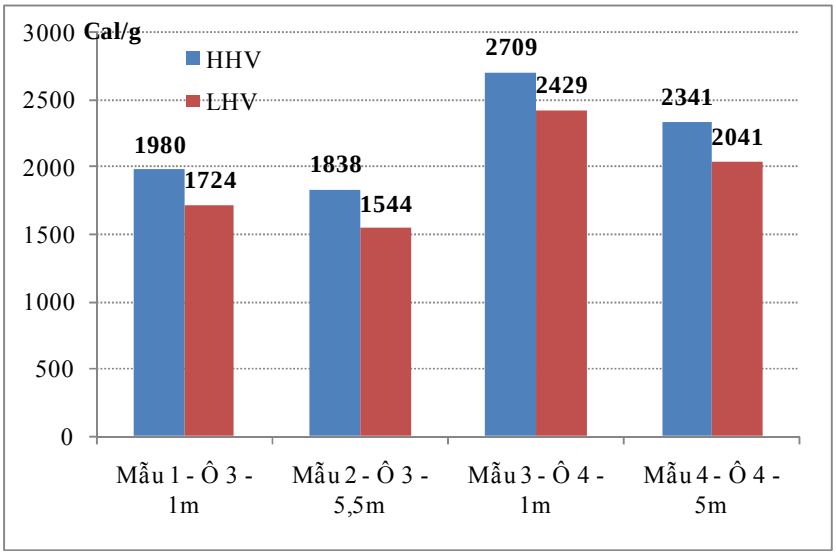


Figure 20. HHV and LHV of the SW samples in Go Cat Landfill.

4 CONCLUSION

The SW after being buried for a long time will be decomposed and rotten as well as affected by leachate in the landfill cells, so this SW will be significantly changed compared to the SW unburied. It could be applied to explain the difference between the SW in the Phuoc Hiep Landfill with the SW in the Dong Thanh Landfill and Go Cat Landfill. The SW components and properties in these landfills are summarized as follows:

SW in Phuoc Hiep Landfill:

- ***Composition***: The food occupies up to 66.2%ww and 49.1%dw that are many times higher than the other components. Next, the plastic has also high proportion with 17.0%ww and 27.2%dw. The other components namely textile , diaper, paper, inorganic components, shell-bone, rubber-leather, wood, metal and others have low proportion, in range of 0.2 – 5.8%ww and 0.4 – 7.7%dw.

- ***Moisture content***: The moisture content of the food, paper, diaper and textile is rather high, in range of 45.9 – 76.4%. In which, the diaper has the highest moisture content (76.4%), followed by food (71.6%), textile (47.6%) and paper (45.9%). The components that have average moisture content includes plastic (36.2%), wood (28.4%), rubber-leather (21.4%), and others (29.6%). The other components that have rather low moisture content, approximately 10% include shell-bone, metal and others.

- ***Relation between moisture content, ash content and VS:*** The relation between the moisture content, ash content and VS of the SW samples in the Phuoc Hiep Landfill shows that the moisture content, VS and ash content of the SW samples are 55.4 – 70.9%, 23.7 – 32.2% and 5.4 – 12.4% respectively.

- ***HHV:*** The plastic has the highest heating value, approximately 8,400 Cal/g in average while the food has the lowest heating value, approximately 3,700 Cal/g. The other components have the average heating value in range of 4,100 – 5,500 Cal/g. The mixed sample has about 1,300 – 2,300 Cal/g (HHV) and 980 – 1,800 Cal/g (LHV).

SW in Dong Thanh Landfill and Go Cat Landfill:

- ***Composition***: The SW components in these landfill are mainly mud created by the decomposition of organic matters and inorganic or persistent biodegradable components such as nylon, paper (carton, plastic coated paper), wood, metal, rubber, textile , coconut fiber, mango seeds, shell-bone. In which, the plastic mainly nylon

occupies about 20 – 65% and others (mud, soil, stone, hair, scrap paper, scrapnylon, etc.) occupies about 50% of total amount of SW.

- ***Moisture content***: The moisture content of the buried SW components that is rather high is mainly affected by leachate inside the landfill cells. The components that have high moisture content include paper with the highest moisture content (70 – 80%); coconut fiber, mango seeds (60 – 75%); plastic, textile , wood (45 – 60%); mud, soil, stone (approximately 50%), rubber (15 – 40%). The other components that have low water absorption leading to low moisture content, in range of 5 – 20% include metal, glass, inorganic components, shell-bone, etc.

- ***Relation between moisture content, ash content and VS:*** The moisture content of SW buried in landfill cells (50 – 60%) is lower than one of SW unburied (before being buried) (about 60 - 80%). The VS of the SW buried is also lower than one of the SW unburied. As a result, the ash content and the incombustible components have higher proportion.

- ***HHV:*** In buried SW components, some combustible components that could be burned to produce the HHV include plastic, wood, paper, rubber, textile (HHV in range of 3,600 – 9,800 Cal/g); the other components that are persistent biodegradable components (e.g. coconut fiber, mango seeds) or others (mud, soil, stone; scrap textile , scrap nylon, hair, etc.) and shell-bone have lower heating values in range of 900 – 3,300 Cal/g.

2-5 DETERMINATION OF THE HEATING VALUE OF SOLID WASTE FROM THE SOLID WASTE SEPARATION PROGRAM AT SOURCE IN ISTRICT 1 AND BINH THANH DISTRICT

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Report 3

DETERMINATION OF THE HEATING VALUE OF SOLID WASTE FROM THE SOLID WASTE SEPARATION PROGRAM AT SOURCE IN DISTRICT 1 AND BINH THANH DISTRICT

October 2014

Contents

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APHA	American Public Health Association
DONRE	Department of natural Resources and Environment
DW	Dry weight
EM	Effective Microganisms
ETM	Center for Environmental Technology and Management
GHV	Gross heating value
HCMC	Ho Chi Minh City
HDPE	High Density Polyethylene
HHV	Higher heating value
LHV	Lower heating value
MSW	Municipal solid waste
SW	Solid waste
TCVN	Vietnam Standards
VS	Volatile solid
WW	Wet weight

1. OVERVIEW OF SW COMPONENTS WITH HIGHER HEATING VALUE (HHV)

The heating value includes higher heating value (HHV) and lower heating value (LHV), in which the HHV or gross heating value (GHV) is the heating value of SW mixture and the LHV is net heating value. As M.F.Seelig et al., the HHV and LHV of MSW is about 9.98 MJ/kg (≈ 2,395 Cal/g) and 4.77 MJ/kg (≈ 1,145 Cal/g) respectively. For MSW in Vietnam, the heating value is about 10 MJ/kg (≈ 2,400 Cal/g). In which, the components that have the HHV of over 20 MJ/Kg (≈ > 4,800 Cal/g) include paper and plastic (Amrehn, 2014).

The MSW consists of many components including many combustible components that could significantly create the energy (the heating value) for the power generation. As Tchobanoglous, 1993, the heating value of the MSW components is presented in **Table 1** below.

Table 1 Heating value of MSW components

No.	Component	Heating value (KJ/kg)		Heating value (Cal/g)	
		Range	Specific value	Range	Specific value
1	Food	3,489 – 6,978	4,652	837 – 1,675	1,116
2	Paper	11,630 – 18,608	16,747	2,791 – 4,466	4,019
3	Carton	13,956 – 17,445	16,282	3,349 – 4,187	3,908
4	Plastic	27,912 – 37,216	32,564	6,699 – 8,932	7,815
5	Textile	15,119 – 18,608	17,445	3,629 – 4,466	4,187
6	Rubber	20,934 – 27,912	23,260	5,024 – 6,699	5,582
7	Leather	15,119 – 19,771	17,445	3,629 – 4,745	4,187
8	Garden waste	2,326 – 18,608	6,513	558 – 4,466	1,563
9	Wood	17,445 – 19,771	18,608	4,187 – 4,745	4,466
10	Glass	116 – 223	140	28 – 54	34
11	Tin can	233 – 1163	689	56 – 279	165
12	Other metals	233 – 1163	689	56 - 279	165
13	Dust, ash, etc.	2,326 – 11,630	6978	558 – 2,791	1,675
14	MSW (mixture)	9,304 – 13,956	11,630	2,233 – 3,349	2,791

Source: Tchobanoglous et al., 1993.

As mentioned in Table 1, the plastic has the highest heating value with a specific value of 7,815 Cal/g. The components that have the HHV include paper (4,019 Cal/g), carton (3,908 Cal/g), textile (4,187 Cal/g), rubber (5,582 Cal/g), leather (4,187 Cal/g) and wood (4,466 Cal/g). The other components namely food, metal, glass, garden waste, dust, ash, etc. have the LHV of below 1,500 Cal/g. The heating values of the components namely

glass, tin can or metal as mentioned in Table 1 are not their own heating values, but are the heating values of their external coats, labels and materials attached. Therefore, these components could be considered as incombustible components that could not form the heat if they burned.

The SW components in Vietnam in general and in HCMC in particular could be separated into some main types namely food (meat, fish, vegetables, rice, bread, fruits, etc.), paper; diaper, plastic, textile, wood, rubber and leather, metal, inorganic components (ash, brick, glass, etc.), shell, bone and other components (that have too small sizes or could not visually separated namely soil, stone, hair, cigarette butt, etc.). In which, as Kosuke Kawai (2012), the components that could be burned (combustible components) include paper, plastic, fresh and raw food, grass, rubber and leather, fiber, tree, diaper and other components. These are the components that have the HHV in range of 40 – 90%, ash occupies 1 – 13%, especially other components have volatile solid (VS) and ash content that are similar with the percentage of approximately 30%. The heating values of these components are rather high, so they could be burned for the power generation.

As the analytical result of the heating value of the MSW taken in the Phuoc Hiep Landfill, HCMc, it showed that the HHV and LHV of MSW fluctuated about 1,600 – 2,300 Cal/g and 980 – 2,000 Cal/g respectively. In which, the plastic is the most combustible component with the heating value of about 7,000 – 9,000 Cal/g; paper, diaper, textile, wood, rubber and leather have the heating value in range of 3,000 – 6,000 Cal/g. Otherwise, the food is the component that has the LHV in range of 3,000 – 4,000 Cal/g (see **Table 2**).

Table 2 Heating value of MSW in the Phuoc Hiep Landfill, HCMC

No.	Component	Heating value (Cal/g)		
		Average	Minimum	Maximum
1	Food	3,693	3,187	4,246
2	Paper	4,282	3,578	4,893
3	Diaper	5,467	4,582	6,280
4	Plastic	8,406	7,372	9,204
5	Textile	4,811	4,500	5,067
6	Wood	4,172	3,945	4,428
7	Rubber, leather	5,519	4,455	6,736
8	Others	3,917	3,917	3,917

Source: Joint Venture of KOBELCO and HITACHI ZOSEN, 2012, 2013 and 2014.

In comparison with the landfill technology, the application of incineration technology for the SW treatment brings more advantages, significantly reduces the volume of SW buried and could recover the energy by the heat exchange of high-temperature gases formed for

the power generation. The trend of SW incineration for the energy recovery to operate the generator is being currently applied in many countries all over the world to tend to limit and thoroughly remove the SW treatment by the landfill method. As the research of Ph.D Kosuke Kawai, 2012 on the MSW management in the Southeast Asian countries, especially in Vietnam, it showed that the optimum heat value for the MSW treatment by incineration method is HHV > 800 Cal/g, and the suitable heat value threshold for the MSW treatment by incineration method together with the energy recovery for the power generation is HHV > 1,500 Cal/g. Therefore, as above-mentioned analytical result of the heating value of the SW in the Phuoc Hiep Landfill, the SW in HCMC could be absolutely treated by the incineration method together with the energy recovery for the power generation.

2. PROGRAM ON SW SEPARATION AT SOURCE

In 2013, Center for Environmental Technology and Management (ETM) combined with the HCMC's DONRE to carry out the program on SW separation at source at two areas namely Ward 14, Binh Thanh District (July, 2013) and Ben Nghe Ward, District 1 (December, 2013), HCMC under the Project on "***Solid Waste Separation at Source Pilot Programme – Composition Analysis of Household Waste in the Model Areas of Source Separation in Ho Chi Minh City***". The program aimed mainly at the determination of the quantity and quality of household SW before implementing the model of SW research and separation at source.

2.1 Implementing organization

ETM will combine with the HCMC's DONRE to carry out the program. In which, DONRE is responsible for collecting and separating the household SW, then ETM is responsible for sampling and analyzing the physical and chemical components of SW. The responsibilities are specifically presented as follows:

DONRE

- Provide nylon bags for all households to store SW within the researched areas;
- Collect SW from households and transport SW to the concentration station for separation;
- Separate SW components and weigh each component sorted.

ETM

- Take SW sample and analyze the physical components;

- Analyze the components such as humidity, ash content, VS and gross heating value (GHV).

2.2 Implementing content

2.2.1 Analytical plan

The SW that is collected from the households is separated into 14 components. The analyzed parameters of each component are presented in **Table 3.**

Table 3 Plan of analyzing 14 components of SW

No.	Component	Moisture content	VS	GHV
1	Food	○	○	○
2	Shell – bone (also including durian skin, coconut shell, corn cores, egg shells, mango seed, etc.)	○	○	○
3	Paper	○	○	○
4	Plastic	○	○	○
5	Diaper	○	○	○
6	Textiles	○	○	○
7	Garden waste (green leaves, flower, etc.)	○	○	○
8	Wood	○	○	○
9	Rubber and leather	○	○	○
10	Glass	○	x	x
11	Metal	○	x	x
12	Ceramics	○	x	x
13	Coal ash	○	x	x
14	Others (soil, sand, hair, cigarette butts, sawdust, etc.)	○	○	○

Note: ○ – Analyzed; x – Not analyzed.
Source: Joint Venture of KOBELCO and HITACHI ZOSEN, 2012, 2013 and 2014.

2.2.2 Analytical method

The household SW is separated into 18 components that are stored in 80-liter buckets. After that, ETM will take the sorted SW sample for analyzing its components. Each component is taken and analyzed by the following steps:

Sampling method

- All SW component after separation will be manually mixed by shovels to become a homogeneous mixture;
- SW samples will be cut into smaller pieces in a size of less 15cm by knives or scissors to be thoroughly mixed;
- The quantity of sample that is analyzed is taken depending on the method of 4 parts (SW sample is divided into 4 parts in which two parts are only taken for analysis and two other parts removed) and the method is carried out two times. For food and plastic, the quantity of analyzed sample that is taken two times is 5 - 10kg and 2 - 5kg in order. For other components, if the quantity of sample is less 2kg, it will be all taken, if it is more 2kg, the quantity of sample is taken in range of 2 – 5kg.

Analytical method

❖ *Moisture content*

- Moisture content of each component will be separately analyzed under APHA 2540 G (2012);
- Each SW component will be cut into smaller pieces in a size of less 2 - 3 cm^3, then stored in a metal plate (a height of SW shout be smaller than 10 cm if any);
- After that, the SW in metal plate will be dried in the drying oven. The temperature is adjusted at 105^oC, the SW will be continuously dried in 4 - 5 days until the weight of SW in the plate is not changed any more.
- Moisture content of the SW is estimated by the difference of the SW sample before and after drying (evaporation released after drying).

❖ *VS, ash content and GHV*

- VS, ash content and GHV are analyzed by SW after being dried for its moisture content determination.
- There are 8 – 10 components (food, bone and shell-bone, paper, diaper, plastic, Textile, garden waste, wood, leather and rubber, others) compared to the plan as mentioned **Table 3** that are analyzed . The SW will be cut into smaller pieces in a size of less 1cm before analyzing its ash content and VS. The SW will be burned at a temperature of 550^oC under APHA 2540 G (2012).
- These components after being cut into smaller pieces in a size of less 1cm will be reduce their sizes of less 2mm to analyze the GHV under TCVN 200-2007 (ISO 1928:1995).
- The analytical methods of the parameters are presented in **Table 4**.

Table 4 Analytical methods

No.	Parameter	Analytical method	Analytical Instrument
1	Moisture content	APHA 2540 G	WTB Binder, Germany, Mettler Toledo MS204 balance, Switzerland
2	VS and ash content	APHA 2540 G	Nabertherm oven, Mettler Toledo MS204 balance, Switzerland
3	Gross calorific value (GHV)	TCVN 200 -2011 (ISO 1928:2009)	IKA calorimeter C 4000

3 ANALYTICAL RESULTS OF GHV OF SW COMPONENTS UNDER THE IMPLEMENTED PROGRAMS ON SW SEPARATION AT SOURCE

3.1 Analysis of GHV of SW components

Among 14 components are separated from household SW in this program, there are 8 – 10 components that are determined their GHV, including food, paper, diaper, plastic, textile, garden waste, wood, rubber and leather, shell-bone and others.

The program on analyzing the taken samples is performed in alternating 4 days of 8 days of taking the sorted samples. The average heating value of household in District 1 is shown in **Figure 1.**

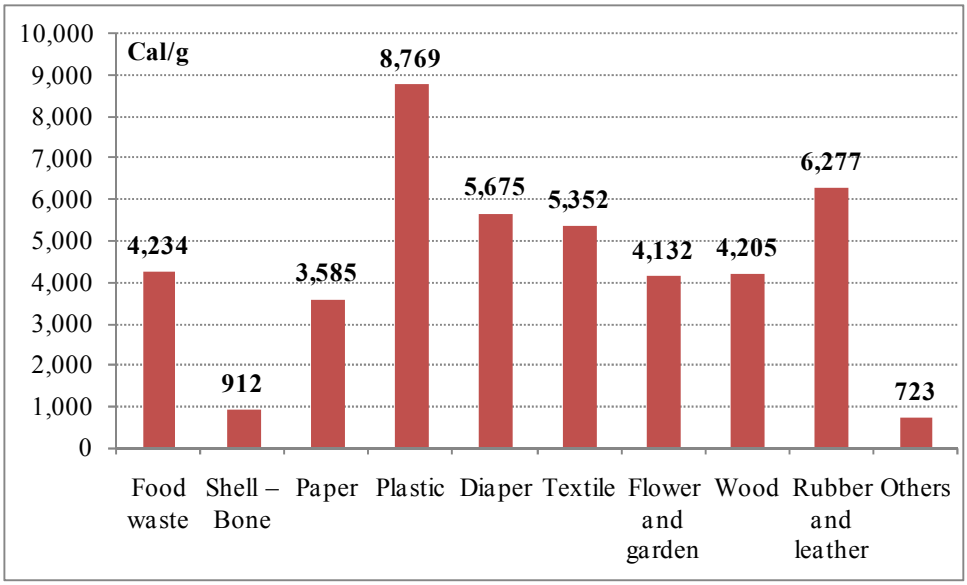

Figure 1 Average heating value of each component of household MSW samples in District 1.

As shown in **Figure 1**, it shows that the average heating value of the plastic is the highest, reached 8,769 Cal/g.

The components that have the average heating value in range of 4,000 – 6,500 Cal/g include rubber and leather (6,277 Cal/g), diaper (5,675 Cal/g), textile (5,352 Cal/g), food (4,234 Cal/g), wood (4,205 Cal/g) and garden waste (4,132 Cal/g).

The average heating value of the paper that ranges 3,000 – 4,000 cal/g is 3,585 Cal/g.

The analytical result showed that the GHV of two components is about 912 Cal/g (bone & shell-bone) and 723 Cal/g (others) that are 4 – 8 times lower than the GHV of the other components.

The analytical result of the average heating values of the components in household in District 1 is presented in **Table 5** below.

Table 5 Average heating value of each component of household SW samples

No.	Composition	Average (Cal/g)	Minimum (Cal/g)	Maximum (Cal/g)
1	Food waste	4,234	3,654	4,680
2	Shell – Bone	912	579	1,280
3	Paper	3,585	3,428	3,767
4	Plastic	8,769	8,273	9,473
5	Diaper	5,675	5,111	5,860
6	Textile	5,352	4,262	5,139
7	Flower and garden	4,132	3,501	4,444
8	Wood	4,205	3,953	4,313
9	Rubber and leather	6,277	5,401	6,752
10	Others	723	318	1,601

3.2 Physical and chemical properties of HHV components

3.2.1 Physical property

The percentage (by wet weight (WW) and dry weight (DW)) of the components of household SW samples is shown in Figure 2, Figure 3 and Figure 4 below.

Percentage of SW components by WW

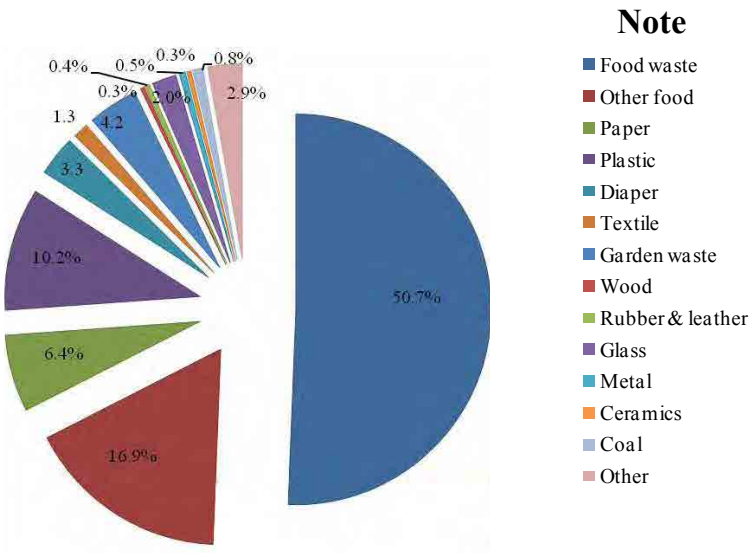

Figure 2 Percentage of household SW components in District 1 by WW.

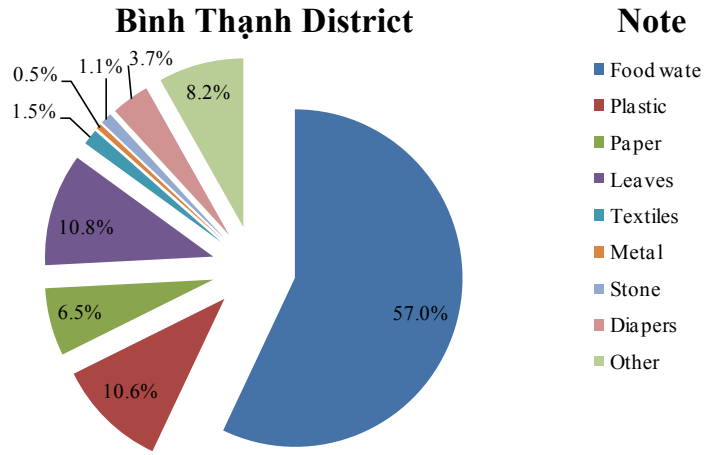

Figure 3 Percentage of household SW components in Binh Thanh District by WW.
(Source: Hayama Kazuyuki, 2014)

As shown in **Figure 2** and **Figure 3**, the food has the highest percentage, occupied 67.6% by WW for SW samples in District 1 and 57.0% by WW for SW samples in Binh Thanh District (including food waste and other food), lower than one in the Phuoc Hiep Landfill (61.3% by WW) (ETM, 2014). The food percentage of SW samples in District 1 is higher than one in Binh Thanh District and Phuoc Hiep Landfill (61.3% by WW) (ETM, 2014).

The plastic is mainly nylon bags, occupied about 10% by WW (10.2% by WW and 10.6% by WW for SW samples in District 1 and Binh Thanh District respectively). This is a persistent bio-degradable component with a high percentage in MSW due to a habit of using nylon bags in Vietnam now.

The garden waste (in District 1) or leaves (in Binh Thanh District) and others are two components that have rather high percentage of 10.8% by WW and 5.0% by WW respectively compared to the other components of household SW samples in Binh Thanh District. However, the values are a half lower than the percentage of these two components of household SW samples in District 1 that is 4.2% by WW and 2.9% by WW respectively.

The paper, diaper, fabric, rubber and leather are the components that have similar percentage between the SW samples in District 1 and Binh Thanh District. In which, there are about 6.5% by WW for paper, 3.5% by WW for diaper, 1.5% by WW for textiles, 0.4% by WW for rubber and leather.

The wood has rather low percentage that is different between the SW samples in District 1 and in Binh Thanh District. Specifically, the percentage of wood in the SW samples in District 1 is about 0.9% by WW while one in Binh Thanh District is only 0.3% by WW. Thus, the percentage of wood of the SW samples in these two districts that is not similar but insignificantly different is still a specific percentage by WW in MSW. Moreover, the wood is also a component that is daily generated with a little amount daily activities from the households in the urban areas like HCMC, so it occupies a little amount of the SW components compared to other components.

In summary, the percentage of the SW components by WW in District 1 and Binh Thanh District is similar, except some components with different percentage but insignificant. The analytical results still obviously show the percentage of the MSW components by WW.

Percentage of SW components by DW

The percentage of the components by DW of household SW samples in District 1 is shown in **Figure 3**).

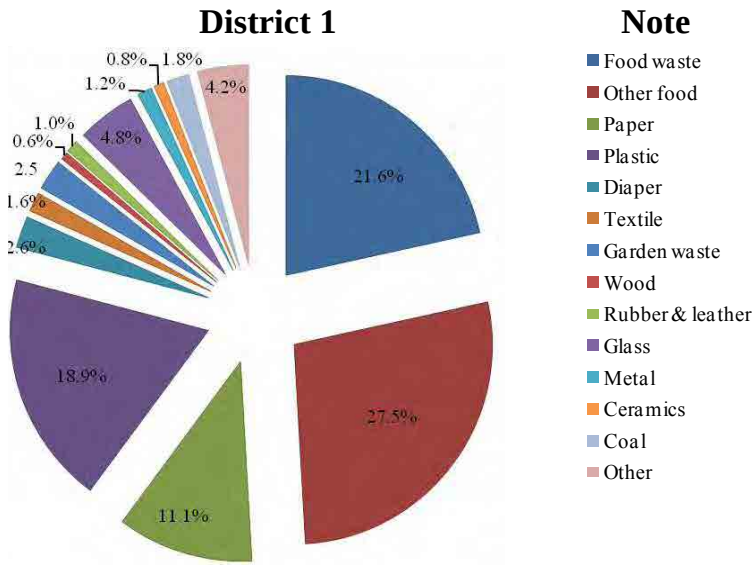

Figure 4 Percentage of SW components in District 1 by DW.

The percentage of food by DW is still the highest, occupied 21.6% by DW respectively.

The percentage of plastic by DW that is similar to the percentage of food is about 18.9% by DW respectively. Additionally, there are about 11.1% by DW for paper; about 2.5% by DW for garden waste; about 2.6% by DW for diaper.

The percentage of other components namely textile, rubber and leather that is rather low ranges 0.6 – 2.2% by DW.

3.2.2 Moisture content, ash content, VS

The analytical results of moisture content, ash content and VS of the household SW components in District 1 that are performed under the SW separation programs are presented in **Table 6** below.

Table 6 Analytical result of moisture content, ash content and VS of household SW components in District 1

No.	Component	Moisture content (%)	VS (%)	Ash content (%)
1	Food	83.0	13.7	3.4
2	Other food	32.9	14.2	53.0
3	Paper	29.3	59.6	11.1
4	Plastic	25.9	69.1	5.0
5	Diaper	69.3	26.5	4.2
6	Textile	51.1	44.7	4.2
7	Garden waste	75.8	20.4	3.8

No.	Component	Moisture content (%)	VS (%)	Ash content (%)
8	Wood	22.4	71.6	6.0
9	Rubber & leather	7.2	71.9	20.9
10	Glass	4.4	-	95.7
11	Metal	4.0	-	96.0
12	Ceramics	2.5	-	97.5
13	Coal	27.8	-	72.2
14	Other	41.9	11.4	46.7

For moisture content, among the components of household SW samples sorted, there are rather many components that have high moisture content. Specifically, there are 5 – 7 components out of 14 components with a moisture content of 40 – 83%, 3 - 5 components out of 14 components with a moisture content of 20 – 30%, other components with very low moisture content of less 5%. The moisture content of the components of household SW samples sorted is presented as follows:

- Food, diaper and garden waste are the components that have the highest moisture content of over 60%. In which, the food includes the wastes from the food processing activities (e.g. vegetables, fruits, meat, fish, rice, etc.) or residual food (bread, rice, noodle, vermicelli, etc.) that are a component with the highest moisture content of about 83.0%.

- Specifically, the moisture content is 63.2% respectively for diaper; 75.8% respectively for garden waste.

- The moisture content of textile of the household SW samples that fluctuates about 40 – 50%.

- The moisture content of paper of the household SW samples is only 29.3%.

- The moisture content of plastic and wood is low in range of 20 – 30%.

- The moisture content of rubber and leather is very low, less 10%.

For **VS and ash content**, the VS and ash content of the components show the combustible possibility of the SW at 550^{o}C, especially for the HHV components as follows:

- The components that have high combustible possibility include plastic, wood, rubber and leather. These are the HHV components. The VS and ash content of plastic is 69.1%; about 4 – 5% respectively. Similarly, the VS and ash content of is 71.6%;

8.8% respectively. The rubber and leather have high combustible possibility with the VS of 71.9. Otherwise, the ash content of this component that is rather higher than one of two other components is 20.9% respectively (the moisture content of this component is very low about 7.2% respectively).

- The paper and textile have rather high combustible possibility while the ash content of these components is rather low, approximately 10%. The VS of paper and textile are 59.6% and 44.7% respectively.

- The VS of diaper and garden waste fluctuates about 20 - 30% and the ash content of these components is about 4%.

- The VS and ash content of food is about 13 – 17% and 3 – 5% respectively.

The relation between the moisture content, ash content and VS of the components of the household SW samples in District 1 is shown in **Figure 6**.

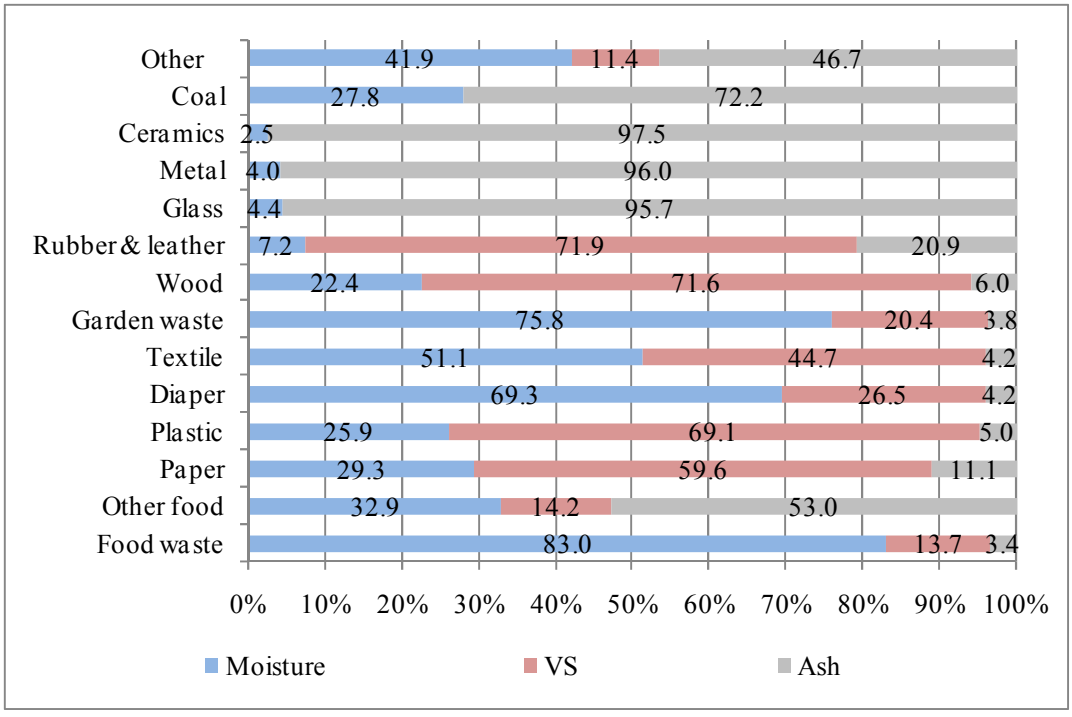

Figure 5 Relation between moisture content, ash content and VS of the components of the household SW samples in District 1.

4 CONCLUSION

The programs on SW separation at source in 2013 were performed to separate and analyze the components of the SW taken from households together with the physical and chemical properties of the SW (e.g. moisture content, ash content, VS, GHV). In which, the components that are identified with high combustible possibility include plastic, paper, wood, rubber & leather, diaper, textile, garden and food. The SW components and their physical properties are presented as follows:

Composition: the food that has the highest percentage among the components of the household SW samples ranges about 45 – 50%. The plastic that has the second percentage is about 10%. The percentage of other components is about 6.5% for paper, 3.5% for diaper, 1.5% for textile, 0.4% for wood and rubber & leather.

Moisture content: the food and diaper have both the highest moisture content, above 60%; the textile has the second moisture content in range of 40 – 50%; the paper has the moisture content in range of 30 – 50%; the plastic and wood has the moisture content in range of 20 – 30%; the rest component namely rubber – leather has the lowest moisture content, less 10%.

Relation between ash content and VS: most of the SW components has high combustible possibility and low ash content. The components including plastic, wood, rubber – leather have the highest combustible possibility with VS of about 65 – 75% and ash content of 4 – 30%. Similarly, the paper and textile have both low ash content, less 10% while they have high VS in range of 40 - 60%. The diaper could be highly combustible at 550^{o}C with ash content of about 4% and VS of about 20 – 30%. The food has high moisture content (over 60%). The rest components that are mostly combustible organic matters occupies about 13 – 17% with ash content of about 3 – 5%.

As above-mentioned analytical result of the average heating value, the components that could be burned to recover the energy for the power generation (HHV > 1,500 Cal/g, as Kosuke Kawai, 2012) include plastic, rubber and leather, diaper, textile, garden waste, wood, paper and food. These components have the HHV in range of 3,000 – 9,000 Cal/g.

添付資料

3-1 REPORT
WATER SURVEY AND ANALYSIS FOR THE PROPOSED SOLID WASTE INCINERATION PROJECT WITH CAPACITY OF 300 TONS/DAY

TSUNEISHI KAMTECS CORPORATION

REPORT

WATER SURVEY AND ANALYSIS FOR THE PROPOSED SOLID WASTE INCINERATION PROJECT WITH CAPACITY OF 300 TONS/DAY

HO CHI MINH, AUGUST, 2014

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REPORT

WATER SURVEY AND ANALYSIS FOR THE PROPOSED SOLID WASTE INCINERATION PROJECT WITH CAPACITY OF 300 TONS/DAY

REPRESENTATIVE
TKC

REPRESENTATIVE
ENTEC

HO CHI MINH, AUGUST, 2014

CONTENTS

ABBREVIATION

BOD	Biochemical Oxygen Demand
BTNMT	Ministry of Natural Resources and Environment
CEMTES	Centre of Environmental Monitoring & Technical services
COD	Chemical Oxygen Demand
DO	Dissolved oxygen
ENTEC	Environmental Technology Center
IPs	Industrial park
LA	Long An
QCVN	Vietnam Technical Regulations
TCVN	Vietnam Standard
TDS	Total Dissolved Solid
TKC	Tsuneishi Kamtecs Corporation
TSS	Total Suspended Solid
VCD	Vam Co Dong river

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

1.1. Objective of the Survey

At the present, the Representative Office of Tsuneishi Kamtecs Corporation in Vietnam (hereinafter referred to as TKC) is carrying out the pre-feasibility study on the waste-to-energy project with capacity of 300 tons per a day in Ho Chi Minh City and neighboring provinces (including Dong Nai, Binh Duong, Ba Ria - Vung Tau and Long An).

One of the important issues to be investigated is the water survey and analysis in the proposed project's area (hereinafter referred to as the Work).

Tsuneishi has asked the Environmental Technology Centre (ENTEC) to cooperate with Tsuneishi implementing the "Work" above.

Purpose of the Study is to carry out Water Survey and Analysis for the Proposed Solid Waste Incineration Project with Capacity of 300 tons/day.

1.2. Scope of Work

ENTEC shall carry out the Work under the supervision of the TKC . The Work consists of the followings;

– Preparation work

– Collection of existing data on surface and ground waters in the proposed project area (Water flow, capacity in dry and rainy seasons, quality etc.)

– Water sampling and analysis, including ground water and surface water during both rising and shifting tides.

– Reporting

1.3. The Legal and Technical Documents

1.3.1. The Vietnam environmental standards and regulations

– TCVN 7704:2007/BTNMT - National technical regulations on boilers - technical requirements for the design, structural fabrication, installation, use and repair

– Standard for feed water to boiler according to ABMA

– QCVN 02:~~2008~~2009/~~BTNMT~~ BYT – National Technical Regulation on domestic ~~surface~~ water quality;

~~– QCVN 09:2008/BTNMT – National Technical Regulation on groundwater quality;~~

1.3.2. The Technical Documents

01]. Joint Venture Investment Development of Ben Luc Industrial Park. Report on environmental impact assessment of construction investment and business infrastructure project of Thuan Dao Industrial Park - Ben Luc. February 2004.
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[03]. Sub-Institute of Meteorology, Hydrology and Environment. Report " Evaluation of computational load capacity of the main canals and rivers of Ben Luc district, Long An Province", 2009
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[05]. Department of Natural Resources and Environment of Long An Province. Report "Environmental Planning of Long An province until 2015 and orientation to 2020", 2010.
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[07]. People Committee of Long An province. Research on master plan for socio-economic development for Long An province in 2020 and vision to 2030. Final report prepared by ALMEC Corporation, January 2011.
[08]. Division of Natural Resources and Environment of Ben Luc District/ Environmental Technology Centre (ENTEC). Report "Plan for municipal wastewater treatment of Ben Luc town and medical waste water of communes and towns", December, 2012.
[09]. Economic Zone Management Board of Long An province. Report on environmental management of industrial parks in Long An Province, November 2013.
[10]. Nguyen Minh Lam. PhD thesis "Evaluating the carrying capacity and proposing measures to protect the Vam Co Dong River water quality - Long An Province", February 2013.
[11]. Center for Environmental Monitoring and Technical Services of Long An province. Environmental Monitoring Report in 2013.
[12]. Report on environmental impact assessment of the project "Construction of recycling and hazardous waste disposal plant, Chan Ly Environmental Co, 2014
[13]. Report on Environmental Impact Assessment Project "Investment of water treatment chemicals and industrial chemical production factory with capacity of 500 tons/year at Nhut Chanh Industrial Park, Ben Luc District, Long An Province" ; 2014
[14]. Report on Environmental Impact Assessment Project "Investment in increasing the capacity of the processing, bottling and packing pesticides factory with capacity of 450 tons/year" in Duc Hoa 1 Industrial Zone, Long An Province; 2014
[15]. Environmental Impact Assessment of the Project "Paper recycling plant with capacity of 3,000 tonnes/ year" at Thinh Phat Industrial Park, Ben Luc District, Long An Province; 2014
[16]. Environmental impact assessment of the project "Increasing the production capacity of the paper, packaging paper products production factory from 4,000 tons / year to 12,000 tonnes/year," at Thinh Phat Industrial Park, Ben Luc District, Long An Province; 2014

[17]. Environmental impact assessment of the project "Investment in construction of water treatment purification, enzyme and soil improvement material production plant with capacity of 700 tonnes/year" at Phuc Long Industrial Park, Ben Luc District, Long An province; 2014
[18]. Environmental impact assessment of the project "Chemical Storage Warehouse with capacity of 1,000 tons" at Nhut Chanh Industrial Park, Ben Luc district, Long An province, 2014.

2. COLLECTION OF EXISTING DATA ON WATER RESOURCES IN PROJECT AREA

2.1. Surface water

2.1.1. Water reserves

On the Ben Luc district, there are 2 main flows, including the Vam Co Dong River (VCD) and Ben Luc River, in addition to a system of small canals.

Network flow diagrams in Ben Luc district is presented in Figure 1.

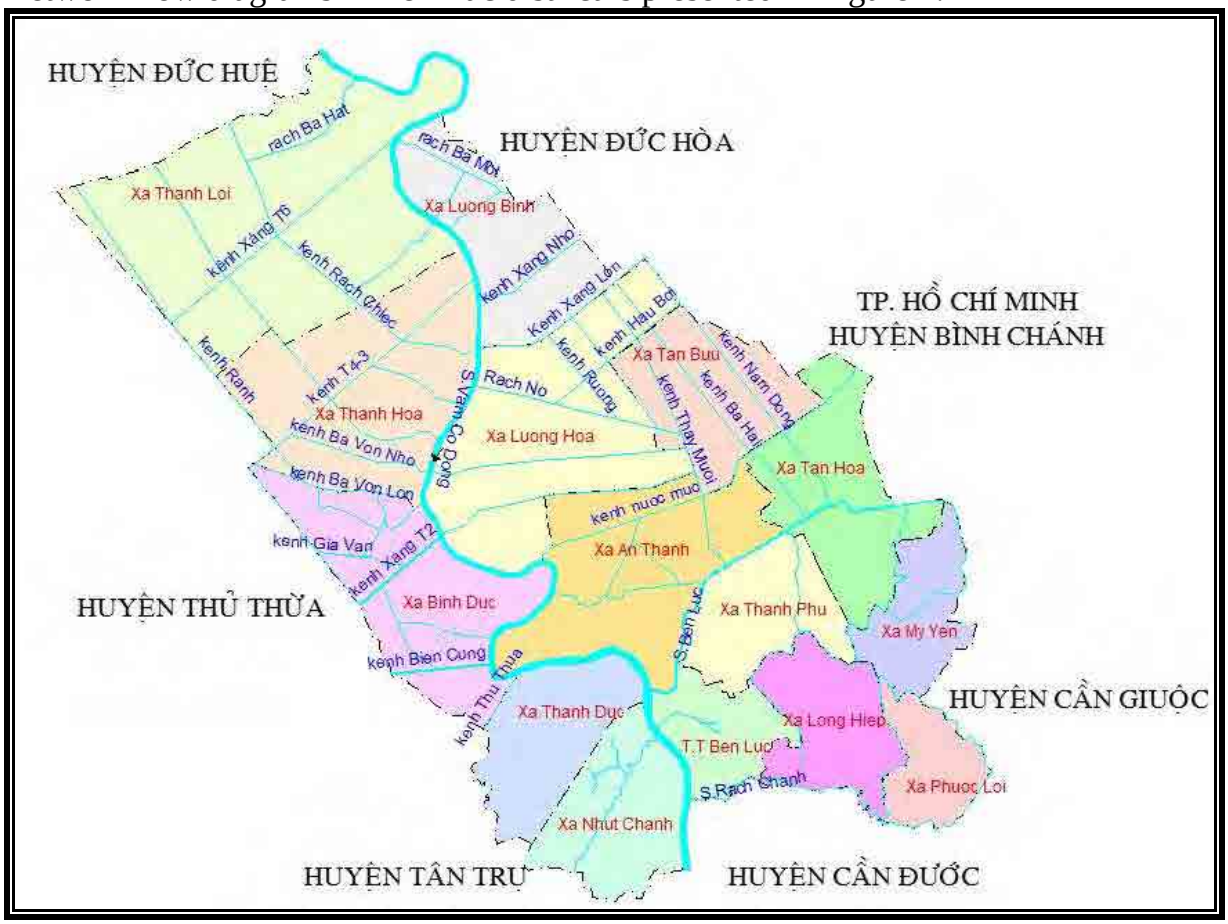

Figure 1. Network diagram of rivers and canals in Ben Luc district, Long An province

(1). Vam Co Dong River

VCD river have catchment area of 6,000 km^2, derived from Cambodia passing through Vietnam in Xamat and runs through Tay Ninh Province from the Northwest and then

in Long An Province through Hue Duc, Duc Hoa, Ben Luc district southeast direction; connected to the Vam Co Tay River at Tan Tru district of Vam Co Lon River estuary Soai Rạp. VCD river stretch passing through Long An 145 km long, 400 m wide average, depth of the river bed in Duc Hue demand is -17 m, in Ben Luc bridge is -21 m. VCD River is a tributary of the Dong Nai river level 1, connect the Vam Co Tay River in the horizontal channel; VCD River connect with Saigon River, Dong Nai river run through Thay Cai channel, Ha An channel, Ben Luc River, ...

Because there are many small tributaries, thus VCD river very convenient for traffic in waterways to transport commodity from other place to Tay Ninh or the opposite from Tay Ninh to other places . VCD River is the source of irrigation water for Duc Hoa, Duc Hue, Ben Luc district with an area of about 84,000 ha of rice cultivation. Every day, VCD River to receive a relatively large amount of waste from factories, industrial parks, residential areas and households scattered along the river.

Section of the VCD river flowing through Ben Luc District approximately 36.5 km long, and the main source of water supply with rainwater. Annual precipitation is large, but unevenly distributed: heavy rainfall coincides with a flood of the Mekong river, it often happens inundation, dry season rainfall was low, accounted for 15% of the total rainfall of year, so the water supply for agricultural production and dosmetic water is difficult.

The average discharge year of VCD river is about 94 m^3/s, the average discharge of dry season is about 10 m^3/s. VCD basin is relatively contained, unless Mekong river flood is large and discharge of Dau Tieng decrease to 10-12 m^3/s (1996) will be strongly influenced basin.

(2). Ben Luc River

Ben Luc river connecte with Saigon River through Kenh Doi , large 20-25 m, deep 2-5 m, influenced hydrological regime of VCD river. This is the draining for regional Ben Luc, Nha Be, Binh Chanh and urban areas of HCMC; is waterway connecting the Western provinces with Ho Chi Minh City, which borders the water at Binh Dien Bridge, the boundary between sour and sweet water in the rainy season. Long section through Ben Luc district is 7.8 km, split Ben Luc district to two region North and South.

Discharge for many years of Ben Luc River is about 46.8 m^3/s, the average dry season flow of about 7.5 m^3/s. Discharge average of flood season is about 78.8 m^3/s.

(3). The system of small canals

– The horizontal channel system, with the main canal as Xang Lon, Xang Nho canal, Rach No, Rach Vong, Nuoc Muc, Thu Thua, Bien Cung, Ba Mot, T4 canal with total length of about 46 km. The horizontal channel system to keep water from the VCD river to inland areas;

– Canal vertical system as Rach Chiec canal of Thanh Loi commune and Thanh Hoa commune, Go Dung canal, Ba Vu canal, Nam Dong canal connecting Xang Lon channel to Ben Luc river , total length of canal vertical system about 41 km, have mission lead water in the dry season and drainage in flood season;

– Natural canal and incision system about 65 km, incision and canal of main beginVCD river to turn west and east of the district. The main of incision as Bac Tan, Ong Huu, Ba Lang, Ba Cua…

– The hydrology of Ben Luc district is influenced by west sea tidal semi-diurnal. The hydrology in the VCD river is higher the receipt of irrigation water upstream, possibility transmission of tide and salty is quick about 0.09 g/l/km.

– Because the average tide changes from 0.66 m - 0.95 m, thus gravity irrigation capabilities are limited, except the riparian zone. October and May of year have flood water, high tide should be dike to protect. Height of dike is (+) 1.9 m - 2.2 m.

Information about network flows in Ben Luc District are summarized in Table 1.

Table 1. The summary of the stream system in Ben Luc district.

No	**Name of river/canal**	**Length (km)**	**Average width (m)**	**Average flow (m^3/s)**	**Location**
1	Vam Co Dong River	145	.400	94	Cambodia→ Tay Ninh province → Long An province (Duc Hue, Duc Hoa, Ben Luc Districts) under the southeast, connecting with Vam Co Tay River at Tan Tru District of Vam Co Lon River pour into Soai Rap estuary.
2	Ben Luc River	7,8	20 - 25	46,8	Connecting VCD River with Saigon River through Kenh Doi canal
3	The horizontal canal system	Total length about 46km	10 - 15	23	There are mission transfer water from VCD river to inland areas such as Xang Lon, Xang Nho canal, Rach No, Rach Vong...
4	Channel system vertical	Total length about 41km	8 - 12	14,2	The mission lead in the dry season and drainage in flood season as canal Rach Chiec of Thanh Loi commune and Thanh Hoa commune ...
5	Natural river and	Total length	5 - 7	9,7	Begin in VCD river to turn west and east of the district

No	Name of river/canal	Length (km)	Average width (m)	Average flow (m^3/s)	Location
	canals	about 65km			as Bac Tan, Ong Huu, Ba Lang, Ba Cua…

(4). General remarks

Through collecting the above results showed that the volume of surface water in the project area is abundant. This surface water source is capable of supplying water for agricultural activities, industrial activities…

2.1.2. Surface water quality

The latest monitoring results (in 2013) by Centre of Environmental Monitoring & Technical services (CEMTES) performed. Specifically as follows:

(1). Frequency of monitoring

Frequency of Vam Co Dong River water quality monitoring was conducted in 4 times/year. Specifically as follows:

– The 1st: in March every year (characteristic of the dry season and low flows in the year);

– The 2nd: in June every year (characterizes of the early rainy season);

– The 3rd: in September every year (characteristic of flood peak periods);

– The 4th: in December everyyear (characterizes of the early dry season, tide).

(2). Time of monitoring

The time of monitoring in each monitoring is determined based on the lowest tidal regime in month (usually from date 9 to 12 or date from 23 to 25 of lunar month).

(3). Position of monitoring

Position of Vam Co Dong River water quality monitoring in Ben Luc District area consists of 04 points with specific locations are presented in Table 2 and Figure 2.

Table 2. Water quality monitoring position of VCD river section running through Ben Luc district

No.	Location	Notation	Longitude	Latitude
1	Confluence of Xang Lon canal and Vam Co Dong river	LA-W01 (National)	574428	1186112
2	Near Tan Nghe Nam Co., Ltd.	VCĐ-10	576525	1179852

No.	Location	Notation	Longitude	Latitude
3	Ben Luc Bridge	LA-W02 (National)	579033	1176517
4	500m downstream from Bourbon port (Confluence of Chanh canal and Vam Co Dong river)	VCĐ-11	580211	1173849

Source: CEMTES, 2013

Note: The coordinate system is used in Table 2 is the VN2000 coordinate system

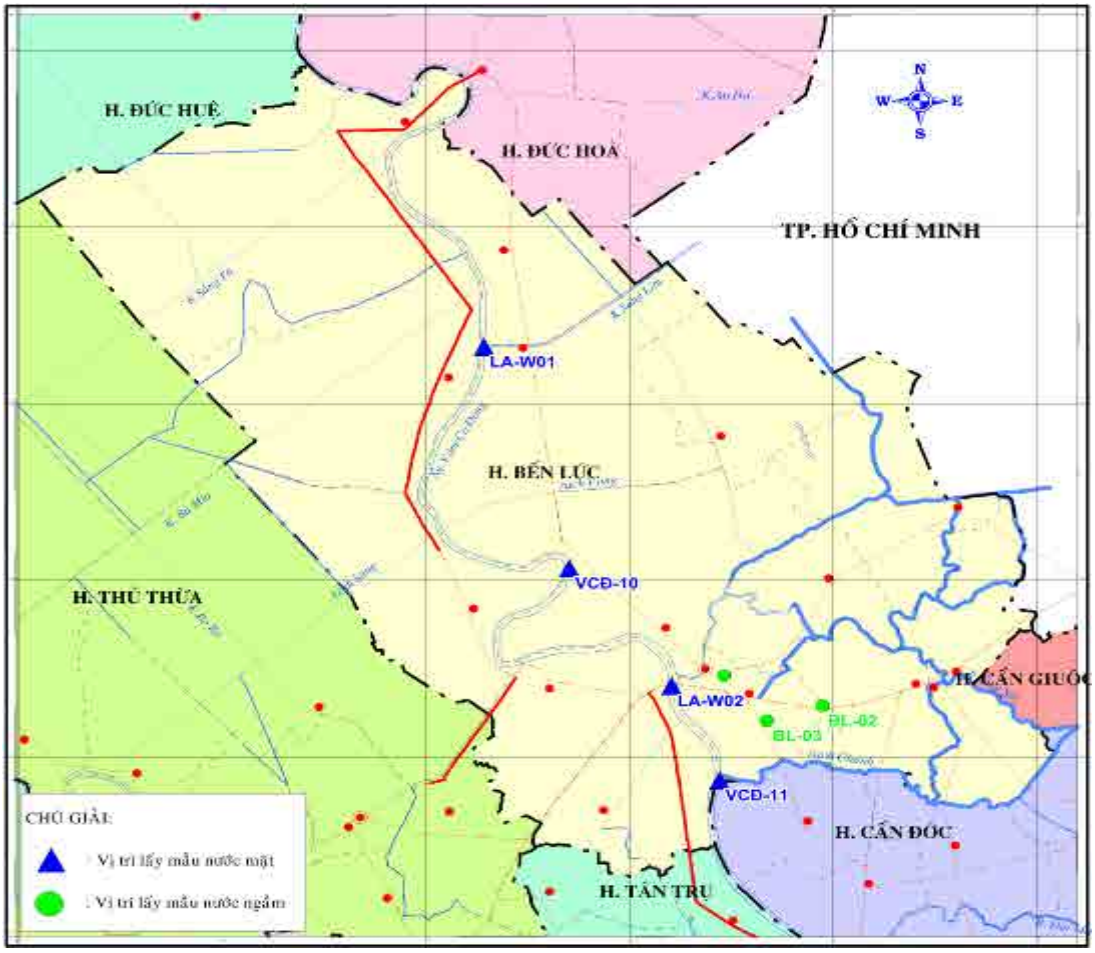

Figure 2. Locations of surface water and groundwater sampling

(4). Monitoring results

Monitoring results are compared with TCVN 7704:2007 - National technical regulations for boilers - technical requirements for the design, structural fabrication, installation, use and repair, (Section 9.6.2: feed water quality criteria is specified for natural circulation boiler pressure up to 4 MPa)

Evolution of the parameters at the monitoring position of the months in the year as follows:

1). pH

Based on monitoring results Monitoring and Technical Environmental Services center of Long An Province, compared pH values with TCVN 7704:2007 are presented in Table 3 and Figure 3 follows.

Table 3. Monitoring results of pH indicator in VCD river section running through Ben Luc District

Monitoring period	Position				TCVN 7704:2007	
	LA-W01	VCĐ10	LA-W02	VCĐ11	Feedwater	Boiler water
March 2013	5.97	6.09	6.38	6.53	8.5 – 10.5	10.5 – 11.5
June 2013	6.18	6.06	5.85	5.47	8.5 – 10.5	10.5 – 11.5
September 2013	6.59	6.28	6.09	6.12	8.5 – 10.5	10.5 – 11.5
December 2013	5.78	5.01	5.89	5.79	8.5 – 10.5	10.5 – 11.5

Source: Monitoring and Technical Environmental Services center of Long An Province, 2013

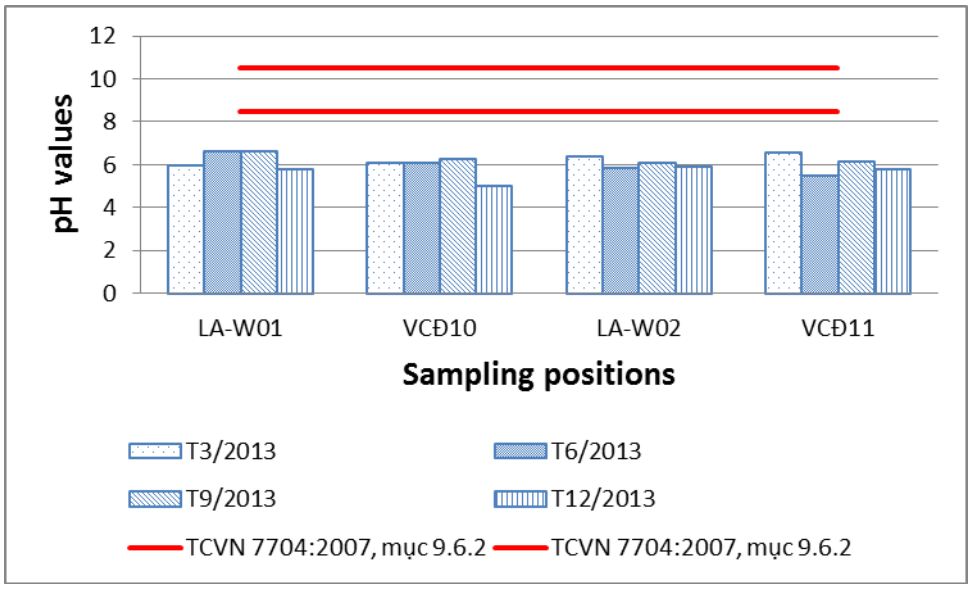

Figure 3. Fluctuation of pH on the Vam Co Dong river (section running through Ben Luc District), 2013

PH values measured on the Vam Co Dong river section running through Ben Luc district ranged from 5.01 to 6.59; highest value at the LA-W01 position in June and September (6.59); lowest value at VCĐ10 position in September (5.01). This suggests that Vam Co Dong River water quality is weak acidity, all of monitoring points are not achieved TCVN 7704: 2007 - National technical regulations for boilers - technical requirements for the design, structural fabrication, installation, use and repair, (Section

9.6.2: feed water quality criteria is specified for natural circulation boiler pressure up to 4 MPa). Acidification problems of Vam Co Dong River will greatly affect the water supply for the operation of the boiler as well as drinking water, irrigation and aquaculture process in the region.

2). Dissolved Oxygen in Water (DO)

DO values in river water is shown in Figure 4 and Table 4

Table 4. Monitoring results of DO concentrations in the Vam Co Dong River water

Monitoring period	**Units**	**Position**				**TCVN 7704:2007**
		LA-W01	VCD 10	**LA-W02**	**VCĐ11**	**Feedwater**
March 2013	mg/kg	**1.63**	**1.39**	**1.82**	**2.54**	≤ 0.4
June 2013	mg/kg	**3.02**	**3.63**	**3.02**	**2.98**	
September 2013	mg/kg	**3.02**	**3.15**	**3.05**	**3.03**	
December 2013	mg/kg	**3.63**	**3.77**	**3.86**	**2.14**	

Source: Monitoring and Technical Environmental Services center of Long An Province, 2013

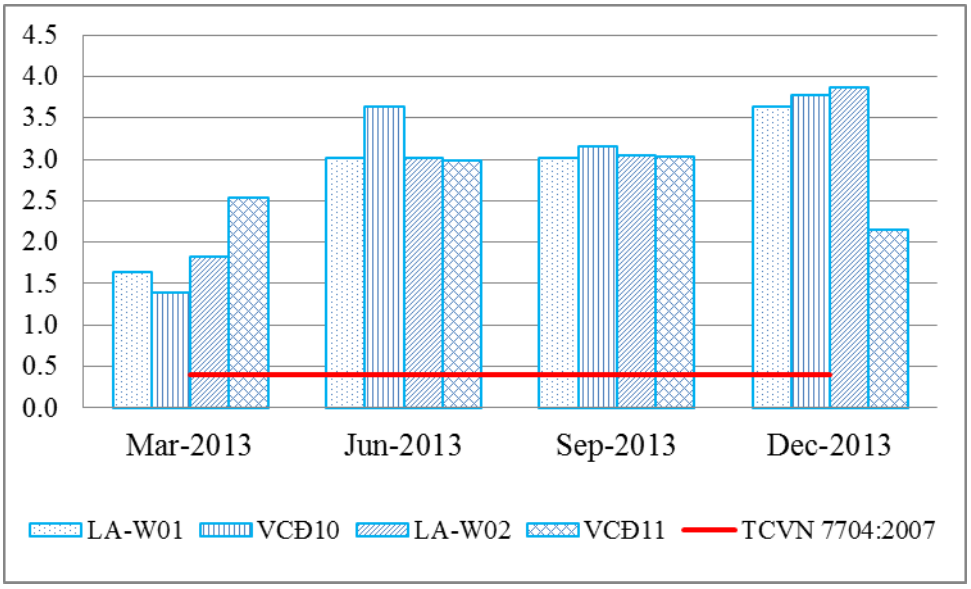

Figure 4. Comparing DO values of in Vam Co Dong river water (section running through Ben Luc District), 2013with TCVN 7704:2007

Through monitoring results so that, DO parameter value is from 1.63 to 3.86, highest in December in position LA-W02 (3.86 mg/kg); lowest value at the VCĐ10 position in March (173.75 µgdl/kg) and most sample do not meet TCVN 7704:2007.

3). The turbidity

Monitoring results of turbidity in Vam Co Dong river section flow through Ben Luc District are shown in Table 5.

Table 5. Monitoring results of turbidity in VCD river section running through Ben Luc District

Monitoring period	**Units**	**Position**				**TCVN 7704:2007**
		LA-W01	VCD 10	**LA-W02**	**VCĐ11**	
March 2013	NTU	18	35	28	34	≤ 23
June 2013	NTU	46	43	36	37	
September 2013	NTU	58	40	43	59	
December 2013	NTU	37	20	45	51	

Source: Monitoring and Technical Environmental Services center of Long An Province, 2013

Comparison of changes in turbidity parameter values are shown in Figure 5.

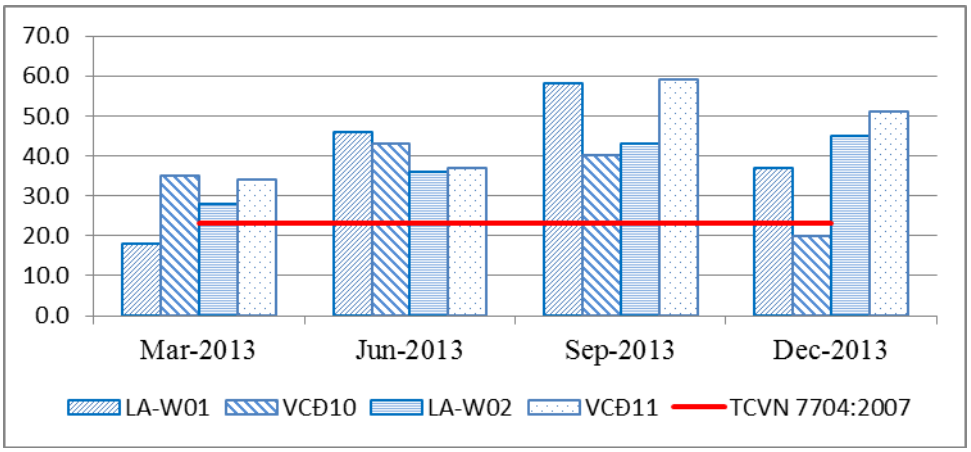

Figure 5. Comparison of changes in turbidity parameter values in VCD river section through Ben Luc District with TCVN 7704:2007

Results of measurement of turbidity on VCD river of section through Ben Luc District in 2013 with considerable differences, ranging from 18 to 59 NTU, average annual value is 38.5 NTU, most sample do not meet TCVN 7704:2004, except samples LA-W01 in March and sample VCD10 in December.

4). TSS

Comparing TSS concentrations in the river water at monitoring locations are presented with TCVN 7704:2007 as show follow in Table 6 and Figure 6.

Table 6. Monitoring results of TSS in Vam Co Dong river section running through Ben Luc District in 2013

Unit: mg/l

Monitoring period	**Position**			
	LA-W01	**VCĐ10**	**LA-W02**	**VCĐ11**
March 2013	15	22	51	21
June 2013	22	17	16	19
September 2013	19	21	21	41
December 2013	26	17	10	14
TCVN 7704: 2007	***≤15***			

Source: Monitoring and Technical Environmental Services center of Long An Province, 2013

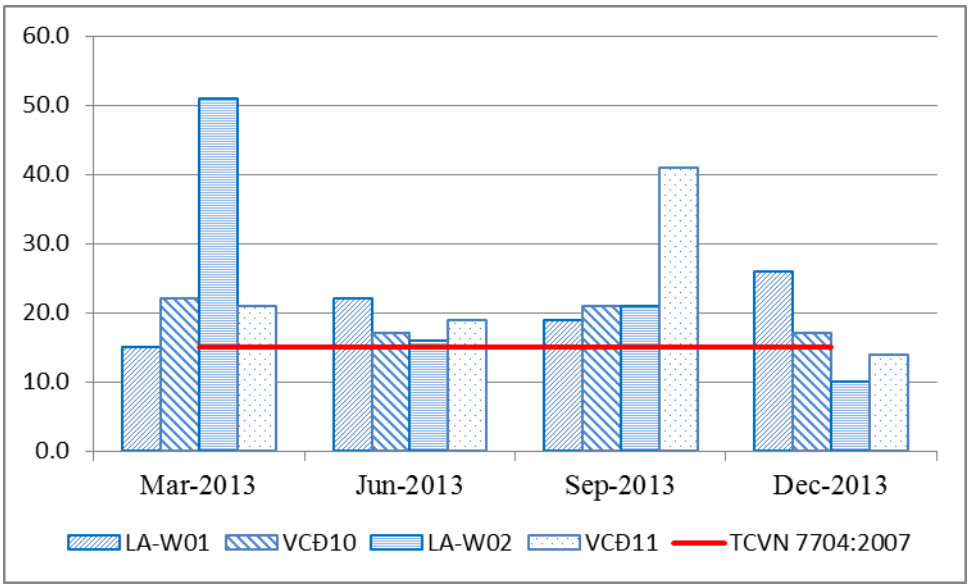

Figure 6. Comparing TSS concentrations in VCD river section through Ben Luc District in 2013 with TCVN 7704:2007

Table 6 and Figure 6 show that TSS concentration values from 10 to 51 mg/l, most of sample exceeded TCVN 7704:2007 Standard, except samples LA-W02 and VCD11 at the time of December.

5). Amonium

Comparing Ammonium concentration at the monitoring location in river water with TCVN 7704: 2007 are presented in Table 7 and Figure 7.

Table 7. Monitoring results of ammonium in Vam Co Dong river section running through Ben Luc District in 2013

*Unit: mg/l***Monitoring period**	**Position**			
	LA-W01	**VCĐ10**	**LA-W02**	**VCĐ11**
March 2013	0.049	0.048	0.039	0.057
June 2013	0.607	0.573	0.746	0.769
September 2013	0.208	0.268	0.267	0.293
December 2013	0.576	0.264	0.405	0.331

TCVN 7704:2007	***1***

Source: Monitoring and Technical Environmental Services center of Long An Province, 2013

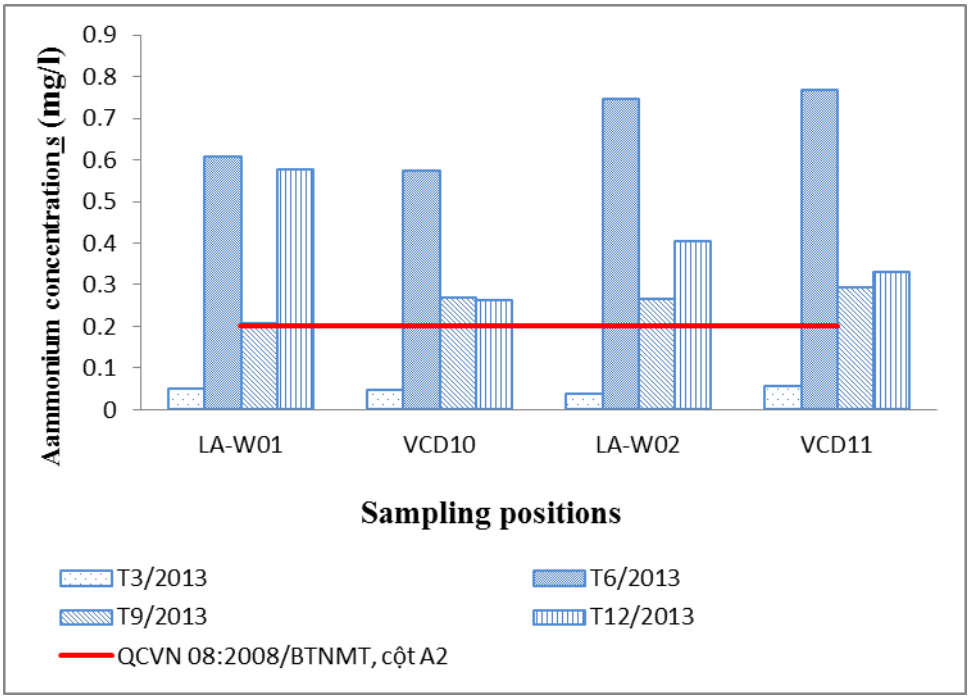

Figure 7. Fluctuation of the ammonium concentration in Vam Co Dong river section running through Ben Luc District in 2013

Figure 7 show that, ammonium concentrations in surface waters of the vam Co Dong river section through Ben Luc District from 0.048 to 0.769 mg/l, the average values is 0.343 mg/l, all the samples meet TCVN 7704:2007 Standard.

6). Iron

Evolutions of iron concentrations in the river water at monitoring locations are presented in Table 8. Values were compared with TCVN 7704:2007 is shown in Figure 8.

Table 8. The value of iron content over the monitoring periods 2013

Unit: mg/l

Monitoring period	**Position**			
	LA-W01	**VCĐ10**	**LA-W02**	**VCĐ11**
March 2013	0.75	0.8	**1.66**	0.67
June 2013	**1.21**	0.98	0.91	0.99
September 2013	**1.71**	**1.38**	**1.36**	**2.47**
December 2013	**1.87**	**1.73**	**1.6**	**175**
TCVN 7704:2007	***≤0,3 mg/l***			

Source: Monitoring and Technical Environmental Services center of Long An Province, 2013

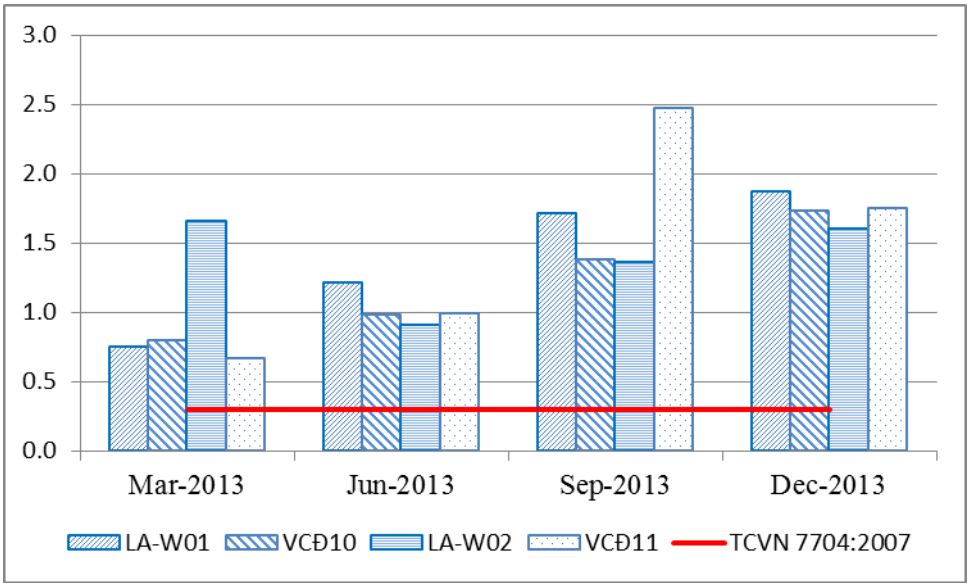

Figure 8. Comparing of iron concentrations in Vam Co Dong river section through Ben Luc District in 2013 with TCVN 7704:2007

Figure 8 show that, iron content in the monitoring of positions in VCĐ in Vam Co Dong river section through Ben Luc District ranged from 0.670 to 2.470 mg/l, the average value is 1.36 mg/l, exceed TCVN 7704:2007 many time with all samples.

7). Total oil and grease

Evolutions of total oil and grease concentrations in the river water at monitoring locations are presented in Table 9. Values were compared with TCVN 7704:2007 is shown in Figure 9.

Table 9. The value of total oil and grease over the monitoring periods 2013

Unit: mg/l

Monitoring period	**VCĐ11**
March 2013	0.68
June 2013	0.47
September 2013	0.17
December 2013	0.85
TCVN 7704:2007	***< 0.3 mg/l***

Source: CEMTES, 2013

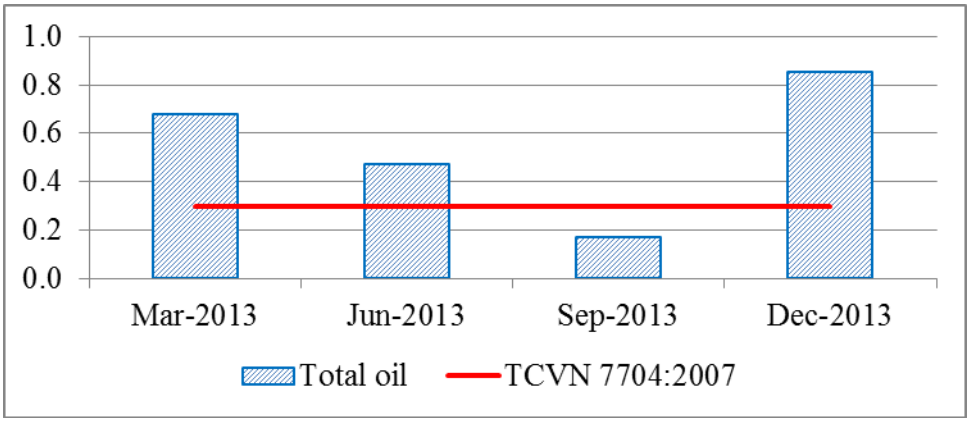

Figure 9. Fluctuation of total oil and grease values in Vam Co Dong river section running through Ben Luc District in 2013

Figure 9 show that total oil and grease values in all positions of the monitoring period ranged from0.17 mg/kg to 0.85 mg/kg, the average value is 0.54, most of sample exceeds TCVN 7704-2007, except sample at September.

2.1.3. Assessment of surface water resources and quality in the project area

(1). Reserves

The obtained results show that the surface waters of the Vam Co Dong river, Ben Luc river, canal systems in the project area are capable of providing enough water demand for the project.

However, the river's flows in Ben Luc District are strongly influenced by the tide, so the water is saline, containing high iron concentration. So now most of the industrial production facilities in Ben Luc district using waters from the groundwater treatment plants as Go Den Water Supply Plant, Thuan Dao Industrial Park water supply plant, Hoang Long Water Supply Plant, Ben Luc Water Supply Plant.

(2). Surface water quality

Comparison of surface water quality in the project area with TCVN 7704: 2007 shows that:

– pH values of the VCD river water running through Ben Luc district ranged from 5.01 to 6.59, did not meet TCVN 7704: 2007;
– The iron content ranged from 0.67 – 2.470 mg/kg higher than the TCVN 7704: 2007;
In addition, the quality of surface water in Ben Luc district is unqualified for boiler's supply due to the following reasons:

– Water flow is unstable, influenced by semi-diurnal tides - twice a day tide and low tide. Besides, the difference in flow between seasons is quite large;
– Due to tidal effects, surface water in Ben Luc district is saline.

– Due to the influence of the acidification land area, surface water in Ben Luc district is affected by acidity;

Therefore, industrial parks and manufacturing plants in this area do not use surface water for the production activities.

2.2. Groundwater

2.2.1. Current status of exploitation and use

According to a survey to assess the status of groundwater in Long An province, characteristics of main aquifers in Long An province is presented in Table 10.

Table 10. Characteristics of main aquifers in Long An province

No	Name of aquifers	Deep (m)	Thickness of aquifers (m)	Characteristics
1	Holocene aquifer (qh)	8	8 - 20	Salinization, aluminous
2	Middle-upper Pleistocene Aquifer (qp2-3)	23.5	23.5 - 55.7	It is possible water supply dosmetic and production
3	Pleistocene Aquifer (qp1)	6	6 - 113	Affected by alum and total higher mineralization
4	Pliocene Aquifer (n_2^2)	19.3	32,4 – 86,7	It is possible water supply dosmetic and production
5	Lower Pliocene Aquifer (n_2^1)	123,0 – 200,5 m	76,3	It is possible water supply dosmetic and production
6	Miocene Aquifer vulnerability (n_3^1)	211 m – 348 m	87,1	It is possible water supply dosmetic and production

The current, Long An province focus mainly exploiting in the 2 floors water Pliocene and Miocene. The total capacity of ground water extraction from deep wells in the Long An province currently around 110,000 m^3/day, mining focus primarily in stories n_2^2 relatively shallow waters in the region. Alone in the floor n_2^2 mining capacity is 63,585 m^3/day, but still smaller than the potential reserves but has exceeded the volume of aquifer (40,430 m^3/d), resulting lever water of aquifer are lowering.

– Ben Luc has 3 projects focused urban water supply (Water Supply Company of Ben Luc, Go Den Water supply, water supply system Ben Luc), extraction capacity is 2,160 m^3/day, water extraction from the aquifer n_2^2, mining depth from 50 m - 210 m;

– There are 122 works of rural piped water supply, mining capacity 7,459 m^3/day, water extraction from the floor n_1^3, n_2^1 and n_2^2. Most floors in depth from 180 m to exploit 220 m;

– There are 381 individual mining projects, mining capacity of 223.5 thousand m3/day of water extraction from the floor n13, n21 and n22, mining depth from 140 m to exploit 220 m;

– Also, Ben Luc District has some plants that use groundwater as large as:

+ Formosa Taffeta Textile Company (4 drilling wells with capacity of 80 m^3/h/ well);

+ Chungshing Textile Company (2 drilling wells with capacity 60 m^3/h/well);

+ Luong Hoa Sugar Factory (2 drilling wells with capacity of 30 & 80 m^3/h/well);

+ Ben Luc Dyeing Factory (3 drilling wells with capacity of 80 m^3/h/well);

+ Dong Tam Tiles Company (1 drilling well with capacity of 30 m^3/h);

+ Thang Loi Brick Company (1 drilling well with capacity of 30 m^3/h);

+ CheiJeDang fodder factory (1 drilling well with capacity of 30 m^3/h).

The other industrial wells are concentrated in the area of Long Hiep commune, Ben Luc Town, Phuoc Loi, Nhut Chanh etc. and are focused on exploiting the aquifer n_2^2, installed at depths from 190 m to 240 m has lowered the groundwater in the area.

2.2.2. Ground water quality status

According to the latest monitoring results (2013) by Environmental Monitoring & Technical services Center performed.

(1). Frequency of monitoring

Monitoring and environmental technical services center performed 2 times/year (in March, August).

(2). Position monitoring

The ground water position monitoring in Ben Luc district is decribled in Table 11.

Table 11. The ground water monitoring positions in Ben Luc district

No.	Monitoring Positions	Symbol	Coordinates	Number of wells	Well capacity	Deep (m)/layer
01	Mining well of Ben Luc town water plant (Ben Luc District), Ben Luc	BL-01	580320; 1176813	2	50 m^3/h	190-210/ N_2^2

No.	Monitoring Positions	Symbol	Coordinates	Number of wells	Well capacity	Deep (m)/layer
	water Supply and Urban service Corporation company					
02	Mining well of Go Den water plan (Ben Luc district) – well No.6	BL-02	582732; 1175963	9 (7 active wells)	50 m^3/h/well	250/ N_2^2
03	Mining well of Thuan Dao IP water plan (Ben Luc district) – well No.6	BL-03	581377; 1175540	2	900 m^3/day/well	200/ N_2^2

Source: Monitoring and environmental technical services center, 2013

Notes: The coordinate system is used in above table is VN-2000 coordinate system

(3). Monitoring result

Groundwater monitoring results in 2013 in the project area compared to the ISO 7704: 2007 is presented in Table 12:

Table 12. Monitoring result of ground waster at phase 1 in Ben Luc district (March, 2013)

No.	Position sampling	Code	pH	Hardness	TSS	COD	Amonia	Clorua	Florua	Nitrate	Sulfate	Xianua	Phenol	Asen	Mangan	iron	E.Coli	Coli form
				mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	mg/l	MPN/100 mL	MPN/100 mL
1	NN03: Mining well of Cai Cat water plant (Moc Hoa district)	MH-01	7,49	121	KPH	23,9	0,165	376	0,051	0,5	5	1,53	0,064	-	0,008	-	KPH	KPH
2	NN04: Mining well of Go Den water plant (Ben Luc district)	BL-02	6,06	216	8	253	0,339	1026	0,205	0,03	18	21,3	0,614	-	0,008	-	KPH	KPH
3	NN05: Mining well of Thuan Dao IP water plant – Ben Luc district (Hoang Long water supply company)	BL-03	6,36	223	5	332	0,277	1108	0,226	0,03	43	20,6	0,024	0,021	0,009	KPH	KPH	KPH
4	NN06: Mining well of Ben Luc town water plant (Ben Luc district)	BL-01	6,1	145	6	234	0,278	776	0,124	0,05	46	18,8	0,767	-	0,005	-	KPH	KPH
TCVN 7704:2007		Feed water	8,5 - 10,5	1	15	-	1	-	-	≤ 0.02	-	-	-	-	-	0,3	-	-

Notes:

TCVN 7704:2007 - National technical regulations on boilers - technical requirements for the design, structural fabrication, installation, use and repair.
"-": Not regulation

Results of monitoring of groundwater quality in Ben Luc District phase 2 (August 2013) is presented in Table 13.

Table 13. Monitoring result of ground waster at phase 2 in Ben Luc district (August, 2013)

No.	Position sampling	Code	pH	Hardness	TS	COD	Amonia	Clorua	Florua	Nitrate	Sulfate	Xianua	Phenol	Asen	Mangan	Iron	E.Coli	Coliform
				mg/L	mg/L	mg/L	mg/L	mg/L	(mg/L)	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	mg/L	MPN/100mL	MPN/100 mL
1	NN04: Mining well of Go Den water plant (Ben Luc district)	BL-02	6,11	350	1,187	5	0,259	406	1,106	0,17	24,96	-	-	KPH	0,87	35	KPH	KPH
2	NN05: Mining well of Ben Luc town water plant (Ben Luc district)	BL-01	6,54	140	473	5	0,154	245	1,096	0,12	86,08	-	-	KPH	0,72	18	KPH	KPH
3	NN06: Mining well of Thuan Dao IP water plant – Ben Luc district (Hoang Long water supply company)	BL-03	6,07	232	1,029	5	0,184	360	1,101	0,14	63,82	KPH	KPH	KPH	0,11	22,8	KPH	KPH
TCVN 7704:2007		Feed water	8,5 - 10,5	1	15	-	1	-	-	-	≤ 0.02	-	-	-	-	0.3	-	-

Source: Monitoring and environmental technical services center, 2013

Notes:

TCVN 7704:2007 - National technical regulations on boilers - technical requirements for the design, structural fabrication, installation, use and repair. "-": Not regulation

Comparing monitoring results of Center of Environmental Monitoring and Technical Services present on table 10 and table 11 with TCVN 7704:2007 with parameters as pH, **Hardness**, amonium, total iron as follow:

1). pH

Results comparing the pH of the groundwater samples with standards TCVN 7704: 2007 are shown in Figure 10.

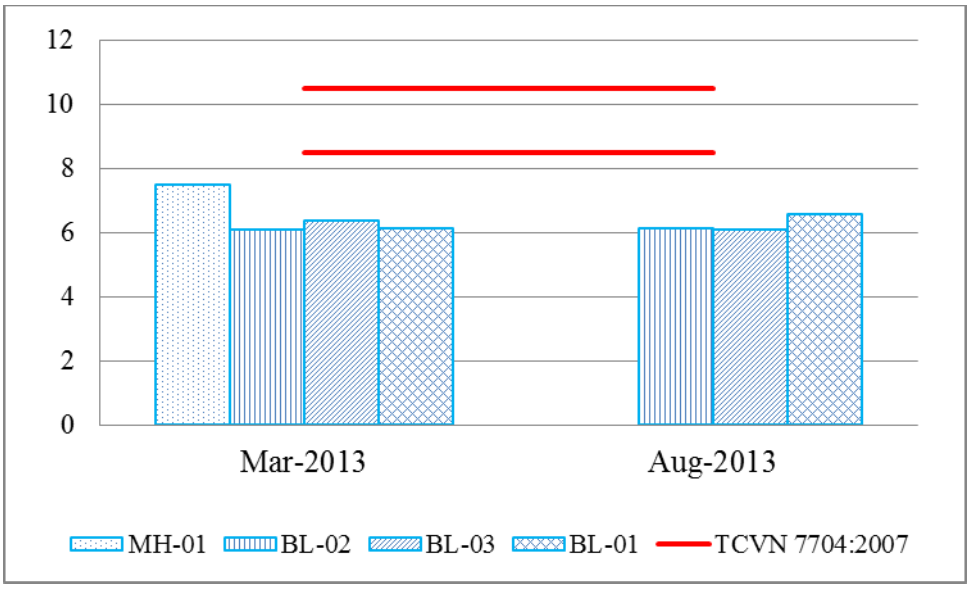

Figure 10. Compare the pH of the groundwater samples Ben Luc district with TCVN 7704: 2007

Figure 10 show that, the value of pH paremeter on groundwater sample from 6.06 to 7.5, average is 6.5, much lower than TCVN 7704:2007.Therefore, pH parameter do not meet TCVN 7704:2007.

2). Hardness

Results comparing Hardness of the groundwater samples with standards TCVN 7704: 2007 are shown in Figure 11.

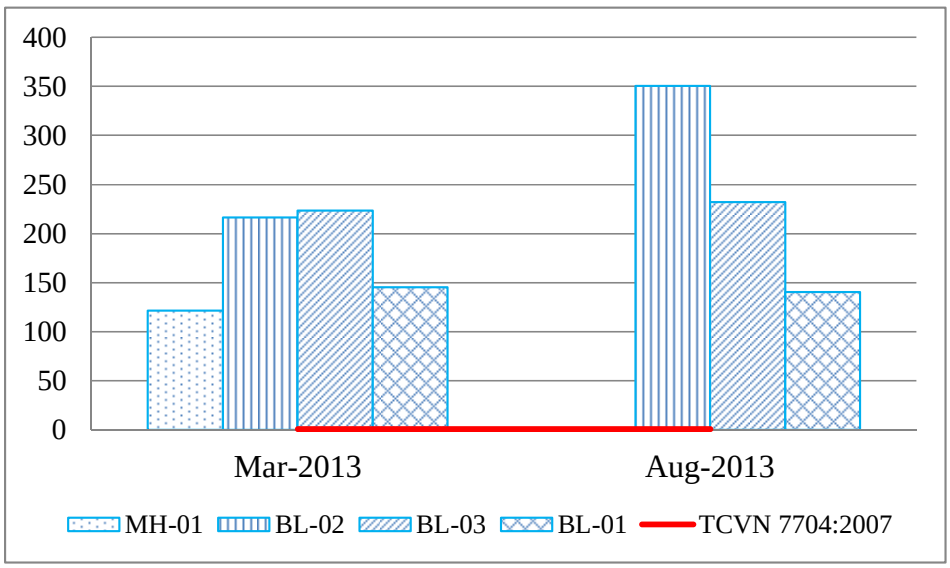

Figure 11. Compare the handness of the groundwater samples Ben Luc district with TCVN 7704: 2007

Figure 11 show that, the value of handness paremeter on groundwater sample from 121 to 350, average is 178.38, exceeded TCVN 7704:2007. Therefore, handness parameter do not meet TCVN 7704:2007.

3). TSS

Results comparing TSS concentrations of the groundwater samples with standards TCVN 7704: 2007 are shown in Figure 12.

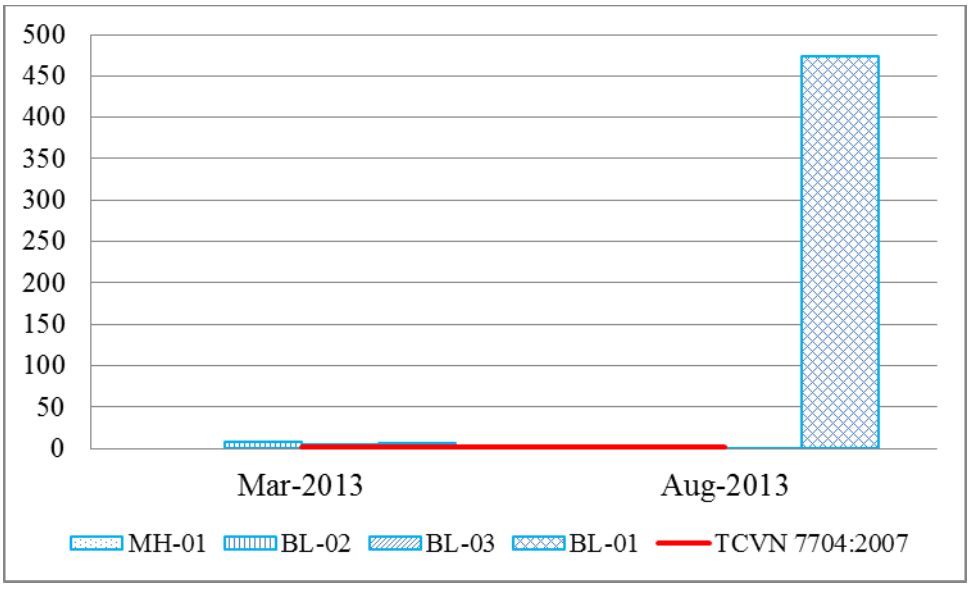

Figure 12. Compare the TSS concentrations of the groundwater samples Ben Luc district with TCVN 7704: 2007

Figure 12 shows that, the TSS concentrations ranging from 0 - 473 mg/l, the average of value is 61.8 mg/l, most of the samples exceeded TCVN 7704: 2007, except for sample MH-01.

4). Ammonium

Results comparing ammonium concentrations in the groundwater samples with standard TCVN 7704: 2007 is presented in Figure 13.

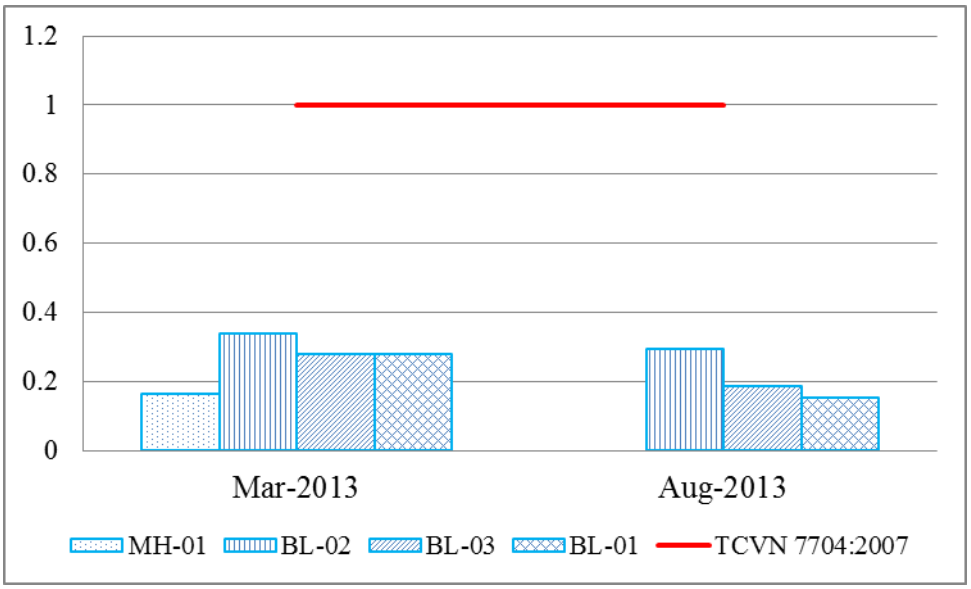

Figure 13. Comparing ammonium concentrations in the groundwater samples with standard TCVN 7704: 2007

Figure 13 show that, ammonium concentrations ranged from 0.15 to 0.34 mg/l, the average of value is 0.21 mg /L, the samples meet the standard TCVN 7704: 2007.

5). Total iron

The results comparing the iron contentrations in groundwater samples compared to standard TCVN 7704: 2007 is presented in Figure 14.

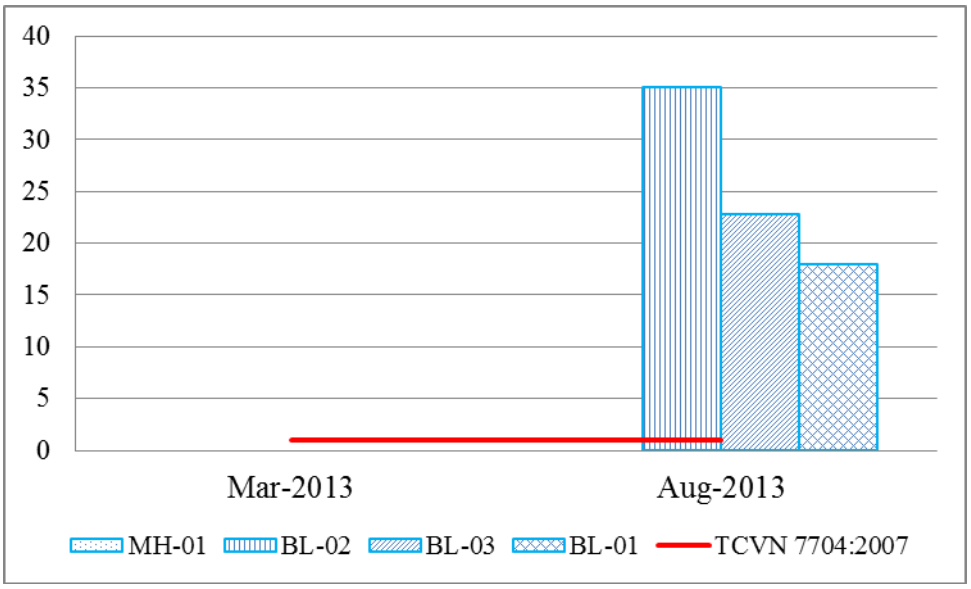

Figure 14. Comparing the iron contentrations in groundwater samples compared to standard TCVN 7704: 2007

Figure 14 show that, the iron content ranged from 0-35 mg/L, averaging 9.5 mg/L, the sample monitoring phase 1 (March 2013) meet the standard TCVN7704: 2007, the sample monitoring phase 2 (August 2013) exceeded significantly from standard.

2.2.3. Quantity and quality assessment of ground water in project area

(1). Quantity

From the results obtained showed that ground water quantity in the project area can provide enough water for the project, especially in Pliocene and Miocene aquifers.

(2). Quality

Comparison of the results collected groundwater quality in the project area with TCVN 7704: 2007 show:

pH and ammonium parameters at most monitoring sites were substandard water supply to the boiler;

Iron and TSS concentrations measured at three water supply plants (BL-01, BL-02, BL-03) does not meet TCVN 7704: 2007.

Therefore, want to use groundwater supply for incinerator, Tsuneishi company should handle parameters such as pH, ammonia, TSS, iron.

2.3. Current status of water supply and surface water quality in Thuan Dao Industrial Park

The receiving source of wastewater from Thuan Dao IP is the Chanh canal, then discharging into the Vam Co Dong river, distance from the discharge point of Industrial Park to the Vam Co Dong River is about 200 m. The width and depth of the Chanh canal are 10 - 15 m and 5 - 7 m, respectively, therefore, it is easy to drainage.

Currently, water source supplied for the production of Thuan Dao industrial zone is taken from Go Den water plant within Long An Water Supply Company with capacity of about 10,000 m^3/day. In addition, in the project area, there is also a water supply plant within Hoang Long Corporation with a capacity of about 5,000 m^3/day. Therefore, the ground water is satisfied for water supply for the project activities.

3. SURVEY AND ANALYSIS OF WATER IN THE PROJECT AREA.

3.1. Survey and Analysis of Surface Water

3.1.1. Sampling locations and time

To assess the current status of surface water quality in the project area, July 30, 2014, Environmental Technology Centre - ENTEC conducted taking 12 samples of surface

water (6 position in 2 time falling tide and rising tide). Location of sampling points is presented in Table 14 and Figure 15

Table 14. Location of surface water quality monitoring in Ben Luc district

No.	Symbol	The water level	Position	Purpose
1	NM1-1	Falling tide	Vam Co Dong River before the confluence with the Ben Luc River	Assessment of river water quality of receiving water VCD before Ben Luc River
2	NM1-2	Rising tide		
3	NM2-1	Falling tide	Ben Luc River before the confluence with the Vam Co Dong River	Evaluation Ben Luc River water quality
4	NM2-2	Rising tide		
5	NM3-1	Falling tide	Vam Co Dong River after the confluence with the Ben Luc River	Assessment of river water quality of receiving water VCD after Ben Luc river
6	NM3-2	Rising tide		
7	NM4-1	Falling tide	Chanh canal before flowing through Thuan Dao Industrial Park	Assessing the quality surface water of Chanh canal after through Thuan Dao IP.
8	NM4-2	Rising tide		
9	NM5-1	Falling tide	Chanh canal flowing through Thuan Dao Industrial Park	Assessing the quality surface water of Chanh canal before through Thuan Dao IP.
10	NM5-2	Rising tide		
11	NM6-1	Falling tide	Vam Co Dong River after flowing into Chanh canal	Assessment of river water quality VCD after through Thuan Dao Industrial Park
12	NM6-2	Rising tide		

Figure15. Locations of surface water sampling points

Location coordinates of sampling water quality in the area for Ben Luc District dated July 30, 2014 is presented in Table 15.

Table 15. Location coordinates of water quality sampling in Ben Luc District

No.	Low tide		Tide		Latitude	Longitude
	Symbol samples	Times	Symbol samples	Times		
1	NM1-1	10h15	NM1-2	16h10	10°38'43.16"N	106°26'33.60"E
2	NM2-1	9h25	NM2-2	16h45	10°38'37.40"N	106°28'52.40"E
3	NM3-1	9h45	NM3-2	16h30	10°38'17.80"N	106°28'29.90"E
4	NM4-1	10h45	NM4-2	14h20	10°37'7.66"N	106°29'55.31"E
5	NM5-1	11h00	NM5-2	15h00	10°36'53.50"N	106°29'12.50"E
6	NM6-1	11h40	NM6-2	14h30	10°36'5.53"N	106°28'57.47"E

3.1.2. Methods of analysis

The parameters of surface water quality analyzes are presented in Table 16.

Table 16. Analysis parameters of surface water quality

No.	Parameter	Unit	Analysis method
1	Transparency	NTU	SWEWW 2012-Transparency

No.	Parameter	Unit	Analysis method
2	pH	-	TCVN 6492:2011
3	Electric conductivity (EC)	μs/cm	SMEWW 2012 (2510B)
4	Total hardness	mg$CaCO_3$/l	SMEWW 2012 (2340C)
5	Total suspended solid (TSS)	mg/l	TCVN 6625-2000
6	Total Dissolved Solids (TDS)	mg/l	SMEWW 2012 (2540B)
7	Total Alkalinity	mg$CaCO_3$/l	SWEWW 2012 (2320B)
8	Dissolved oxygen	mgO_2/l	TCVN 7325:2004
9	Soluble SiO_3^{2-}	mg/l	APHA 4500.Si.E
10	Total Fe	mg/l	SMEWW 2012 (2130C)
11	Sodium Sulfite SO_3^{2-}	mg/l	SMEWW 2012 SO_3^{2-}
12	Phosphate PO_4^{3-}	mg/l	TCVN 6202-1996
13	Chloride Cl^-	mg/l	SMEWW 2012 (4121B)
14	Hydrazine N_2H_4	mg/l	SMEWW 2012-Hydrazine
15	Total hydrocarbon	mg/l	US EPA Method 1664
16	Copper (Cu)	mg/l	SMEWW 2012 (3120C)
17	Ammonium	mg/l	SMEWW 4500-NH_3-2005
18	Nitrite	mg/l	TCVN 6178-1996
19	Nitrate	mg/l	TCVN 6180-1996

3.1.3. The analytical results

The analysis results of water quality in the area for Ben Luc district at falling tide are presented in Table 17.

Table 17. The analysis results of water quality in Ben Luc district at falling tide

No.	Parameter	Unit	Symbol samples						Water standards (TCVN 7704:2007)	Water furnace standard VBC company
			NM1-1	NM2-1	NM3-1	NM4-1	NM5-1	NM6-1		
1	Turbidity	NTU	108.0	85.4	86.8	89.2	90.8	112.0	≤ 23 (*)	≤ 23 (*)
2	pH	-	6.0	5.8	6.2	6.1	6.5	6.1	8.5 – 10.5	10.5 – 11.5
3	Electrical conductivity (EC)	µs/cm	113	118	133	114	119	101	1000	1000
4	Total hardness	$mgCaCO_3/l$	10	15	27	15	15	10	1	1
5	Suspended solid	mg/l	49	41	47	40	41	48	15 (**)	15
6	Total Dissolved Solids (TDS)	mg/l	56	59	71	57	59	51	< 640	< 4.480
7	Total Alkalinity	$mgCaCO_3/l$	5	5	9	5	5	5	250 - 1000	250 - 1000
8	Dissolved oxygen	mgO_2/l	5.9	6.4	6.3	5.9	6.0	6.0	≤ 0.4	
9	Soluble SiO_3^{2-}	mg/l	23.2	17.6	19.2	17.3	17.6	23.6	≤ 0.04	75 - 300
10	Total Fe	mg/l	2.550	2.162	3.090	1.803	1.846	2.838	≤0.3	≤0.3
11	Sodium Sulfite SO_3^{2-}	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	20 - 40	20 - 40
12	Phosphate PO_4^{3-}	mg/l	0.249	0.264	0.405	0.390	0.316	0.405	30 - 60	30 - 60
13	Chloride Cl^-	mg/l	17.0	20.9	16.4	22.4	23.8	18.5	-	-
14	Hydrazine N_2H_4	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	0.03 - 0.1	0.03 - 0.1
15	Total hydrocarbon		KPH	KPH	KPH	KPH	KPH	KPH	≤ 3 (***)	≤ 3 (***)
16	Copper (Cu)	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	≤ 0.007	≤ 0.007
17	Ammonium	mg/l	0.4	0.3	0.4	0.4	0.4	0.3	1	1
18	Nitrite	mg/l	0.680	0.490	0.560	0.610	0.545	0.610	-	-
19	Nitrate	mg/l	0.151	0.141	0.175	0.185	0.159	0.154	-	-
20	Total nitrite and nitrate(****)	mg/l	0.831	0.631	0.735	0.795	0.704	0.764	≤ 0.02	≤ 0.02

The analysis results of water quality in the area for Ben Luc district at high tide are presented in Table 16.

Table 18. The analysis results of water quality in Ben Luc district at rising tide

No.	Parameter	Unit	Symbol samples						Water standards (TCVN 7704:2007)	Water furnace standard VBC company
			NM1-2	NM2-2	NM3-2	NM4-2	NM5-2	NM6-2		
1	Turbidity	NTU	73.6	71.6	90.6	55.9	68.0	75.6	≤ 23 (*)	≤ 23 (*
2	pH	-	5.9	6.1	6.2	6.3	6.1	6.0	8.5 – 10.5	10.5 – 11.5
3	Electric conductivity (EC)	µs/cm	109	134	123	188	106	106	1000	1000
4	Total hardness	mg$CaCO_3$/l	15	15	24	25	10	15	1	1
5	Suspended solid	mg/l	39	39	83	42	26	34	15 (**)	15
6	Total Dissolved Solids (TDS)	mg/l	55	67	65	94	53	53	< 640	< 4.480
7	Total Alkalinity	mg$CaCO_3$/l	5	5	9	5	5	5	250 - 1000	250 - 1000
8	Dissolved oxygen	mgO_2/l	5.8	6.1	7.2	6.2	6.3	5.6	≤ 0.4	
9	Soluble SiO_3^{2-}		16.2	16.8	19.2	17.1	15.3	17.1	≤ 0.04	75 - 300
10	Total Fe	mg/l	1.950	1.822	3.240	1.661	1.690	7.548	≤0.3	≤0.3
11	Sodium Sulfite SO_3^{2-}	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	20 - 40	20 - 40
12	Phosphate PO_4^{3-}	mg/l	0.271	0.271	0.249	0.219	0.242	0.390	30 - 60	30 - 60
13	Chloride Cl^-	mg/l	16.7	23.4	13.6	36.6	21.3	19.9	-	-
14	Hydrazine N_2H_4	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	0.03 - 0.1	0.03 - 0.1
15	Total hydrocarbon	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	≤ 3 (***)	≤ 3 (***)
16	Copper (Cu)	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	≤ 0.007	≤ 0.007
17	Ammonium	mg/l	0.4	0.3	0.4	0.4	0.3	0.3	1	1
18	Nitrite	mg/l	0.690	0.475	0.585	0.545	0.505	0.585	-	-
19	Nitrat	mg/l	0.141	0.154	0.146	0.105	0.115	0.139	-	-
20	Total nitrite and nitrat (****)	mg/l	0.831	0.629	0.731	0.65	0.62	0.724	≤ 0.02	≤ 0.02

Notes:

(*)According to the converting of University of Wisconsin Green Bay
(**)Boiler's feed water standard according to ABMA
(***)THC concentrations in water as a function of the origin of oil;
(****)Total analysis results of nitrite and nitrate concentrations measured in the parameters 18 and 19 .

KPH: Undetected

3.1.4. Surface Water Quality Assessment

3.1.4.1. Assesment follow dosmetic supply standard

According Regulation QCVN 02:2009/BYT on domestic water quality, prescribe conditions for domestic water quality, including the following parameters: color, odor, turbidity, residual chlorine, pH, concentration of ammonium , the total iron content, Anat Pecman index, hardness, chloride content, fluoride content, content of total arsenic, total coliform, E. coli or thermo-tolerant coliform. However, the purpose of water quality sampling service of boiler operation, the team only conducted sampling and analysis parameters: turbidity, pH, ammonia concentration, total iron content, hardness, chloride concentrations.

The results compare the quality of surface water samples with Ben Luc District Regulations QCVN 02: 2009 / BYT of the Ministry Health is presented in Table 19.

Table 19. The results comparison with surface water quality standards QCVN 02: 2009/BYT

No.	Parameter	Unit	Symbol samples												QCVN 02:2009/BYT
			NM1-1	NM2-1	NM3-1	NM4-1	NM5-1	NM6-1	NM1-2	NM2-2	NM3-2	NM4-2	NM5-2	NM6-2	
1	Turbidity	NTU	108.0	85.4	86.8	89.2	90.8	112.0	73.6	71.6	90.6	55.9	68.0	75.6	5
2	pH	-	6.0	5.8	6.2	6.1	6.5	6.1	5.9	6.1	6.2	6.3	6.1	6.0	6 - 8.5
3	Electric conductivity (EC)	µs/cm	113	118	133	114	119	101	109	134	123	188	106	106	-
4	Total hardness	mgCaCO3/l	10	15	27	15	15	10	15	15	24	25	10	15	350
5	Suspended solid	mg/l	49	41	47	40	41	48	39	39	83	42	26	34	-
6	Total Dissolved Solids (TDS)	mg/l	56	59	71	57	59	51	55	67	65	94	53	53	-
7	Total Alkalinity	mgCaCO3/l	5	5	9	5	5	5	5	5	9	5	5	5	-
8	Dissolved oxygen	mgO2/l	5.9	6.4	6.3	5.9	6.0	6.0	5.8	6.1	7.2	6.2	6.3	5.6	-
9	Soluble SiO32-	mg/l	23.2	17.6	19.2	17.3	17.6	23.6	16.2	16.8	19.2	17.1	15.3	17.1	-
10	Total Fe	mg/l	2.550	2.162	3.090	1.803	1.846	2.838	1.950	1.822	3.240	1.661	1.690	7.548	0.5
11	Sodium Sulfite SO32-	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	-
12	Phosphate PO43-	mg/l	0.249	0.264	0.405	0.390	0.316	0.405	0.271	0.271	0.249	0.219	0.242	0.390	-
13	Chloride Cl-	mg/l	17.0	20.9	16.4	22.4	23.8	18.5	16.7	23.4	13.6	36.6	21.3	19.9	300
14	Hydrazine N2H4	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	-
15	Total hydrocarbon		KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	-
16	Copper (Cu)	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	KPH	-
17	Ammonium	mg/l	0.4	0.3	0.4	0.4	0.4	0.3	0.4	0.3	0.4	0.4	0.3	0.3	3
18	Nitrite	mg/l	0.680	0.490	0.560	0.610	0.545	0.610	0.690	0.475	0.585	0.545	0.505	0.585	-
19	Nitrat	mg/l	0.151	0.141	0.175	0.185	0.159	0.154	0.141	0.154	0.146	0.105	0.115	0.139	-

Notes:
QCVN 02: 2009/BYT: National Technical Regulation on domestic water quality;
"_" : Not specified.

Comment:

According Table 19 comparison quality of surface water Ben Luc District with QCVN 02: 2009/BYT show that:

– Value of turbidity parameters ranged from 55.9 -112 NTU, average value is 84 NTU, exceeded so many times over the Regulation QCVN 02:2009/BYT;

– pH values ranging from 5.8 - 6.5, the average value is 6.1, most of the samples meey QCVN 02:2009/BYT, except samples NM2-1 and NM1-2;

– Value of hardness surface in Ben Luc district ranged 10-27 mgCaCO3/kg, average is 16.3, meet QCVN 02: 2009/BYT;

– The total iron contentation in the water samples ranged 1.67 - 7:54 mg/l, average is 2.68 mg/l, exceeding significantly from QCVN 02: 2009/BYT;

– Chloride concentration of the water samples in the area for Ben Luc district ranged from 13.6 - 36.6 mg/L, The average is 20.9 mg/L, lower than the QCVN 02: 2009 / BYT;

– Value ammonium concentrations in surface water samples ranged from 0.3 - 0.4 mg/L, the average is 0:35 mg/L, lower than the QCVN 02: 2009/BYT.

Thus, the water quality in the area for Ben Luc district do not meet the Regulation on QCVN 02: 2009/BYT to target domestic water supply.

3.1.4.2. Assesment follow feedwater for incinerator standard

Comparing the results of water quality analysis at 6 locations at the high tide and low tide with TCVN 7704 : 2007 shows that :

– Electrical conductivity, TDS , SO_3^{2-}, phosphate, chloride, N_2H_4, THC, Cu, ammonium meet the standard in both rising tide and falling tide ;

– The parameters such as turbidity, hardness, DO, SiO_3^{2-}, total iron do not meet the standard. pH range from 5.6 - 6.5 , much lower than the standard for boiler feed water (8.5 – 9.5).

Detailed assessment for each parameter on the locations of water quality monitoring in Ben Luc district on July 30, 2014 is presented below:

(1). Turbidity

Comparing the turbidity analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 16:

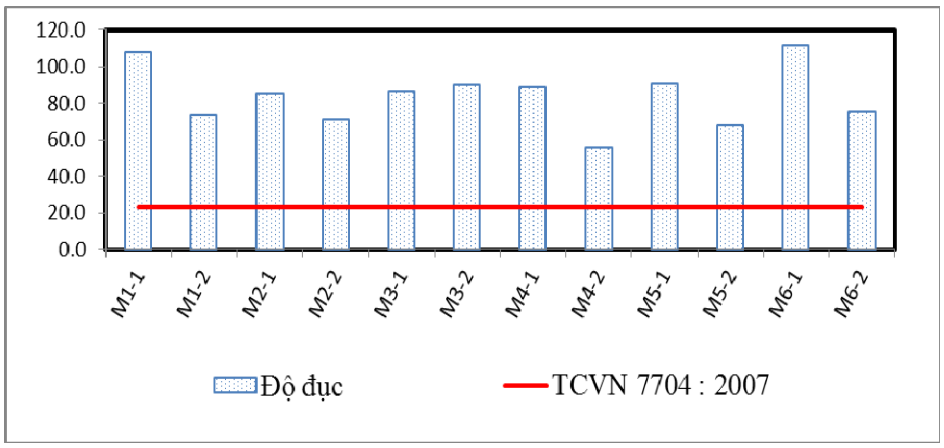

Figure 16. Comparing the turbidity analysis results of surface water in Ben Luc district with TCVN 7704:2007

Figure 11 shows that turbidity ranged from 55 – 112 NTU, the average value is 84 NTU, exceeded TCVN 7704:2007 at both time of high tide and falling tide;

(2). pH

Comparing the pH values of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 12:

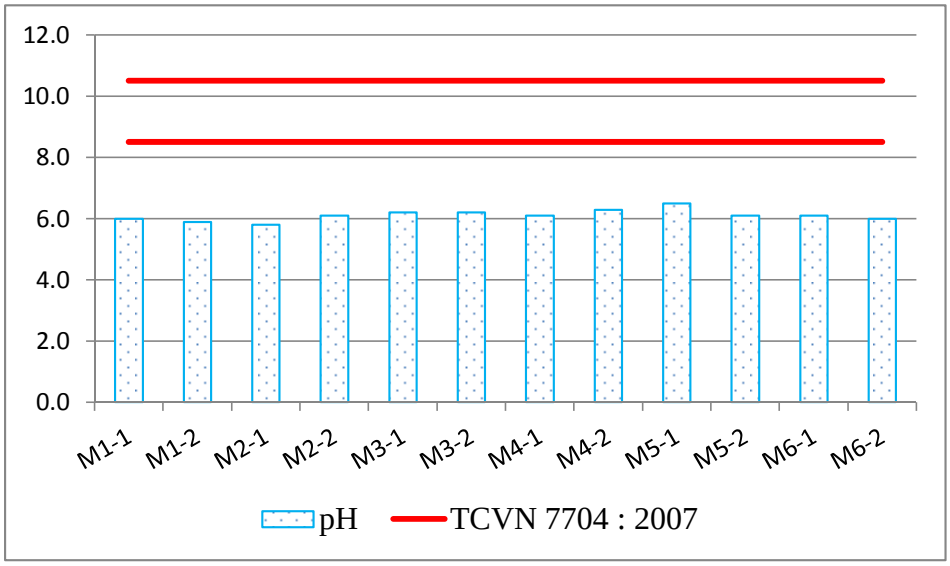

Figure 17. Comparing the pH analysis results of surface water in Ben Luc district with TCVN 7704:2007

Figure 17 shows that pH ranged from 5.8 – 6.5, the average value is 6.1, did not meet TCVN 7704:2007 at both time of rising tide and low tide;

(3). Electrical conductivity (EC)

Comparing the electrical conductivity measurement results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 18:

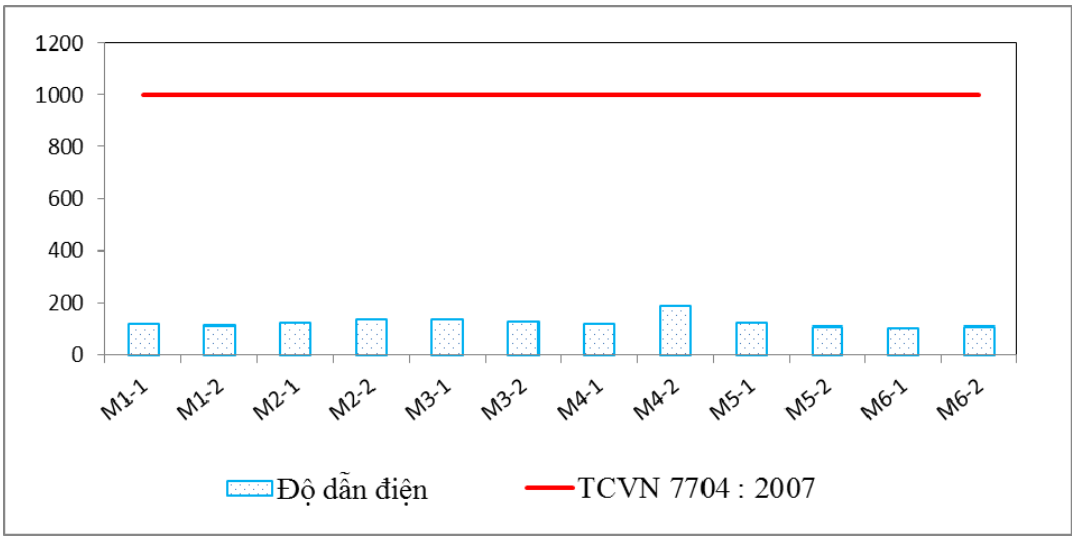

Figure 18. Comparing the electrical conductivity of surface water in Ben Luc district with TCVN 7704:2007

Figure 18 shows that Electrical conductivity in the range of 101-188 µs/cm, the average value is 122 µs/cm, meet TCVN 7704:2007 at both time of rising tide and falling tide.

(4). Hardness

Comparing the hardness analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 19:

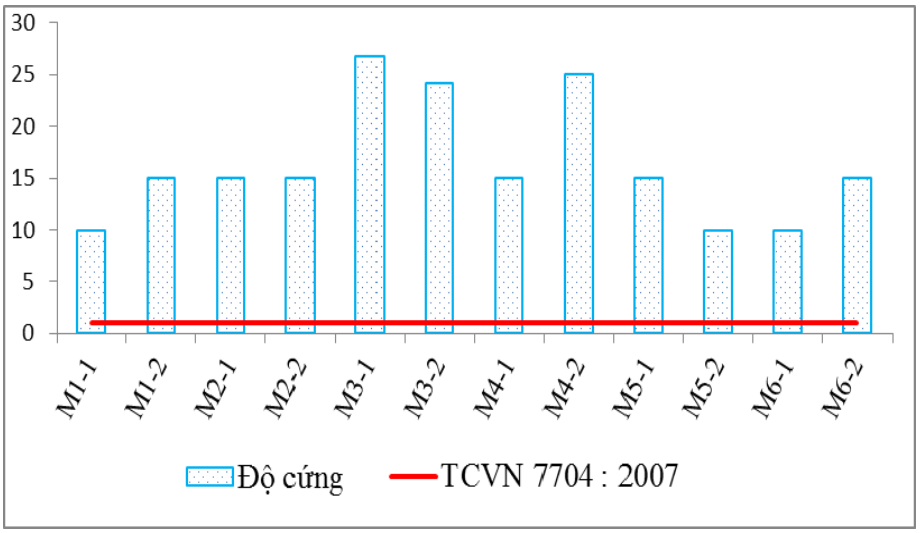

Figure 19. Comparing the hardness values of surface water in Ben Luc district with TCVN 7704:2007

Figure 19 shows that hardness ranged from 101-188 mg$CaCO_3$/l, the average value is 122 mg$CaCO_3$/l, exceeded TCVN 7704:2007 at both time of rising tide and falling tide.

(5). TSS

Comparing the TSS analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 20:

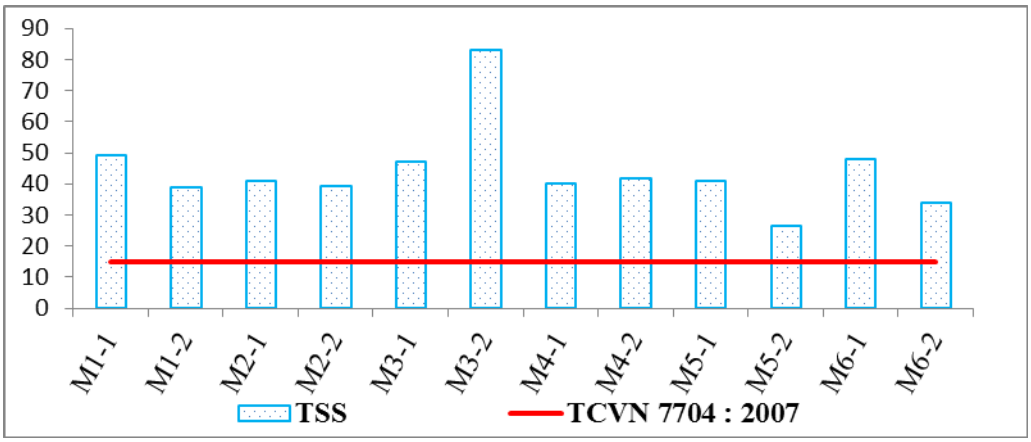

Figure 20. Comparing the TSS concentrations of surface water in Ben Luc district with TCVN 7704:2007

Figure 20 shows that TSS concentrations ranged from 26-83 mg/l, the average value is 44.1 mg/l; exceeded TCVN 7704:2007 at both time of rising tide and falling tide.

(6). TDS

Comparing the TDS analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 21:

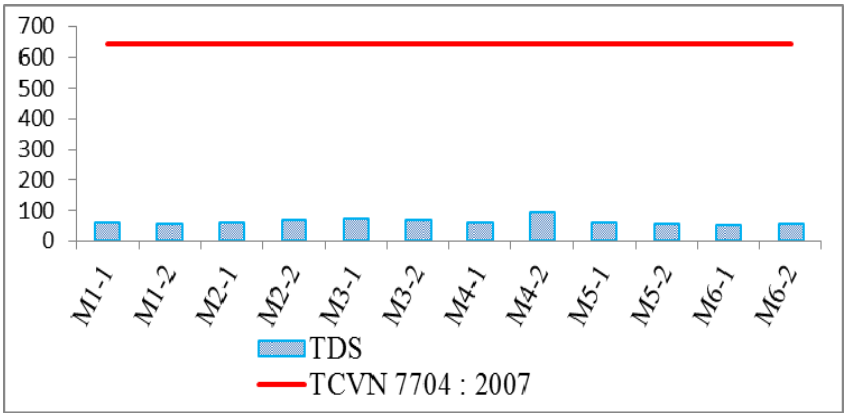

Figure 21. Comparing the TDS concentrations of surface water in Ben Luc district with TCVN 7704:2007

Figure 21 shows that TDS concentrations in the range of 51-94 mg/l, the average value is 61.7 mg/l, meet TCVN 7704:2007 at both time of rising tide and falling tide.

(7). Alkalinity

Comparing the alkalinity analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 22:

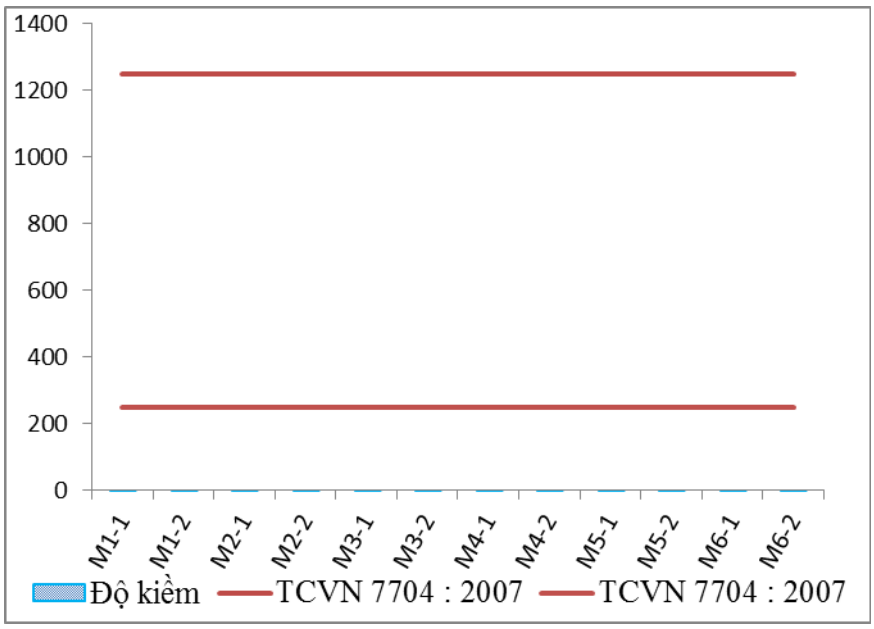

Figure 22. Comparing the alkalinity of surface water in Ben Luc district with TCVN 7704:2007

Figure 22 shows that alkalinity values in the range of 5-9 mg$CaCO_3$/l, the average value is 7 mg$CaCO_3$/l, meet TCVN 7704:2007 at both time of rising tide and falling tide.

(8). Dissolved oxygen (DO)

Comparing the DO measurement results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 23:

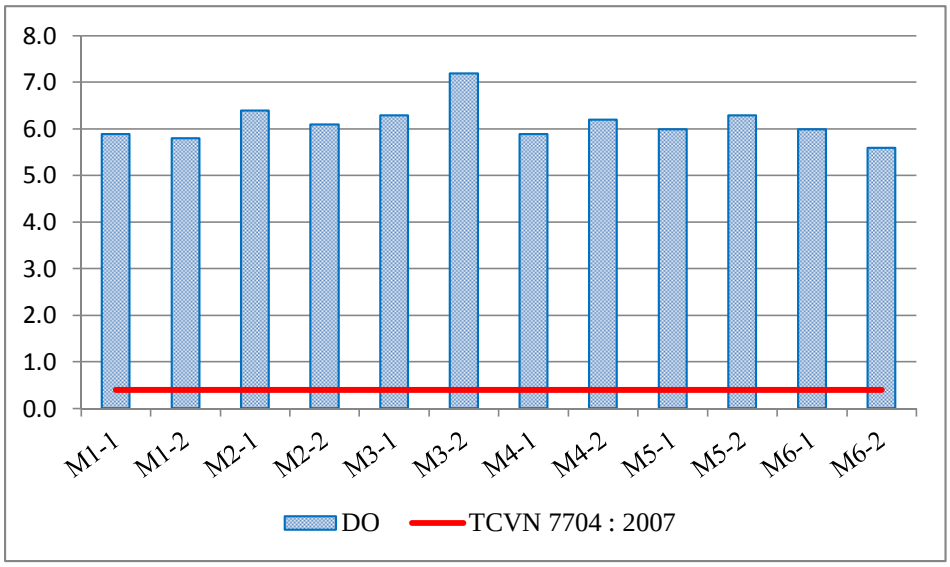

Figure 23. Comparing the DO of surface water in Ben Luc district with TCVN 7704:2007

Figure 23 shows that DO concentration values ranged from 5.8 - 7.2 mgO_2/l, the mean value is 6.1 mgO_2/l, did not meet TCVN 7704:2007 at both time of rising tide and falling tide.

(9). SiO_3^{2-} concentrations

Comparing the SiO_3^{2-} analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 24:

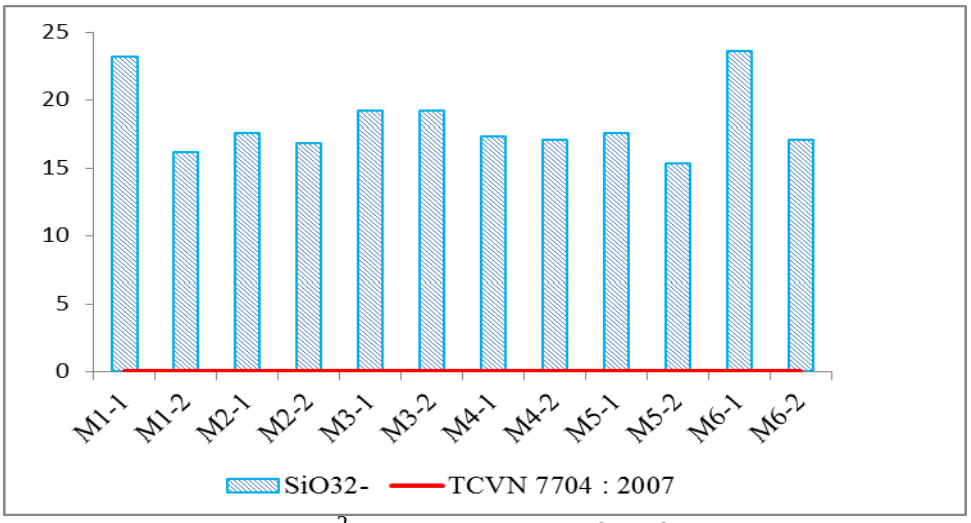

Figure 24. Comparing the SiO_3^{2-} concentrations of surface water in Ben Luc district with TCVN 7704:2007

Figure 24 shows that SiO_3^{2-} concentrations values in the range of 15.3 - 23.6, the average value is 18.4; exceeded many times compared with the technical standards TCVN 7704:2007 at both time of rising tide and falling tide.

(10). Total iron

Comparing the total iron analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 25:

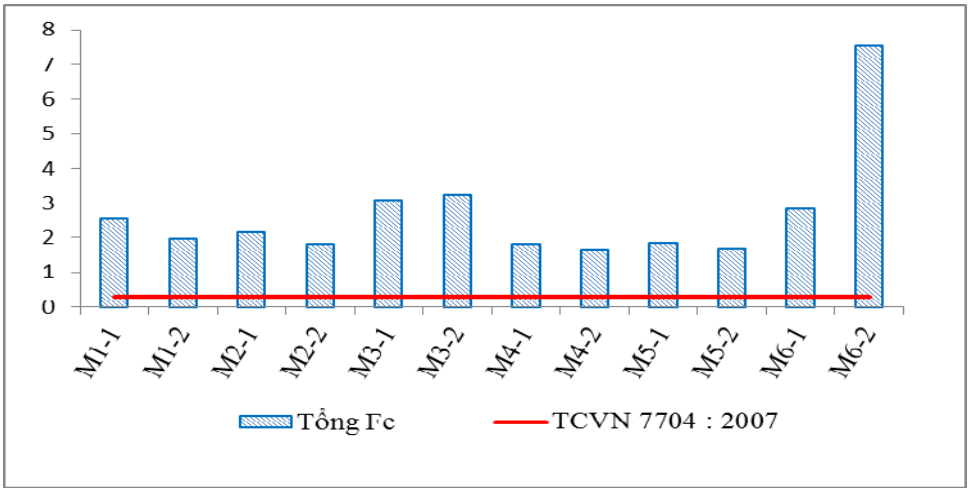

Figure 25. Comparing the total iron of surface water in Ben Luc district with TCVN 7704:2007

Figure 25 shows that total iron values ranging from 1.82 – 7.54 mg/l, the average value is 2.70 mg/l, exceeded TCVN 7704:2007 at both time of rising tide and falling tide.

(11). SO_3^{2-} concentrations

The analysis results shows that SO_3^{2-} values in water samples are not detectable.

(12). Phosphate

Comparing the PO_4^{3-} analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 21:

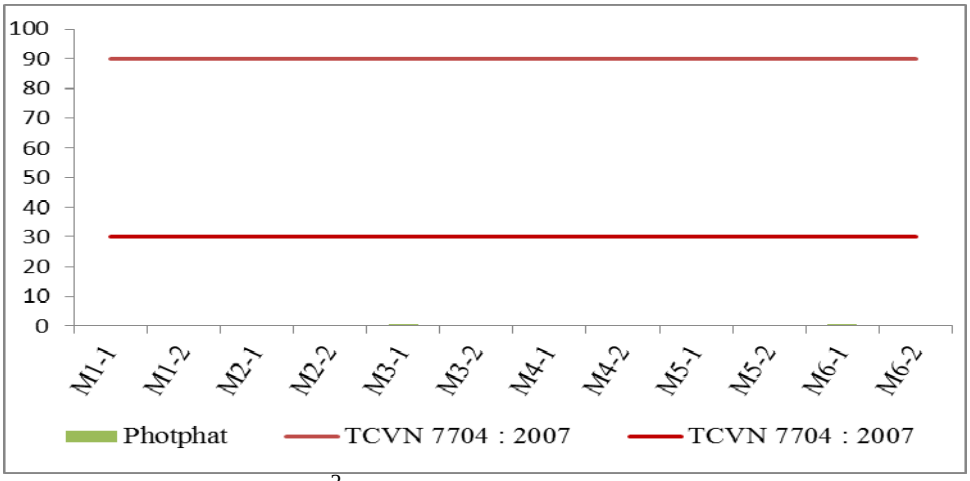

Figure 26. Comparing the PO_4^{3-} concentrations of surface water in Ben Luc district with TCVN 7704:2007

Figure 26 shows that PO_4^{3-} values in the range of 0.24 to 0.40 mg/l, the average value is 0.34 mg/l; meet TCVN 7704:2007 at both time of rising tide and falling tide.

(13). Chloride

The analytical results shows that Cl^- values ranged from 12.6 to 33.6 mg/l, the average value is 20.9 mg/l; meet TCVN 7704:2007 at both time of rising tide and falling tide.

(14). N_2H_4

The analysis results shows that N_2H_4 values in water samples are not detectable.

(15). THC

The analysis results shows that THC values in water samples are not detectable.

(16). Cu

The analysis results shows that copper concentrations in water samples are not detectable.

(17). Amoni

Comparing the ammonium analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 27:

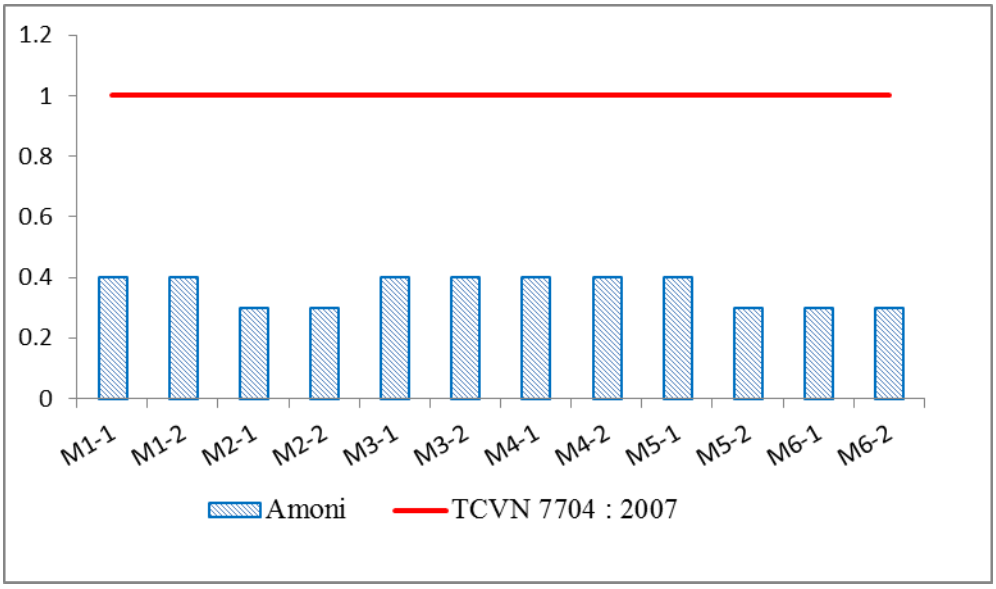

Figure 27. Comparing the ammonium concentrations of surface water in Ben Luc district with TCVN 7704:2007

Figure 27 shows that ammonium values in the range of 0.3 to 0.4 mg/l, the average value is 0.35 mg/l; meet TCVN 7704:2007 at both time of rising tide and falling tide.

(18). Total nitrite and nitrate

Comparing Total nitrite and nitrate analysis results of surface water in Ben Luc district with TCVN 7704:2007 is presented in Figure 28:

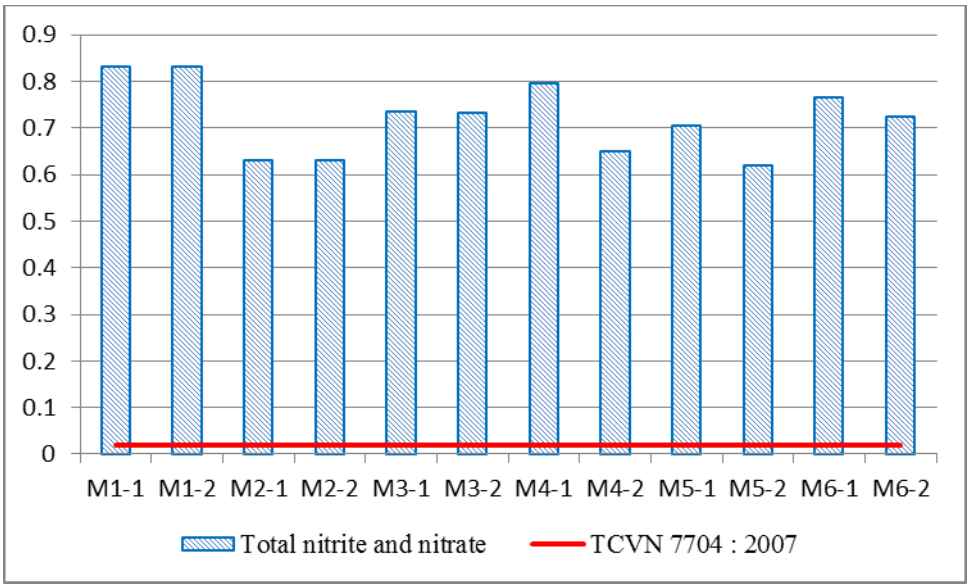

Figure 28. Comparing total nitrite and nitrate concentrations of surface water in Ben Luc district with TCVN 7704:2007

Figure 28 shows that the total amount of nitrite, nitrate ranged from 0.62 - 0.83 mg/l, the average value is 0.7 mg/l; exceeded TCVN 7704: 2007 at both time of rising tide and falling tide.

(19). Summary of the water quality analysis results

The summary of the water quality analysis results of 12 surface water samples in Ben Luc District, Long An Province versus TCVN 7704-2007 is presented in Table 19.

Table 20. Summary results of the surface water quality analysis in comparison with TCVN 7704: 2007

No.	Parameter	Unit	The range of values	Average	Water supply standard (TCVN 7704:2007)	Conclusion
1	Transparency	NTU	55.9 - 112.0	84.0	≤ 23 (*)	**Do not meet**
2	pH	-	5.8 – 6.5	6.1	8.5 – 10.5	**Do not meet**
3	Electric conductivity (EC)	µs/cm	101.4 – 187.5	122.0	1000	meet
4	Total hardness	$mgCaCO_3/l$	10.0 – 26.8	16.3	1	**Do not meet**
5	Total suspended solid (TSS)	mg/l	26.4 – 83.0	44.1	15 (**)	**Do not meet**
6	Total Dissolved Solids (TDS)	mg/l	50.7 – 93.8	61.7	< 640	meet
7	Total Alkalinity	$mgCaCO_3/l$	5.0 – 8.6	5.6	250 - 1000	**Do not meet**
8	Dissolved oxygen	mgO_2/l	5.6 – 7.2	6.1	≤ 0.4	**Do not meet**
9	Soluble SiO_3^{2-}	mg/l	15.3 – 23.6	18.4	≤ 0.04	**Do not meet**
10	Total Fe	mg/l	1.7 – 7.5	2.7	≤0.3	**Do not meet**
11	Sodium Sulfite SO_3^{2-}	mg/l	0	0	20 - 40	meet
12	Phosphate PO_4^{3-}	mg/l	0.2 – 0.4	0.3	30 - 60	meet
13	Chloride Cl^-	mg/l	13.6 – 36.6	20.9	-	meet
14	Hydrazine N_2H_4	mg/l	0	0	0.03 - 0.1	meet
15	Total hydrocarbon	mg/l	0	0	≤ 3 (***)	meet
16	Copper (Cu)	mg/l	0	0	≤ 0.007	meet
17	Ammonium	mg/l	0.3 – 0.4	0.4	1	meet
18	Nitrite	mg/l	0.5 – 0.7	0.6		

No.	Parameter	Unit	The range of values	Average	Water supply standard (TCVN 7704:2007)	Conclusion
19	Nitrate	mg/l	0.1 - 0.2	0.1		
20	Total NO_2^- and NO_3^-	mg/l	0.6 – 0.8	0.7	≤ 0.02	**Do not meet**

Table 19 shows that there are 9 parameters such as turbidity, pH, suspended solids, alkalinity, SiO_3^{2-}, total Fe, Total NO_3^- and NO_2^- exceeded the standard many times.

3.2. Survey and Analysis of Ground Water

3.2.1. The sampling locations and time

To assess the quality of groundwater in the project area, Environmental Technology Centre (ENTEC) have taken 06 ground water samples. Sampling locations is presented in Table 21.

Table 21. Groundwater sampling locations

No.	Symbol	Position	Deep (m)	Distance to Thuan Dao Industrial Zone (km)
01	NN01	Groundwater wells No. 7 at Go Den Water Supply Plant	210	3.5
02	NN02	Groundwater well at Ben Luc Water Supply Plant	220	2.4
03	NN03	Groundwater wells No. 8 at Go Den Water Supply Plant	220	3.6
04	NN04	Groundwater well No. 1 at Hoang Long Water Supply Plant	215	1.3
05	NN05	Groundwater well No. 2 at Hoang Long Water Supply Plant	220	1.7
06	NN06	Groundwater well No. 10 at Go Den Water Supply Plant	215	4.2

Location's coordinates and time of sampling groundwater in Ben Luc district area are presented in Table 22.

Table 22. Location coordinates and time of groundwater sampling

No	Symbol	Latitude	Longitude	Time sampling
01	NN01	10°38'48.80"N	106°29'59.50"E	15h30
02	NN02	10°38'25.45"N	106°29'8.78"E	13h00
03	NN03	10°38'59.40"N	106°30'8.04"E	15h40
04	NN04	10°37'57.60"N	106°29'36.80"E	13h40
05	NN05	10°37'51.10"N	106°29'38.40"E	13h50

No	Symbol	Latitude	Longitude	Time sampling
06	NN06	10°39'19.80"N	106°30'20.40"E	15h45

Location map of groundwater sampling in Ben Luc District is presented in figure 29.

Figure 29. Location map of groundwater sampling in Ben Luc District

3.2.2. Analysis methods

The analytical methods of groundwater quality parameters are presented in Table 14.

3.2.3. The analytical results

The analytical results of groundwater quality in Ben Luc district area are presented in Table 23.

Table 23. The analytical results of groundwater quality in Ben Luc district

No.	Parameter	Unit	Symbol sample						Water supply (TCVN 7704:2007)	Water furnace standard VBC company
			NN01	NN02	NN03	NN04	NN05	NN06		
1	Turbidity	NTU	260.0	3.2	13.0	62.5	9.2	13.9	≤ 23 (*)	≤ 23 (*)
2	pH	-	6.5	6.8	6.6	6.8	6.4	6.6	8.5 – 10.5	10.5 – 11.5
3	Electric conductivity (EC)	µs/cm	618	805	395	1055	1074	280	1000	1000
4	Total hardness	mg$CaCO_3$/l	95	117	55	135	125	35	1	1
5	Total suspended solid (TSS)	mg/l	631	527	352	986	1004	229	15 (**)	15
6	Total Dissolved Solids (TDS)	mg/l	309	495	197	527	537	140	< 640	< 4.480
7	Total Alkalinity	mg$CaCO_3$/l	30	54	80	40	45	100	250 - 1000	250 - 1000
8	Dissolved oxygen	mgO_2/l	0	0	0	0	0	0	≤ 0.4	
9	Soluble SiO_3^{2-}	mg/l	29.4	48.2	30.3	53.4	53.9	33.9	≤ 0.04	75 - 300
10	Total Fe	mg/l	7.549	0.270	8.602	7.747	5.205	7.166	≤0.3	≤0.3
11	Sodium Sulfite SO_3^{2-}	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	20 – 40	20 - 40
12	Phosphate PO_4^{3-}	mg/l	0.026	0.011	0.086	0.115	0.101	0.405	30 – 60	30 - 60
13	Chloride Cl^-	mg/l	174	228	99	153	160	51	-	-
14	Hydrazine N_2H_4	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	0.03 - 0.1	0.03 - 0.1
15	Total hydrocarbon	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	≤ 3 (***)	≤ 3 (***)
16	Copper (Cu)	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	≤ 0.007	≤ 0.007
17	Ammonium	mg/l	0.2	KPH	0.2	0.2	0.3	0.2	1	1
18	Nitrite	mg/l	0.075	0.045	0.060	0.045	0.020	<0,01	-	-
19	Nitrat	mg/l	0.004	0.005	0.040	0.010	0.020	0.050	-	-
20	Total nitrite, nitrate (****)	mg/l	0.079	0.050	0.100	0.055	0.040	0.050	≤ 0.02	≤ 0.02

Notes:

(*)According to the converting of University of Wisconsin Green Bay
(**)Boiler feed water standards according to ABMA
(***)THC concentrations in water as a function of the origin of oil;
(****)Total analysis results of nitrite and nitrate concentrations measured in the parameters 18 and 19 .
KPH: Undetected

3.2.4. Ground Water Quality Assessment

3.2.4.1. Assesment follow dosmetic supply standard

The results compare the quality of groundwater samples with Ben Luc District Regulations QCVN 02: 2009 / BYT of the Ministry Health is presented in Table 24.

Table 24. The results comparison with groundwater quality standards QCVN 02: 2009/BYT

No.	Parameter	Unit	Symbol samples						QCVN 02:2009/BYT
			NN01	NN02	NN03	NN04	NN05	NN06	
1	Turbidity	NTU	260.0	3.2	13.0	62.5	9.2	13.9	5
2	pH	-	6.5	6.8	6.6	6.8	6.4	6.6	6 - 8.5
3	Electric conductivity (EC)	µs/cm	618	805	395	1055	1074	280	-
4	Total hardness	mgCaCO3/l	95	117	55	135	125	35	350
5	Suspended solid	mg/l	631	527	352	986	1004	229	-
6	Total Dissolved Solids (TDS)	mg/l	309	495	197	527	537	140	-

No.	Parameter	Unit	Symbol samples						QCVN 02:2009/BYT
			NN01	NN02	NN03	NN04	NN05	NN06	
7	Total Alkalinity	mgCaCO3/l	30	54	80	40	45	100	-
8	Dissolved oxygen	mgO2/l	0	0	0	0	0	0	-
9	Soluble SiO32-	mg/l	29.4	48.2	30.3	53.4	53.9	33.9	-
10	Total Fe	mg/l	7.549	0.270	8.602	7.747	5.205	7.166	0.5
11	Sodium Sulfite SO32-	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	-
12	Phosphate PO43-	mg/l	0.026	0.011	0.086	0.115	0.101	0.405	-
13	Chloride Cl-	mg/l	174	228	99	153	160	51	300
14	Hydrazine N2H4	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	-
15	Total hydrocarbon		KPH	KPH	KPH	KPH	KPH	KPH	-
16	Copper (Cu)	mg/l	KPH	KPH	KPH	KPH	KPH	KPH	-
17	Ammonium	mg/l	0.2	KPH	0.2	0.2	0.3	0.2	3
18	Nitrite	mg/l	0.075	0.045	0.060	0.045	0.020	<0,01	-
19	Nitrat	mg/l	0.004	0.005	0.040	0.010	0.020	0.050	-

Notes:
QCVN 02: 2009/BYT: National Technical Regulation on domestic water quality;
"_" : Not specified.

Comment:

According Table 24 comparison quality of surface water Ben Luc District with QCVN 02: 2009/BYT show that:

– Value of turbidity parameters ranged from 3.2 -260 NTU, average value is 60.3 NTU, exceeded so many times over the Regulation QCVN 02:2009/BYT, except sample NN02;

– pH values ranging from 6.4 - 6.8, the average value is 6.6, meet QCVN 02:2009/BYT;

– Value of hardness surface in Ben Luc district ranged 35-135 mgCaCO3/kg, average is 93.6, meet QCVN 02: 2009/BYT;

– The total iron contentation in the water samples ranged 0.27 – 8.6 mg/l, average is 6.08 mg/l, most of sample exceeding QCVN 02: 2009/BYT, except sample NN02;

– Chloride concentration of the water samples in the area for Ben Luc district ranged from 51 - 228 mg/L, The average is 144.1 mg/L, lower than the QCVN 02: 2009/BYT;

– Value ammonium concentrations in surface water samples ranged from 0.3 - 0.4 mg/L, the average is 0:35 mg/L, lower than the QCVN 02: 2009/BYT.

Thus, the water quality in the area for Ben Luc district meet the Regulation on QCVN 02: 2009/BYT to target domestic water supply, however, be treated as turbidity parameters and check the remaining parameters ensure QCVN 02: 2009/BYT.

3.2.4.2. Assesment follow feedwater for incinerator standard

Comparing the results of analysis of groundwater quality at 6 locations with national technical standards TCVN 7704: 2007 shows that :

– Parameters such as TDS, SO_3^{2-}, phosphate, chloride, N_2H_4, THC, Cu, ammonium meet the standards;

– Parameters such as pH, hardness, TSS, SiO_3^{2-}, total NO_2^- and NO_3 did not meet the standards

– Transparency parameter of all samples meet TCVN 7704: 2007, except for samples NN01 NN01 exceeded the standard;

– Electrical conductivity (EC) at 4/6 sampling locations meet the standard, 2/6 sampling locations have conductivity exceeding the standard.

– Total Fe of most samples do not meet the standard, except for sample NN02 meeting the standard

Detailed assessment for each parameter on the locations of water quality monitoring in Ben Luc district on July 30, 2014 is presented below:

(1). Turbidity

Comparing the turbidity analysis results of ground water in Ben Luc district with TCVN 7704:2007 is presented in Figure 30.

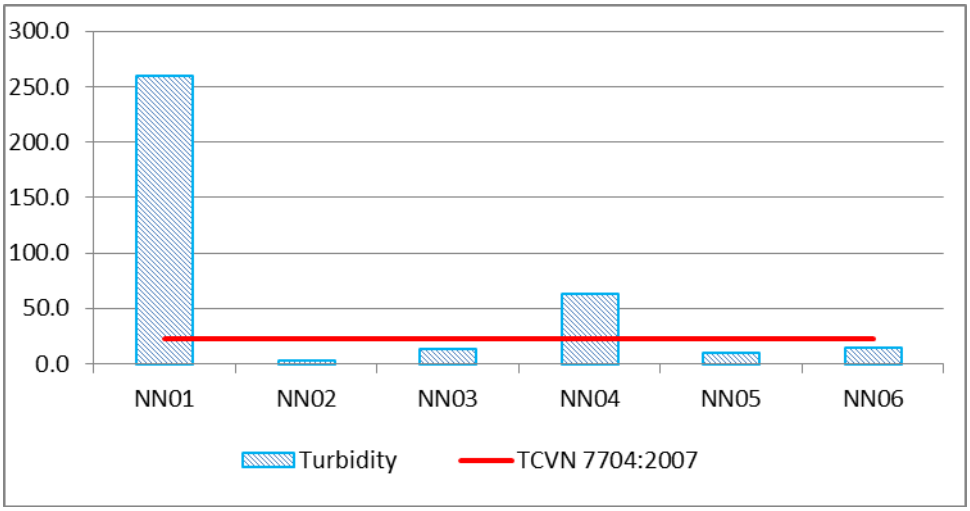

Figure 30. Comparing the turbidity analysis results of ground water in Ben Luc district with TCVN 7704:2007

Figure 30 shows that turbidity ranged from 3.2 – 260 NTU, the average value is 60.3 NTU, most parameters meet TCVN 7704: 2007 except samples NN01 and NN04;

(2). pH

Comparing the pH values of ground water in Ben Luc district with TCVN 7704:2007 is presented in Figure 31:

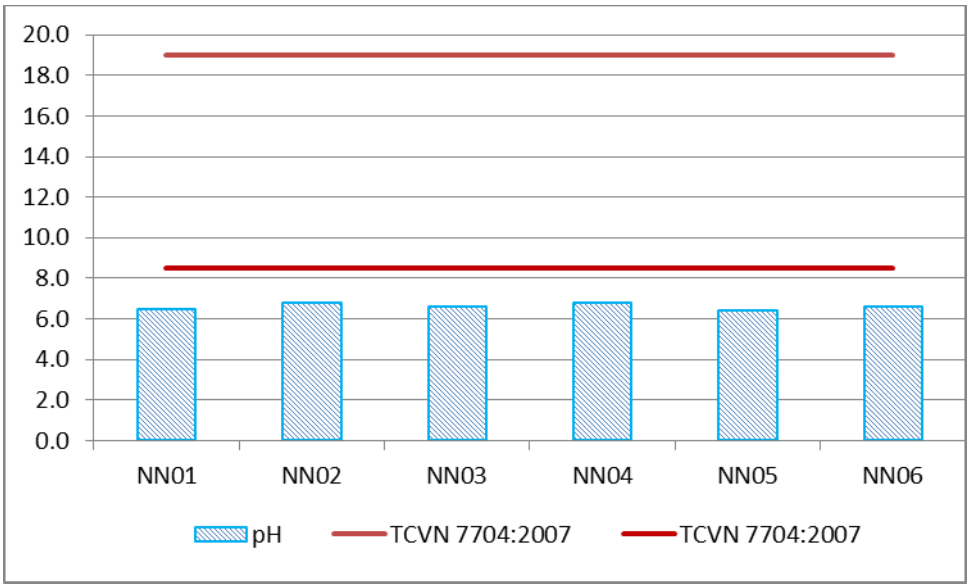

Figure 31. Comparing the pH analysis results of groundwater in Ben Luc district with TCVN 7704:2007

Figure 31 shows that pH ranged from 6.4 – 6.8, the average value is 6.6, did not meet TCVN 7704:2007.

(3). Electrical conductivity (EC)

Comparing the electrical conductivity measurement results of groundwater in Ben Luc district with TCVN 7704:2007 is presented in Figure 32:

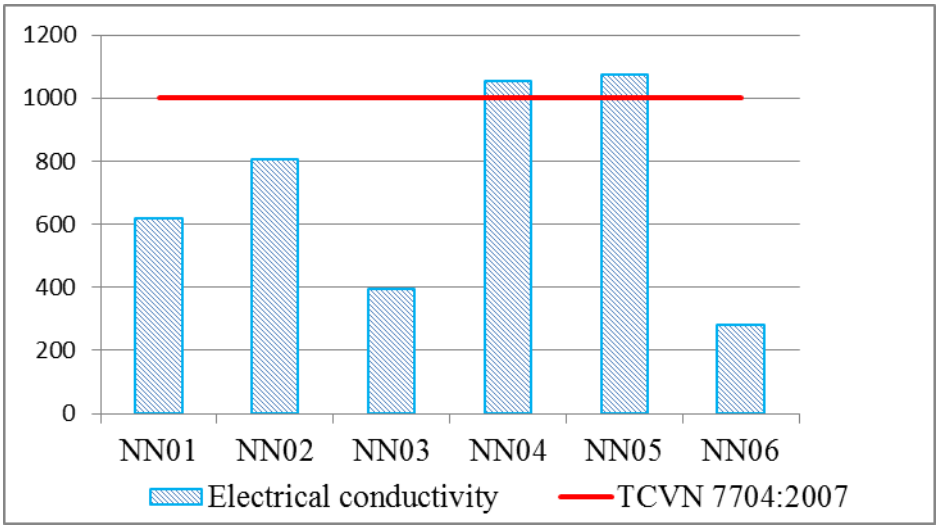

Figure 32. Comparing the electrical conductivity of groundwater in Ben Luc district with TCVN 7704:2007

Figure 32 shows that electrical conductivity ranged from 280 to 1084 µs/cm, the average value is 704.5 µs/cm, meet TCVN 7704:2007, except for samples NN04 and sample NN05.

(4). Hardness

Comparing the hardness analysis results of ground water in Ben Luc district with TCVN 7704:2007 is presented in Figure 33:

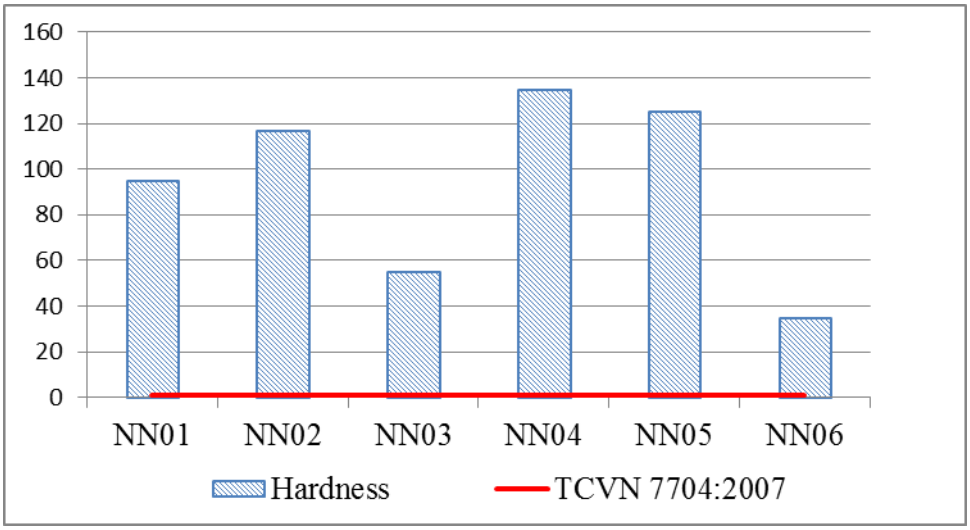

Figure 33. Comparing the hardness values of groundwater in Ben Luc district with TCVN 7704:2007

Figure 33 shows that hardness ranged from 35-135 mg$CaCO_3$/l, the average value is 93.7 mg$CaCO_3$/l, exceeded TCVN 7704:2007.

(5). TSS

Comparing the TSS analysis results of groundwater in Ben Luc district with TCVN 7704:2007 is presented in Figure 34:

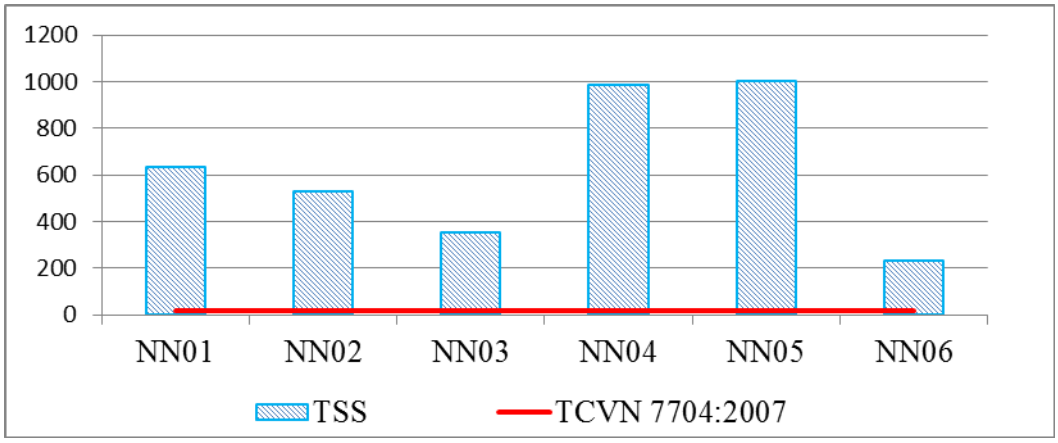

Figure 34. Comparing the TSS concentrations of groundwater in Ben Luc district with ABMA standard

Figure 34 shows that TSS concentrations ranged from 229.2 – 1004.4 mg/l, the average value is 621.67 mg/l; exceeded ABMA standard .

(6). TDS

Comparing the TDS analysis results of groundwater in Ben Luc district with TCVN 7704:2007 is presented in Figure 30:

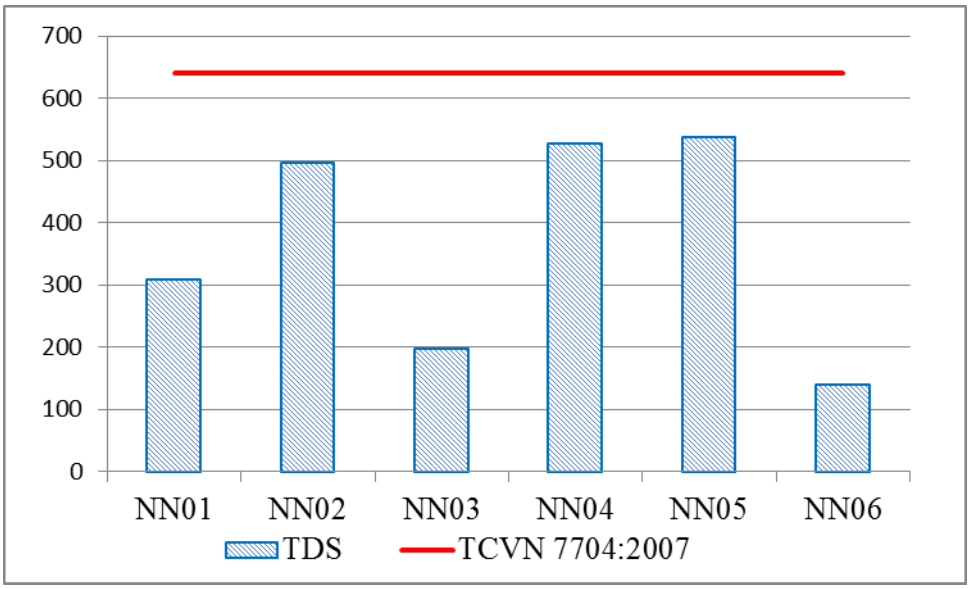

Figure 35. Comparing the TDS concentrations of groundwater in Ben Luc district with TCVN 7704:2007

Figure 35 shows that TDS concentrations ranged from 140 to 537 mg/l, the average value is 376.5 mg/l, meet TCVN 7704:2007.

(7). Alkalinity

Comparing the alkalinity analysis results of groundwater in Ben Luc district with TCVN 7704:2007 is presented in Figure 36:

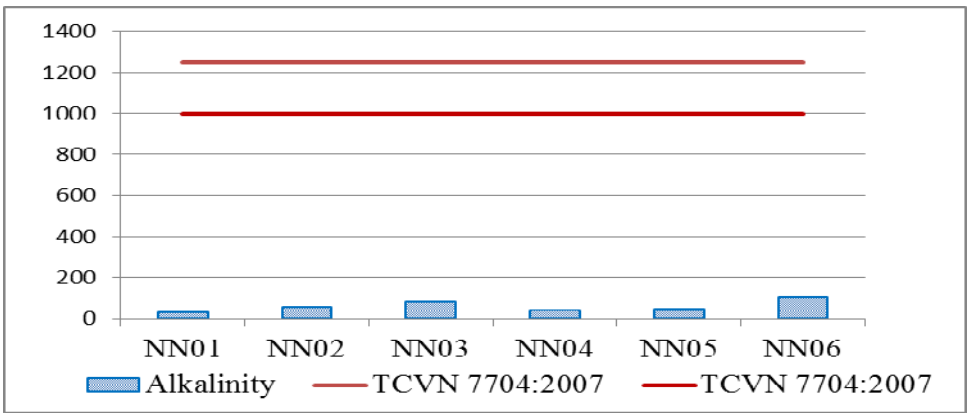

Figure 36. Comparing the alkalinity of groundwater in Ben Luc district with TCVN 7704:2007

Figure 36 shows that alkalinity values ranged from 30 to 100 mg$CaCO_3$/l, the average value is 58.08 mg$CaCO_3$/l, do not meet TCVN 7704:2007.

(8). Dissolved oxygen (DO)

The analysis results shows that DO values in groundwater samples are not detectable.

(9). SiO_3^{2-} concentrations

Comparing the SiO_3^{2-} analysis results of ground water in Ben Luc district with TCVN 7704:2007 is presented in Figure 37:

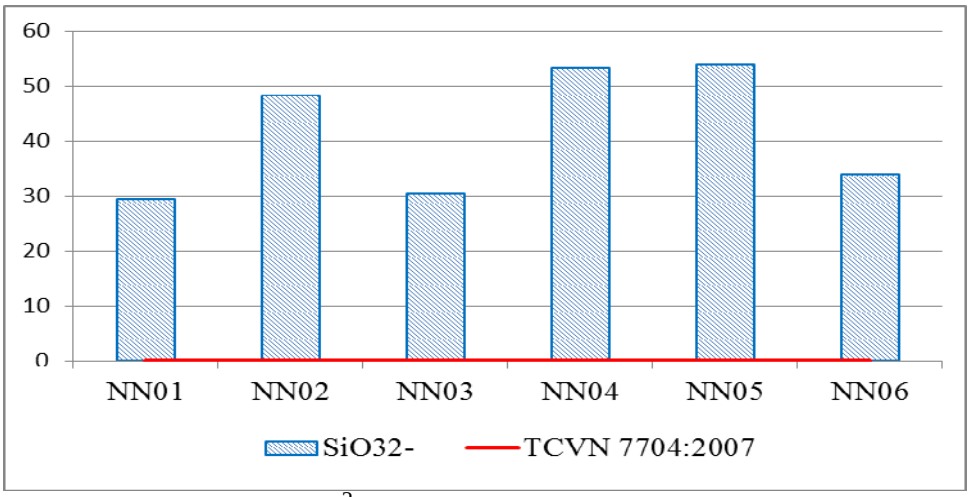

Figure 37. Comparing the SiO_3^{2-} concentrations of groundwater in Ben Luc district with TCVN 7704:2007

Figure 37 shows that SiO_3^{2-} concentrations ranged from 29.4 to 53.9 mg/l, the average

value is 41.5; exceeded TCVN 7704:2007 many times.

(10). Total iron

Comparing the total iron analysis results of groundwater in Ben Luc district with TCVN 7704:2007 is presented in Figure 38:

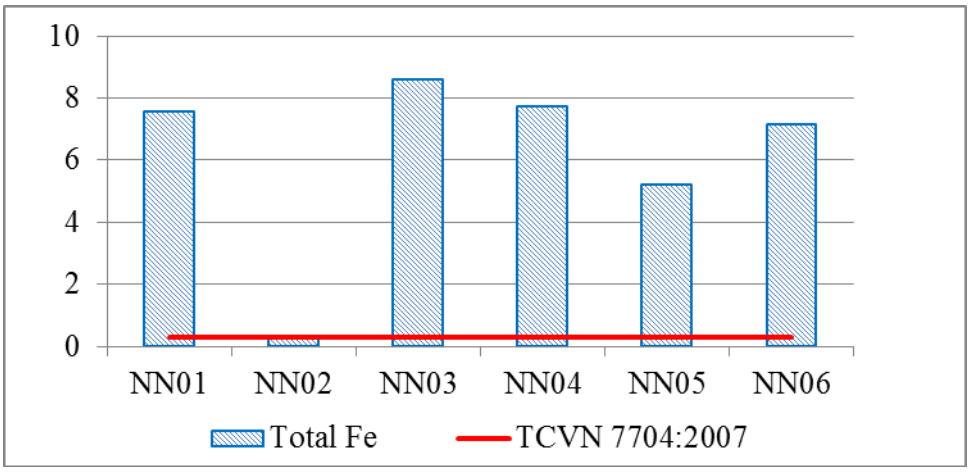

Figure 38. Comparing the total iron of groundwater in Ben Luc district with TCVN 7704:2007

Figure 38 shows that total iron values ranged from 0.27 to 8.6 mg/l, the average value is 6.1 mg/l, exceeded TCVN 7704:2007 except sample NN02.

(11). SO_3^{2-} concentrations

The analysis results shows that SO_3^{2-} values in groundwater samples are not detectable.

(12). Phosphate

Comparing the PO_4^{3-} analysis results of ground water in Ben Luc district with TCVN 7704:2007 is presented in Figure 39:

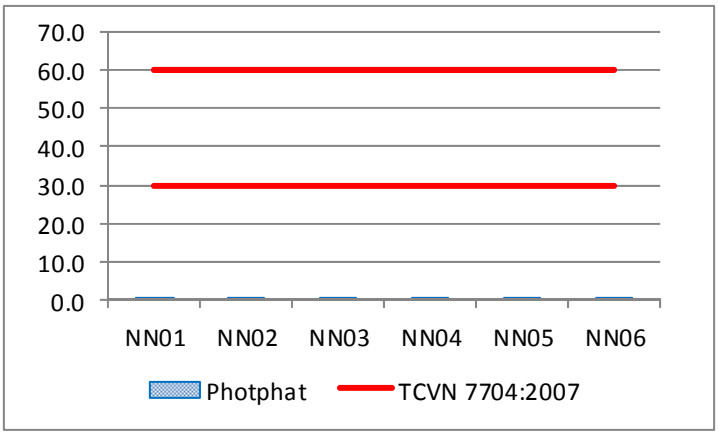

Figure 39. Comparing the PO_4^{3-} concentrations of ground water in Ben Luc district with TCVN 7704:2007

Figure 34 shows that PO_4^{3-} values ranged from 0.01 to 0.41 mg/l, the average value is 0.12 mg/l; meet TCVN 7704:2007.

(13). Chloride

The analytical results shows that Cl^- values ranged from 51.48 to 228 mg/l, the average value is 144.2 mg/l; meet TCVN 7704:2007.

(14). N_2H_4

The analysis results shows that N_2H_4 values in groundwater samples are not detectable.

(15). THC

The analysis results shows that THC values in water samples are not detectable.

(16). Cu

The analysis results shows that copper concentrations in water samples are not detectable.

(17). Amonium

Comparing the ammonium analysis results of ground water in Ben Luc district with TCVN 7704:2007 is presented in Figure 40:

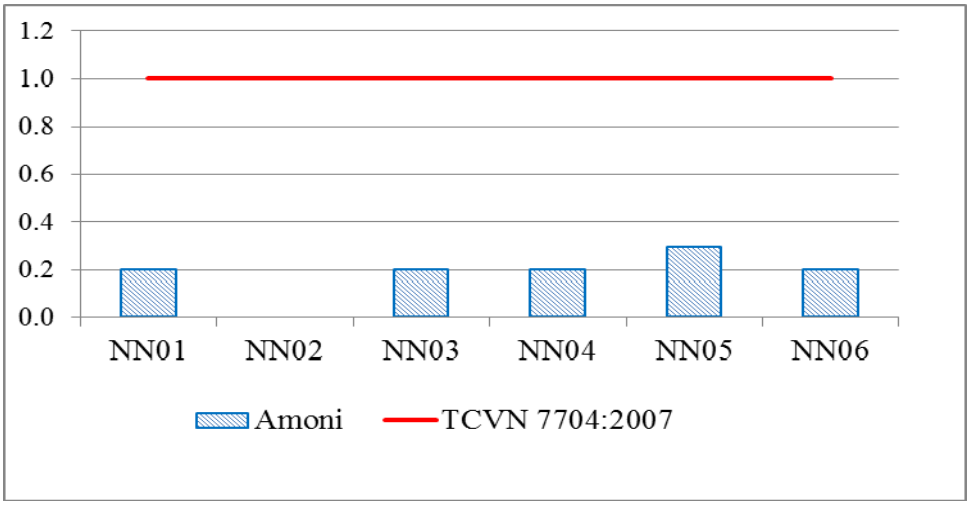

Figure 40. Comparing the ammonium concentrations of groundwater in Ben Luc district with TCVN 7704:2007

Figure 35 shows that ammonium values ranged from 0.0 to 0.3 mg/l, the average value is 0.2 mg/l; meet TCVN 7704:2007.

(18). Total nitrite and nitrate

Comparing Total nitrite and nitrate analysis results of groundwater in Ben Luc district with TCVN 7704:2007 is presented in Figure 41:

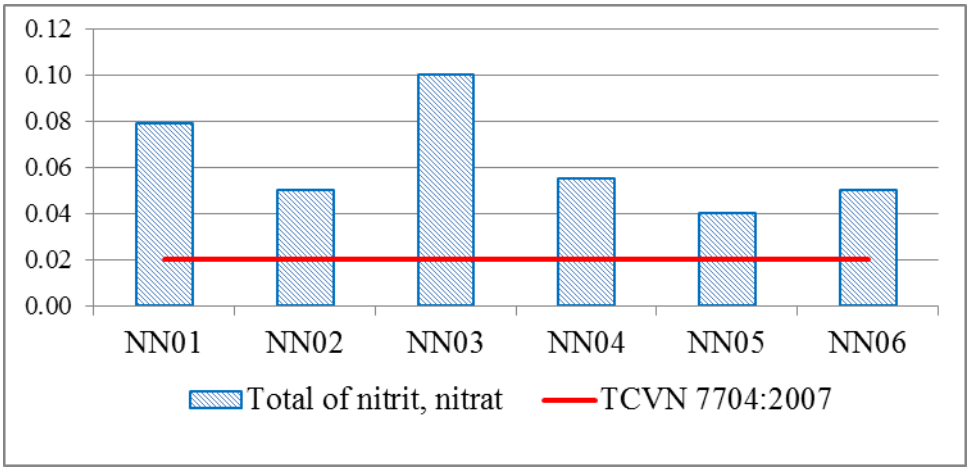

Figure 41. Comparing total nitrite and nitrate concentrations of groundwater in Ben Luc district with TCVN 7704:2007

Figure 41 shows that the total amount of nitrite, nitrate ranged from 0.04 to 0.1 mg/l, the average value is 0.06 mg/l; exceeded TCVN 7704: 2007.

(19). Summary of the ground water quality analysis

Summary results of the groundwater quality analysis versus TCVN 7704: 2007 are presented in Table 25.

Table 25. Summary results of the ground water quality analysis versus TCVN 7704: 2007

No.	Parameter	Unit	The range of values	Average	Water supply standard (TCVN 7704:2007)	Conclusion
1	Transparency	NTU	3.2 - 260	60.3	≤ 23 (*)	Meet the standard, except sample NN01
2	pH	-	6.4 – 6.8	6.6	8.5 – 10.5	Do not meet
3	Electrical conductivity (EC)	µs/cm	280 - 1074.00	704	1000	Meet the standard, except samples NN04 and NN05
4	Total hardness	$mgCaCO_3/l$	35 – 135	93.67	1	Do not meet
5	Suspended solid	TSS	229.2 – 1004.4	621.67	15 (**)	Do not meet
6	Total Dissolved Solids (TDS)	mg/l	140 – 537	367.5	< 640	meet
7	Total Alkalinity	$mgCaCO_3/l$	30 – 100	58.08	250 - 1000	Do not meet

No.	Parameter	Unit	The range of values	Average	Water supply standard (TCVN 7704:2007)	Conclusion
8	Dissolved oxygen	mgO_2/l	0	0	≤ 0.4	meet
9	Soluble SiO_3^{2-}		29.4 – 53.9	41.5	≤ 0.04	Do not meet
10	Total Fe	mg/l	0.27 -8.60	6.09	≤0.3	Do not meet, except for sample NN02
11	Sodium Sulfite SO_3^{2-}	mg/l	0	0	20 - 40	meet
12	Phosphate PO_4^{3-}	mg/l	0.01 – 0.41	0.12	30 - 60	meet
13	Chloride Cl^-	mg/l	51.48 – 228.0	144.2	-	meet
14	Hydrazine N_2H_4	mg/l	0	0	0.03 - 0.1	meet
15	Total hydrocarbon	mg/l	0	0	≤ 3 (***)	meet
16	Copper (Cu)	mg/l	0	0	≤ 0.007	meet
17	Ammonium	mg/l	0.2 – 0.3	0.22	1	meet
18	Nitrite	mg/l	0.02 – 0.08	0.05		
19	Nitrate	mg/l	0 - 0.05	0.02		
20	Total nitrite, nitrate (****)	mg/l	0.05 – 0.1	0.06	≤ 0.02	Do not meet

Notes:

(*)According to the converting of University of Wisconsin Green Bay
(**)Boiler feed water standards according to ABMA
(***)THC concentrations in water as a function of the origin of oil;
(****)Total analysis results of nitrite and nitrate concentrations measured in the parameters 18 and 19 .

Table 25 shows that there are 6/18 parameters (pH, hardness, TSS, alkalinity, SiO_3^{2-}, total nitrite, nitrate) which did not meet the standard at all sampling points, and 3/18 parameters (i.e. turbidity, conductivity , total iron) which did not meet the standard at some points.

4. CONCLUSIONS AND RECOMMENDATIONS

4.1. Conclusions

- Surface waters in Ben Luc district are abundant with Vam Co Dong river system (which is a major tributary of the Dong Nai river system) flowing through, besides

also Ben Luc River with a length of 33km and interlaced canals. However, plan to build the waste-to-energy incinerator plant with capacity of 300 tons/day is located at about 30 km from the sea. Therefore, the water quality in Ben Luc district is unstable over time (between rising tide and falling tide, between the dry season and the rainy season), which is saline and acidified sometimes.

– The result of the investigation and the actual survey of water quality in Ben Luc district showed that the ground waters are main sources of water supply for production and domestic purposes. The ground waters are treated at the Go Den water plant, Ben Luc water plant, Hoang Long water plant. Some companies or investment projects has the individual groundwater wells to supply waters by themselve for production and domestic purposes.

– Comparison of the analysis results of water quality in Ben Luc District in July 2014 with TCVN 7704: 2007 showed that 10/19 parameters (including turbidity, pH, hardness, solids suspended, alkalinity, DO, SiO_3^{2-}, total Fe, total NO_2^- and NO_3^-) did not meet the standard and 9/19 parameters (including conductivity, TDS, SO_3^{2-}, PO_4^{3}, Cl, N_2H_4, total hydrocarbon, total compounds of Cu, NH_4^+). Combined with reference data from Center of Environmental Monitoring and Technical Services of Long An Province in 2013 one can make conclusion that the surface water in Ben Luc district does not meet the standard for feeding the boiler of the waste-to-energy incinerator with capacity of 300 tonnes/day.

– Comparison of analytical results of groundwater quality in Ben Luc District in July 2014 with TCVN 7704: 2007 shows that groundwater quality at depths of about 210-230 m in Ben Luc district is slightly acidified, which have 6/18 parameters (i.e. pH, hardness, TSS, alkalinity, SiO_3^{2-}, total nitrite, nitrate) did not meet the standard at all sampling points, 3/18 parameters (i.e. turbidity, conductivity , total iron) did not meet the standard at some points. Combined with reference data from Center of Environmental Monitoring and Technical Services of Long An Province in 2013 one can make conclusion that groundwater in Ben Luc district can meet the standards for feeding the boiler of the waste-to-energy incinerator with capacity of 300 tonnes/day if some parameters, including electrical conductivity (EC), pH, hardness, suspended solids, alkalinity, SiO_3^{2-}, total NO_2^- and NO_3^- will be improved to meet TCVN 7704: 2007.

– The survey results also show that actual groundwater in the project area is sufficient to provide 500 m^3/day for feeding the boiler of the waste-to-energy incinerator with capacity of 300 tonnes/day.

4.2. Recommendations

-On the basis of the mentioned above results, it can recommend Tsuneishi to sellect the groundwater for supplying water to the boiler of the waste-to-energy incinerator with capacity of 300 tonnes/day.

- Tsuneishi may consider the alternative to sign contracts with Go Den water plant, Ben Luc water plant, Hoang Long water plant to provide water for the waste-to-energy plant's operation.

- To have proactively source of water supply for the waste-to-energy plant's operation, Tsuneishi may request permission from DoNRE of Long An province to exploit and treat groundwater by themselves. However, Tsuneishi must prepare the documents for extraction and use of groundwater, then submit DoNRE of Long An province for review and People Committee of Long An province for getting license. In addition, Tsuneishi have to make a report on environmental impact assessment for groundwater exploitation and treatment project with capacity of 500 m^3/day to submit the Economic Zone Management Board of Long An province for review and approval.

3-2 最終報告書: 処理量 300 トン/日の固形廃棄物焼却事業提案に向けたホーチミン市及び周辺省の固形産業廃棄物、有害廃棄物、医療廃棄物処理の現状調査

TSUNEISHI KAMTECS CORPORATION

最終報告書

プロジェクト

処理量 300 トン/日の固形廃棄物焼却事業提案に向けたホーチミン市及び周辺省の固形産業廃棄物、有害廃棄物、医療廃棄物処理の現状調査

ホーチミン市、2014 年 6 月

TSUNEISHI KAMTECS CORPORATION

最終報告書

プロジェクト

処理量 300 トン/日の固形廃棄物焼却事業提案に向けたホーチミン市及び周辺省の固形産業廃棄物、有害廃棄物、医療廃棄物処理の現状調査

代表者	代表者
TKC	**ENTEC**

ホーチミン市、**2014** 年 **6** 月

目　次

略語

BIWASE	Binh Duong Water Supply Sewerage Environment Co.Ltd. （ビンズン水道・下水環境会社）
BR-VT	Ba Ria-Vung Tau Province（バリア・ブンタウ省）
CITENCO	Ho Chi Minh City Urban Environmental Company Ltd. （ホーチミン市都市環境会社）
Co, Ltd	Company limited(株式会社)
DIT	Department of Industry and Trade(産業及び通商部)
DOH	Department of Health（保健部）
DONRE	Department of Natural Resources and Environment（天然資源・環境部）
DOST	Department of Science and Technology（科学技術部）
DPI	Department of Planning and Investment（計画投資部）
ENTEC	Environmental Technology Center（環境技術センター）
EPZ	Export Processing Zone（輸出加工区）
GDP	Gross Domestic Produst（国内総生産）
HCMC	Ho Chi Minh City（ホーチミン市）
ICs	Industrial Clusters（工業クラスター）
IPs	Industrial Parks（工業団地）
IZA	Industrial Zone Administration（工業ゾーン管理部）
IZs	Industrial Zones（工業ゾーン）
MONRE	Ministry of Natural Resources and Environment（天然資源環境省）
PPC	People's Committees（人民委員会）
QCVN	Vietnam Technical Regulation（ベトナム技術規制）
TCVN	Vietnam Standards（ベトナム基準）
TKC	Tsuneishi Kamtecs Corporation （Tsuneishi Kamtecs 社）
VSIP	Vietnam Singapore Industrial Park（ベトナム・シンガポール工業団地）

表一覧

図一覧

背　景

現在、ベトナムの Tsuneishi Kamtecs Corporation（以降 Tsuneishi とする）は 300 トン/日の固形廃棄物焼却処理事業（以降 Work とする）を提案するためにホーチミン市及び周辺省（ドンナイ省、ビンズン省、バリア・ブンタウ省、ロンアン省）で固形産業廃棄物、有害廃棄物、医療廃棄物の管理状況の調査を行っている。

Tsuneishi は Environmental Technology Centre（ENTEC）に対して上述の Work を実施するために Tsuneishi への協力を依頼した。

その内容は:

(1). 最も正確な方法で、かつ科学的そして現実的な方法でホーチミン市及び周辺省（ドンナイ省、ビンズン省、バリア・ブンタウ省、ロンアン省）での固形産業廃棄物、有害廃棄物、医療廃棄物の発生量や性状、収集・運搬状況、処理・処分業者、収集・運搬割合、処理・処分割合、収集・運搬料金、処理・処分料金等を調査すること;

(2). 2020 年及び 2025 年までのホーチミン市及び周辺省（ドンナイ省、ビンズン省、バリア・ブンタウ省、ロンアン省）の固形産業廃棄物、有害廃棄物、医療廃棄物の発生量を推定すること;

(3). Tsuneishi に対して固形廃棄物焼却事業の提案に関して事業規模、事業サイト、事業の運転管理費算出のための費目単価、法的なライセンス取得や認可手続き、マーケッティング戦略、提案事業の資本分担をアドバイスを行うこと。

業務内容を添付資料 1 の Scope of Work に整理する。

第１章
固形産業廃棄物、有害廃棄物、医療廃棄物処理の現状評価

1.1.固形産業廃棄物、有害廃棄物、医療廃棄物の発生量

1.1.1.ホーチミン市における固形産業廃棄物、有害廃棄物、医療廃棄物の発生量

ホーチミン市は特別の市で、経済、文化、教育・訓練、科学・技術の大中心地で、国内で重要な役割を果たしており、国際輸送のハブであり、東南アジアの総合的なサービス産業センターである。国土面積は 2,095 km^2 、人口は 900 万人以上で（2010 時点）、メコンデルタや東南アジア地域の最もダイナミックな経済地域に位置している。ホーチミン市は地域の経済センターであるのみならず、ベトナムの経済中心地でもあり、 GDP の年間増加率は 12%を超える。

国内需要を満たすためや輸出用に大量の製品を生産している他にホーチミン市は莫大な量の天然資源やエネルギーを消費しており（4,900 万 kWh/日）、200 万トン/日以上の有害廃棄物やリサイクル可能な廃棄物及びリサイクル不可能な廃棄物等の廃棄物（液状、固形、気体）を環境に放出しており、自然環境や人間の生命が非持続的な開発やこれらの廃棄物のために脅威に晒されている。

ホーチミン市の人口は 900 万人以上で、数百の小規模市場や大規模スーパー、数百のレストラン、ホテル、学校、研究機関、役所、約 53,601 の工場、約 12,502 の医療機関が存在している。ホーチミン市は日量約 8,000 トンの都市固形廃棄物を一般家庭、事業所、工場等から排出している。そのうち、埋立地に収集・運搬されているのは約 6,500～6,700 トン/日で、残りはリサイクルのためにスクラップとして売却されている。有機性廃棄物のごくわずかが郊外の低地に廃棄されている。ごみ量の年間の増加率は約 7～8%と推定されている。

今日、市内の工業団地及び都市部の廃棄物処理は非常に改善されている。統計によると、2010 年までに固形廃棄物の平均の収集・処理量は約 6,500 トン/日で発生量の 84%に達した。その多くは都市部に集中している。市内での廃棄物の収集・運搬は組織や個人（業社）によって行われている。都市部での廃棄物収集量を表 1.1 に示す。

表 0.1. 各地区の廃棄物収集量

No	収集主体	収集量（トン/日）
01	都市環境会社 (CITENCO)	2,601.17
02	組合	799.42
03	1 Dictrict	109.71
04	2 Dictrict	27.08
05	3 Dictrict	53.92
06	4 Dictrict	83.67
07	5 Dictrict	269.07
08	6 Dictrict	150.67
09	7 Dictrict	122.25
10	8 Dictrict	102.17
11	9 Dictrict	211.69
12	10 Dictrict	212.23
13	12 Dictrict	261.18
14	Phu Nhuan	164.26
15	Go Vap	403.19
16	Tan Binh	110.37
17	Tan Phu	215.31

No	収集主体	収集量（トン/日）
18	Thu Duc	119.92
19	Hoc Mon	39.41
20	Binh Thanh	142.37
21	Binh Tan	154.23
22	Nha Be	25.78
23	Cu Chi	119.93
合計		6,500

出典: Department of Natural Resources and Environment, 2010.

このように、2011～2020 年の固形廃棄物処理投資計画を承認した首相決定（Decision No.789/QD - TTg May 25, 2011） で示された 2011～2015 年の特別目標、すなわち、都市中心部で発生した廃棄物の 85%が環境保全の為に収集・処分されることとした目標をホーチミン市は既に達成している。しかしながら、家庭系廃棄物の実際の収集・処分率はより高く、収集時点では 100%に達している。しかし、家庭系廃棄物の一部は処理施設や埋立地まで輸送される過程で分別・リサイクルされたり、一部は発生源に保管されている。

市内の家庭系固形廃棄物の収集は 3 種類の組織が行っている: 都市環境会社と 22 の公共サービス会社あるいは郡/地区（Tan Phu と Binh Tan は新たに設置された地区で公共サービス会社はない）である。都市環境会社は株式会社になった。民間のシステムが民間の力によって設立されており、それらは 30 の労働組合（trade union）と 3 つの収集組合（cooperative collection）である（2 District、4 District、6 District、Go Vap 郡、Thu Duc 郡）。統計によると家庭系廃棄物の 60%は民間企業が、40%が収集組合と公共サービス会社が収集している。

ホーチミン市の産業廃棄物及び有害廃棄物に関しては、主要な発生源は工場や企業であるが、その他周辺省（ドンナイ省、ビンズン省、バリア・ブンタウ省）にある工場や施設も発生源である。これらから発生した廃棄物はリサイクルや処分のためにホーチミン市に運ばれる。なぜならば、ホーチミン市はリサイクルや有害廃棄物の処理のための施設や設備を必要としたからである。

最近の統計では、17 の工業ゾーンや輸出加工区内外にある 12,000 以上の大規模、中規模、小規模施設の工業活動によって発生する産業廃棄物及び有害廃棄物の発生量はホーチミン市全体の固形産業廃棄物及び有害廃棄物の約 80%を占めている。ホーチミン市で発生する固形産業廃棄物と有害廃棄物の量を表 1.2 に示す。

表 0.2. ホーチミン市の固形産業廃棄物及び有害廃棄物発生量

No.	廃棄物の種類	発生量 （トン/日）
01	非有害産業廃棄物	1,500 - 2,000
02	有害固形産業廃棄物	250 - 350

出典: Department of Natural Resources and Environment, 2010

市内の 24 種の産業に関する調査では、農薬やメッキ薬品などの非常に有害な廃棄物の発生量は 10%以下で、染料や塗料は 3.0～5.0%、皮革工場からは大量の有害汚泥が（16.5%）、また、金属・機械産業からは 39.2%で、発生割合は最大であった。しかし、これらは実際にはリサイクルされたり再利用されている。産業毎の有害廃棄物の発生量を表 1.3 に示す。

表 0.3. ホーチミン市の産業別の廃棄物発生割合

No.	産業	割合 %

No.	産業	割合 %
01	農薬	0.68
02	メッキ	0.57
03	皮革	16.5
04	化学	0.17
05	バッテリー	0.51
06	電子	2.27
07	金属機械加工	39.16
08	繊維染色	3.5
09	塗装	5.45
10	インクおよび印刷	3.64
11	革靴	5.76
12	油・石油製品	1.72
13	薬品	0.23
14	ゴム	0.25
15	車修理・メンテナンス	0.04
16	木及び木製品	3.75
17	プラスチック及びプラスチック製品	2.34
18	ガラス	0.05
19	建築	0.2
20	石けん・化粧品	0.94
21	紙	2.49
22	服飾	2.26
23	食品	2.79
24	その他	4.73

出典: Department of Natural Resources and Environment, 2010

ホーチミン市で発生する有害廃棄物の性状を表 1.4 に示す。

表 0.4. ホーチミン市で発生する有害廃棄物の性状

No.	種類	発生割合（体積%）	処理方法
01	有害成分付着の大型梱包材、プラスチック容器、鉄製ドラム缶	24.2	洗浄 - リサイクル
02	材料くず、研磨くず（鉄用マーカーインク付着）	22.4	油洗浄、リサイクル
03	オイル（下水汚泥）	13.3	リサイクル
04	廃吸着剤、廃フィルター材（油性フィルター材を含む）、布切れ、有害廃棄物付着防護服	13.1	焼却
05	製造工場、工業団地、輸出加工区排水処理施設汚泥	8.3	回収、焼却、埋め立て
06	酸-アルカリ汚泥、重金属、廃溶剤、廃塗料、廃油	7.5	廃水処理
07	残留溶剤	3.4	焼却、リサイクル
08	廃化学物質（期限切れ化学薬品、不良化学薬品）	2.5	回収、焼却、埋め立て
09	灰、粉じん、廃活性炭	1.7	固化 - 埋め立て
10	廃合金、廃溶接棒、鉛残渣、 鉛スラグ	1.5	リサイクル
11	他の有害物質を含む有害廃棄物	1.3	焼却
12	廃バッテリー、鉛含有残渣	0.6	固化、埋め立て、リサイクル
13	廃蛍光灯	0.3	固化 - 埋め立て
14	廃トナーボックス	0.1	焼却、リサイクル

No.	種類	発生割合（体積%）	処理方法
15	廃電子機器	0.1	焼却、リサイクル
16	廃植物保護剤、廃農薬、廃殺虫剤	0.1	焼却

出典: Department of Natural Resources and Environment, 2010

表 1.4 の結果からホーチミン市で発生する主要な有害廃棄物は梱包材や容器、材料くずや研磨くず、オイル、油圧油、有害物質付着のモップや手袋、下水汚泥等である。産業廃棄物の多くはリサイクル可能で、処理や洗浄を行って有害廃棄物を非有害廃棄物にして、付加価値を高め、リサイクルして他の製品を製造している。有害廃棄物のリサイクル率は 55～70%、焼却率は 15～18%、固化処理は 8%、廃水処理施設での処理は 5 %である。2010 年の全ての排出源（産業以外を含め）からの有害廃棄物発生量は約 300 トン/日で、固形物が 70%、残りは液状（15%）とスラリー状（15%）の廃棄物である。

全ての産業廃棄物や有害廃棄物を収集・運搬、再利用、リサイクル、処分するために市は 11,000 以上のスクラップ回収業者、49 の有害廃棄物輸送会社、13 の有害廃棄物の運搬・処理会社の広域ネットワークを設立した（2011 年 8 月）。

工業団地、輸出加工区、工業クラスターの有害廃棄物の収集率は 80%以上である。工業団地、輸出加工区外のほとんどの大規模工場は委託契約によって廃棄物を運搬している。

しかしながら、小規模工場からの有害廃棄物（主に量は少ないものの廃蛍光灯、バッテリー、モップ）は収集されていないか、規制に従わないルートで収集されている。有害廃棄物をスクラップとして売却したり、家庭系廃棄物に混入している。

1.1.2. ビンズン省における固形産業廃棄物、有害廃棄物、医療廃棄物の発生量

現在、ベトナムの社会経済レベルや人々の生活は改善されている。都市部、住宅地、商業地区は以前に比べるとかなり大規模になっている。成長に支えられて多くの事業や工業ゾーンの開発が進められている。これらの事業は投資や雇用創出に潜在的な魅力がある。これらのポジティブな側面とは別に固形廃棄物は次第に量が多くなり、性状も多様化している。2005 年から 2010 年までに発生した都市ごみや産業廃棄物の量は増大している。

ビンズン省の平均人口は 1,550,000 人以上で（Statistical Yearbook of Vietnam, 2010）、数百の市場、スパーマーケット、数百のレストランやホテル、学校、研究機関、役所があり、約 2,796 の工場が 24 の工業団地や工業クラスターに立地している他、約 8,138 の小規模工場や約 100 の医療機関がある。そして、毎日約 884 トンの都市廃棄物及び固形産業廃棄物、非有害廃棄物がビンズン省で処分されている。

現在、ビンズン省の都市部、農村部での固形廃棄物処理はまだ十分ではない。統計によると 2010 年には固形廃棄物の平均の収集・処理量は 710 トン/日（発生量の 84%）で、それも都市部に集中している。固形廃棄物の収集・運搬は 96 の組織や個人で行われている。都市部でこれらの組織が収集した廃棄物の量を表 1.5 に整理する。

表 0.5. ビンズン省の主要廃棄物収集組織と収集量

No.	収集組織	収集量（トン/日）	割合（%）
01	BIWASE	620	87
02	Urban Tan Uyen 地区作業会社	55	7.9
03	Dau Tieng 地区	20	2.9
04	Phu Giao 地区	15	2.2

出典: Environment Status Report 2005 -2010 of Binh Duong Province

現在、Thu Dau Mot、Di An、Thuan An 地区等から発生する非有害の固形廃棄物のほとんどは Nam Binh Duong 固形廃棄物処理コンプレックスに収集・運搬されて処理されている。その量は約 620 トン/日である。さらに、Nam Binh Duong 固形廃棄物処理コンプレックスから遠くに位置している Dau Tieng、Phu Giao、Tan Uyen 地区では固形廃棄物は各地区の埋立地にオープンダンプされている。

産業廃棄物及び有害廃棄物は 2010 年には 13 の廃棄物運搬・処理会社によって処分されている。そのうち 4 社はビンズン省にある。これらの会社は有害廃棄物運搬、処理の許可を取得している。事実、有害廃棄物総発生量のわずかに約 15%が規制に遵守する形で収集・運搬されている。ISO 9001:2000 や ISO 14000 を取得している大企業は全企業の 14.5%に過ぎないが、これらの企業のみが発生源での廃棄物の減量化に関心がある。

表 0.6. ビンズン省で発生した産業廃棄物と有害廃棄物の総量

場所		発生量	
		固形産業廃棄物	有害固形廃棄物
工業ゾーン		85,626	21,821
工業クラスター		2,179	553
工業ゾーン以外		234,559	39,245
合計	**トン/年**	**322,364**	**61,619**
	トン/日	**883**	**169**

出典: Environment Status Report 2005 -2010 of Binh Duong Province

ビンズン省には 17 の省立病院と地区病院があり、総ベッド数は 2,370 床である。さらに、106 のヘルスケアセンターとクリニックがある。病院では固形医療廃棄物は保健省の規則に従って病院で分別されている。ビンズン省で収集・処理された医療廃棄物の割合は約 91.3%である。その詳細は以下のようである。

- 病院から発生する医療廃棄物の収集・処理の割合は 100%;
- クリニックや民間クリニックから収集・処理される医療廃棄物の割合は 10%。

省立の病院での医療廃棄物の処理方法は焼却である。現在、17 箇所の病院のうち 7 箇所に医療廃棄物用焼却炉があり、焼却される医療廃棄物の総量は約 142 kg/日である。しかしながら、全ての焼却炉に十分な大気汚染防止装置が設置されているわけではなく、特に、都市部住宅地にある 2 箇所の病院、Thuan An 病院と Di An 病院では焼却炉の運転時の環境への悪影響が問題になっている。これらの焼却炉は環境保護上の必要条件を保証していないが、病院は他の病院からの廃棄物も受け入れている。ビンズン省のほとんどの病院は都市部に位置しており、医療廃棄物焼却炉を設置している病院は汚染物質をまき散らしており、管理を難しくしているので医療廃棄物処理は多くの問題に直面している。

現在、ほとんどの固形廃棄物は収集され、Nam Binh Dương 廃棄物処理コンプレックスに運ばれて処分されている。このほか、Dau Tieng、Phu Giao、Tan Uyen 地区では廃棄物は収集されてオープンダンプされている。この処分方法は衛生的な処理を保証できず、環境汚染の原因となっている。

産業廃棄物及び医療系有害廃棄物の処理は適正に行われておらず、投資もまだ少ない。 それにも拘わらず、実際には有害廃棄物処理のライセンスを取得した企業と取得していない企業との協力関係が存在している。調査結果によると、現在、有害廃棄物の収集・運搬及び処分の許可を取得している企業が 13 社あり、159 のスクラップ回収業者がおり、廃棄物の処理に何らかの貢献をしている。

医療廃棄物については 15 社の内わずかに 2 社が有害廃棄物の収集・運搬及び処理のライセンスを取得しているにすぎない。そのうえ、医療廃棄物の処理技術は不十分なもので、周辺の大気、水、土壌の汚染源になっている。医療廃棄物焼却炉を設置している 7 病院の焼却炉には十分な大気汚染防止装置はなく、わずかに 3 箇所の焼却炉にダスト除去用の単純な大気汚染防止装置があるのみである。集められたダストや焼却灰は汚染防止対策を講じずに都市廃棄物と共に埋め立てられている。

1.1.3. ドンナイ省の固形産業廃棄物、有害廃棄物、医療廃棄物の発生量

2012 年末時点でドンナイ省には 31 の工業ゾーンがあり、総計画面積は 9,838.31 ha に及ぶ。そのうち、27 の工業ゾーンは稼働している。また、37 の工業クラスターが計画承認されており、その総面積は 1,942.7 ha である。そのうち、28 工業クラスターのインフラ整備が完了しており、その総面積は 1,442 ha である。28 のうち 11 の工業クラスターが稼働している。

工業発展と共に工業活動に伴う非有害固形廃棄物や有害廃棄物の量は増え、性状も多様化している。持続的な発展を確実なものとするためにも環境規制に従った廃棄物の収集や処理が必要になる。

2012 年の統計によると省内で発生した非有害固形廃棄物及び有害廃棄物の量は 2,694.5 トン/日で、収集・処理された量は 2,489.9 トン/日で、発生量の 92.4%に達する。

– 非有害固形廃棄物（都市固形廃棄物、固形非有害廃棄物）:発生量は約 2,568 トン/日で、収集・処理された量は約 2,382 トン/日（発生量の 93%）、そのうち:

+ 都市固形廃棄物: 発生量は 1,361 トン/日で収集・処理された量は約 1,176 トン/日（86%）; 衛生的な処理が行われたのは約 606 トン/日（Bien Hoa、Tan Phu、Thong Nhat、Long Khanh）で、収集量の 52%である。統計では 71 の組織や個人（25 の協同組合と企業 5 社）が都市系廃棄物の収集・運搬、処理を行っている。
+ 非有害産業廃棄物(スクラップを含む): 発生量は 1,206 トン/日で、収集・処理量は 100%である。統計によると 56 団体（及び個人）が非有害産業廃棄物の分別や収集に携わっている(11 地区の内 8 地区、すなわち Bien Hoa City、Long Khanh Town、Long Thanh、Xuan Loc、Thong Nhat、Trang Bom、Vinh Cuu、Tan Phu)。 特に、ドンナイ省都市環境サービス会社(URENCO Dong Nai)は非有害廃棄物を衛生埋め立てしている。

– 有害廃棄物: 有害廃棄物発生者に対する規則にしたがって事前に報告されている有害廃棄物の発生量は約 126.5 トン/日; 収集・処理量は 107.9 トン/日で発生量の 85.3%である。統計によると省内で有害廃棄物を扱う業社は 54 社で、このうち 20 社は収集・処理の許可を取得している(17 社が天然資源環境省から許可を得ており、3 社は省人民委員会から許可を得ている。省のライセンスを取得している業社の取扱能力は 19,881 トン/年（54.5 トン/日）である)。

ドンナイ省における固形廃棄物の収集・処理の状況を表 1.7 に示す。

表 0.7. ドンナイ省の固形廃棄物の収集・処理状況

種類	非有害廃棄物（トン/日）				有害廃棄物 （トン/日）			合計（トン/日）
	DA	ID	HC	計	ID	HC	計	

発生量	1,361.0	1,206.0	4.5	*2,571.5*	125.0	1.5	*126.5*	2,698.0
収集・処理量	1,176.0	1,206.0	4.5	2,386.5	106.4	1.5	107.9	2,494.4

注:

- *DA:都市活動*
- *ID ： 工業活動*
- *HC: ヘルスケア*

固形廃棄物の処理方法の内訳を表 1.8 に示す、

表 0.8. ドンナイ省の固形廃棄物の処理方法の内訳

処理方法	**処理量 （トン/日）**
埋め立て	972.3
焼却	1.5
売却（スクラップ）	844.2
その他	676.4
合計	**2,494.4**

全体的に見れば省内外の多くの組織や個人によって固形廃棄物や有害廃棄物が処理・処理されており、増大する廃棄物量や多様化する廃棄物に対応している。しかしながら、廃棄物の収集率が高割合にも拘わらず、環境規制を遵守するように処理・処分されている廃棄物量は少ないか、処理状況をモニターすることが困難になっている（都市廃棄物のわずかに 41%が衛生的に処理され、有害廃棄物の 90%が許可業者によって収集され、省外の処理施設に運ばれている。それ故、処理状況は即座にはモニターできない。監視やモニターについては中央と地方あるいは地方政府間レベルでの協力は限られている）。廃棄物処理法の違反事例は増えており、特に、環境被害や人の健康に悪影響を与えるような廃棄物の排出は規制されている。

このような行為の原因は技術基準がないことや廃棄物処理の経済性に起因する。すなわち、環境規制を遵守して廃棄物を処理できる最も安価な技術がない一方で、多くの組織や個人が廃棄物の収集・処理の許可を取得するようになっている。そのため、廃棄物処理契約を得て、スクラップのリサイクルや廃棄物の収集をするために彼らは非常に安い価格で契約を結び、実際には収集した廃棄物の処理ルートが見つからないままに廃棄物を頻繁に不法に環境中に排出しているのである（特に Bien Hoa では 2012 年に省政府は主としてビンズン省の 9 社以上の収集業者の廃棄物処理違反を検挙した）。

ドンナイ省や南部経済拠点地域には中小規模の固形廃棄物、有害廃棄物収集・運搬業者がいる。例えば、Tan Phat Tai （ドンナイ省）；Vietnam – Australia Environment JSC、Green Environment Co. Ltd.、Le Hoang Tuan Co. Ltd.、Thao Thuan Co. Ltd.、Quoc Viet Co. Ltd. （ホーチミン市）；Sao Mai Xanh Co. Ltd.（ティエン・ザン省）；Song Xanh Co. Ltd. （バリア・ブンタウ省））である。Tan Phat Tai は革靴製造に伴う廃棄物の 40～45%を収集、分別、再利用、リサイクルしており、専用の焼却炉や非有害廃棄物用の種々の処理技術を持っている。

1.1.4. ロンアン省における産業廃棄物、有害廃棄物、医療廃棄物の発生量

2013 年の統計ではロンアン省で発生した非有害固形廃棄物及び有害廃棄物は 2,241.1 トン/日で、収集/処理された量は 1,633.0 トン/日であった（72.8%）。ロンアン省における固形廃棄物及び有害固形廃棄物の発生量を表 1.9 に示す。

表 0.9. ロンアン省における固形廃棄物及び有害廃棄物の発生量

種類	非有害廃棄物 （トン/日）				有害廃棄物 （トン/日）			合計（トン/日）
	DA	ID	HC	計	ID	HC	計	
発生量	1,099.0	937.0	0.6	2,036.6	204.0	0.5	204.5	2,241.1
収集・処理量	802.3	625.7	0.6	1,428.5	204.0	0.5	204.5	1,633.0

注:

- *DA:都市活動*
- *ID : 工業活動*
- *HC: ヘルスケア*

処理方法は:

– 都市系廃棄物：多くの企業は廃棄物収集/処分会社と契約している。

– 産業廃棄物:収集された産業廃棄物の一部は選別され、再利用のために売却され、その他は都市廃棄物と共に埋立地で処分される。

– 有害廃棄物:工業団地内の製造企業はロンアン省天然資源環境部に有害廃棄物排出事業者として登録される。有害廃棄物は一時集積所に集められ、規則に従って収集・処理業者に委託される。

処理方法別の廃棄物の量を表 1.10 に示す。

表 0.10. ロンアン省における処理方法別の廃棄物量

処理方法	処理量 （トン/日）
埋め立て	802.9
焼却	0.5
その他	829.7
合計	**1,633.0**

総じて、発生した固形廃棄物は収集され、運搬及び処理業者に委託される。有害廃棄物の処理は次第に行われるようになっているが、有害廃棄物の発生量は少ない。したがって、有害廃棄物処理業者に処理を委託するのは難しい。

現在、省担当局は産業廃棄物処理施設を開発する能力はない一方、工業団地内の企業が多くの廃棄物を発生している。現在、5 社が産業廃棄物を扱う事になっているが、Tan Kien Ngoc Co. Ltd （Duc Hoa 1 工業団地）と Nguyet Minh Co. Ltd.（鉛蓄電池を対象）のみが操業しているに過ぎない。それゆえ、廃棄物排出企業は他の省の廃棄物処理会社に依存しなければならない。

その結果、ロンアン省とホーチミン市は Thu Thua 地区の Tan Thanh Commune に 1,760ha の都市廃棄物及び産業廃棄物の処分施設を建設することで協働している。土地取得のための保証は基本的に終了し、ホーチミン市人民委員会と建設省は Co. Solid Waste Vietnam をこの事業の投資企業として承認した。Co. Solid Waste Vietnam は地質調査や FS、適用すべき適正技術の選定を終えた。投資企業の説明によると、2013 年 11 月にインフラ整備に必要な機材等を運ぶための橋や N2 ルートにつながる道路の建設が始まった。2014 年に処理センターは省内で発生する都市廃棄物を受け入れ始めた。そして、その他の施設は施設を操業しながら順次建設される。

医療廃棄物に関しては、現在、老朽化した地区病院に 7 箇所の医療廃棄物焼却炉があるが、民間クリニックでは処理施設の設置が難しかったり十分ではないので大気や水、土壌汚染の原因になっている。

1.1.5.バリア・ブンタウ省における固形産業廃棄物、有害廃棄物、医療廃棄物の発生量

現在、同省では都市廃棄物、産業廃棄物、有害廃棄物が合計約 1,677.3 トン/日発生している。収集・処理の状況を表 1.11 に示す。

表 0.11. バリア・ブンタウ省の廃棄物の発生量、収集・処理量

種類	非有害廃棄物（トン/日）				有害廃棄物（トン/日）			合計（トン/日）
	DA	ID	HC	計	ID	HC	計	
発生量	742.0	726.3	1.8	1,470.1	208.4	0.6	209.0	1,679.1
収集・処理量	571.3	726.3	1.4	1,299.0	208.4	0.6	209.0	1,508.0

注:

- *DA:都市活動*
- *ID ： 工業活動*
- *HC: ヘルスケア*

処理方法別の廃棄物処理量を表 1.12 に示す。

表 0.12. バリア・ブンタウ省における処理方法別の廃棄物処理量

処理方法	処理量 （トン/日）
埋め立て	1,248.7
焼却	0.6
スクラップ売却	50.3
その他	208.4
合計	**1,508.0**

廃棄物毎の収集・処分状況は以下のようである:

– 都市廃棄物:これまで、都市固形廃棄物の約 77%、571 トン/日は衛生埋立地で処分された。特に、Vung Tau や Ba Ria City、Long Dien District、Tan Thanh District の都市廃棄物は全て KBEC VINA が投資した 100ha の埋立地で処分されている。残りは一時的に、Toc Tien Tan Thanh 地区、Cong Trang Ba Ria 町、Binh Ba Chau Duc 地区、Loc An Dat Do 地区、Phuoc Thuan Xuyenn Moc 地区、Nhat Bon streem Con Dao 地区の埋立地で埋設されている。都市部で発生する都市固形廃棄物は全て地元の都市環境会社によって収集されている。

– 固形産業廃棄物: 鉄鋼スラグについては最近 3 社の廃棄物処理事業が投資ライセンスを取得した。それらは、Green Materials Co., Ltd. （処理能力 1,000 トン/日）、VINA Co. KBEC （処理能力 500～700 トン/日）、Viet Ninh Co., Ltd（処理能力 200 トン/日）である。現在、2 社、Green Materials Co., Ltd と KBEC VINA Co., Ltd.が操業しており、合計処理能力は約 1,500～1,700 トン/日で、省内で発生する鉄鋼スラグを処理できる能力である。

+ 鉄鋼スケール： 現在、溶鉱炉から約 50.3 トン/日のスケールが発生している。これらは輸出用や原材料として再利用用に多くの会社に収集・運搬されている（ドンナイ省 MTV Xuan Phuoc Co., Ltd、Thai Nguyen 省 Vuong Anh CO., Ltd、ハイフォン

市 Viet Phat Corporation、韓国 EWIC Co.、EG Cooperation company）。特に Dông Tien 溶鉱炉では工場で再利用している。

+ スラグ: 石炭を燃料として使用している工場から合計 57 トン/日のスラグが発生している。それらの企業は、Bunge VN Ltd （Phu My I 工業ゾーン）、CCN Boomin Vina （My Xuan Commune）、Eclat FABRICS Co., Ltd （My Xuan A2 工業ゾーン）、Tong Kong CO., Ltd （My Xuan A2 工業ゾーン）、Phu My Plastic Chemical Company （Cai Mep 工業ゾーン）である。最近、これらの工場から排出する石炭スラグは多くの企業によって運搬・処理されている。それらの企業は KBEC VINA Co., Ltd.(100ha の埋立地)、Trang Anh CO., Ltd (Tan Thanh 地区)、Thuy Trieu Phat CO., Ltd（ドンナイ省 Long Thanh 地区)、Thuan Hai Company（ホーチミン市 District 7)、Dong Hoa（ビンズン省 Di An 町)である。さらに、My Xuan セラミックタイル工場（Tan Thanh 地区）も石炭灰の一部を煉瓦用材料の一部として利用している。

– 有害廃棄物: 現在、省内には 12 社の有害廃棄物処理会社がある。このうち、4 社は有害廃棄物の運搬と処分を行っている（天然資源環境部のライセンス取得企業：Song Xanh CO., Ltd；一般環境ライセンス取得企業：Sao Viet environment corporation、Ha Loc Co., Ltd, Dung Ngoc CO., Ltd）。また、8 社は有害廃棄物の運搬を行っている（天然資源環境部のライセンス取得企業：Company services oil port、Quy Tien CO., Ltd, Bay Tuong 民間会社、Thanh Danh 民間会社、Vietsovetro ジョイントベンチャー; 一般環境ライセンス取得企業: Hung Giang CO., Ltd、Bao Ngoc corporation Green Environment、PTSC Marine ships oil and gas services）である。

現在、Song Xanh CO., Ltd、Sao Viet environment corporation、Ha Loc Co., Ltd.が収集・処理している省内で発生する有害廃棄物は約 135 トン/日で、残りは Moi Truong Xanh CO., Ltd （ホーチミン市)、Viet Xanh environment corporation （ビンズン省)、Tan Phat Tai Co., Ltd （ドンナイ省）、Tuong Sang CO., Ltd (Tien Giang 省)が処理している。

– 医療廃棄物: バリア・ブンタウ省には 9 箇所の病院とメディカルセンターに医療廃棄物焼却炉が有り、これらの病院から発生した廃棄物の処理を行う他ヘルスステーションや民間の医療機関から発生した廃棄物を収集・処理するなどの支援を行っている。統計上、医療セクターから発生した約 600kg/トンの廃棄物が焼却されているが、2 箇所の大規模省立病院（Ba Ria Hospital と Le Loi Hospital）のみがスイス、Hoval 社の焼却炉（能力 200kg/バッチ）で、6 時間から 8 時間かけて焼却している。その他のヘルスセンターや民間医療機関から発生する廃棄物は収集されておらず、ほとんどが手作業で燃やされている。

省内で発生する固形廃棄物の処理に資するために、省は現在、計画投資部に対して 2014 年の操業を目指して鉄鋼や精錬工場から発生するスラグや灰を処理するための事業を行うための投資を募るための基準を策定するよう要求している。

1.2.固形産業廃棄物、有害廃棄物、医療廃棄物の収集、処理・処分量

現在、ホーチミン市、ドンナイ省、ビンズン省、バリア・ブンタウ省、ロンアン省で発生する廃棄物の総量は 16,623.1 トン/日である（ホーチミン市で約 8,000 トン/日、ビンズン省で約 2,004.9 トン/日、ドンナイ省で約 2,698.0 トン/日、ロンアン省で約 2,241.1 トン/日、バリア・ブンタウ省で約 1,679.1 トン/日）（表 1.13 及び添付資料 5 参照）。

表 0.13. ホーチミン市及び周辺省で発生する固形廃棄物量

No.	省	非有害廃棄物（トン/日）				有害廃棄物（トン/日）			合計（トン/日）
		DA	ID	HC	計	ID	HC	計	
01	ホーチミン市	5,694.4	1,976.0	10.2	7,680.6	316.0	3.4	319.4	8,000.0
02	ビンズン省	947.0	883.0	4.7	1,834.7	169.0	1.2	170.2	2,004.9
03	ドンナイ省	1,361.0	1,206.0	4.5	2,571.5	125.0	1.5	126.5	2,698.0
04	ロンアン省	1,099.0	937.0	0.6	2,036.6	204.0	0.5	204.5	2,241.1
05	バリア・ブンタウ省	742.0	726.3	1.8	1,470.1	208.4	0.6	209.0	1,679.1
	合計	**9,843.4**	**5,728.3**	**21.8**	**15,593.5**	**1,022.4**	**7.2**	**1,029.6**	**16,623.1**

注:

- *DA:都市活動*
- *ID : 工業活動*
- *HC: ヘルスケア*

通常発生する廃棄物の量は約 15,593.5 トン/日で、都市廃棄物が約 9,843.4 トン/日で全体の 59.21%を占める。非有害産業産業廃棄物が約 5,728.3 トン/日、非有害医療廃棄物が約 21.8 トン/日である。

工業活動やヘルスケア活動から発生する有害廃棄物は比較的多く、平均 1,029.6 トン/日である。このうち、固形産業有害廃棄物は約 1,022.4 トン/日、ヘルスケア活動から発生する有害廃棄物は約 7.2 トン/日である。

ホーチミン市は大量の廃棄物を発生する都市で、平均約 7,680.6 トンの非有害廃棄物と 319.4 トンの有害廃棄物が毎日発生している。そのうち、工業セクターから発生する有害、非有害廃棄物の総量は約 2,392 トン/日である。

バリア・ブンタウ省は調査した 5 省や市の中では最も廃棄物の発生量が少ない。しかし、有害廃棄物の割合は省内で発生する廃棄物の総量の 12.45%で、他の省に比べて高い（ホーチミン市で 4.94%、ビンズン省で 8.49%、ドンナイ省で 4.69%、ロンアン省で 9.13%）。

総発生量 16,623.1 トン/日のうち、工業生産とヘルスケア活動から発生する廃棄物の量は 6,779.7 トン/日である。これは比較的多い量で、収集されて焼却されなければならない。

ホーチミン市及び周辺省で収集・処分される総固形廃棄物量を表 1.14 に示す。

表 0.14. ホーチミン市及び周辺省で収集・処分される廃棄物量

省	非有害廃棄物（トン/日）				有害廃棄物（トン/日）			合計（トン/日）
	DA	ID	HC	計	ID	HC	計	
ホーチミン市	5,549.6	592.8	10.2	6,152.6	316.0	3.4	319.4	6,472.0
ビンズン省	710.0	264.9	4.3	979.2	25.4	1.1	26.4	1,005.7
ドンナイ省	1,176.0	1,206.0	4.5	2,386.5	106.4	1.5	107.9	2,494.4
ロンアン省	802.3	625.7	0.6	1,428.5	204.0	0.5	204.5	1,633.0
バリア・ブ	571.3	726.3	1.4	1,299.0	208.4	0.6	209.0	1,508.0

ンタウ省								
合計	**8.809,2**	**2.209,7**	**21,0**	**12.245,8**	**860,2**	**7,1**	**867,2**	**13.113,1**

注:

- *DA:都市活動*
- *ID : 工業活動*
- *HC: ヘルスケア*

固形廃棄物の収集・処分総量は 13.113,1 トン/日である（ホーチミン市 6,472.0 トン/日、ビンズン省 1,005.7 トン/日、ドンナイ省 2,494.4 トン/日、ロンアン省 1,633.0 トン/日、バリア・ブンタウ省 1,508.0 トン/日）。

1.3. 固形産業廃棄物、有害廃棄物、医療廃棄物の収集、処理・処分会社

1.3.1. 調査した産業廃棄物及び有害廃棄物収集・処分業 25 社の廃棄物収集・処理状況

25 社における産業廃棄物、有害固形廃棄物の収集・処理の状況を本報告書の添付資料 3 に示す。

1.3.2. 固形廃棄物の収集・運搬用の協力会社選定のための多基準解析

多基準解析によって廃棄物の収集・運搬会社の選定を行った。協力ベースの会社を選定するために使用した基準は 車両数、保有する廃棄物処理技術、協力能力（ENTEC による判断）である。各基準の評価点を以下のように選定した。

表 0.15. 協力会社を選定するために用いた評価基準のポイント

点数	輸送車両数	処理能力 （トン/日）			
		焼却	埋立て	他の技術	協力能力
01	<10	<5 トン/日	<50 トン	<10 トン/日	協力能力が非常に低い
02	<20	<10 トン/日	<200 トン	<20 トン/日	協力能力は低い
03	<30	<15 トン/日	<1,000 トン	<100 トン/日	協力能力は普通
04	<40	<25 トン/日	<3,000 トン	<120 トン/日	協力能力は高い
05	≥40	≥25 トン/日	≥3,000 トン	≥120 トン/日	協力能力は非常に高い

多基準解析の結果は本報告書の添付資料 4 に示す。

ホーチミン市、ドンナイ省、ビンズン省、バリア・ブンタウ省、ロンアン省で固形廃棄物、有害廃棄物、医療廃棄物を取り扱う主力民間会社を以下に示す。:

- Sonadezi J/S Service Co.;
- Vietnam Waste Solution Co.Ltd,;
- HCM City Urban Environmental Company (Citenco);
- Holcim Vietnam Cement Co.;
- Binh Duong Water Supply Sewerage Environment Co.;

これら 5 社が年間に収集、処理・処分する廃棄物の量を表 1.16 に示す。

表 0.16. 主力 5 社が一年間に収集、処理・処分する廃棄物の量

No	会社名	処理能力 （トン/日）		
		焼却	埋め立て	その他
01	Sonadezi J/S Service Co.	12.4	60	250
02	Vietnam Waste Solution Co.Ltd,	-	3,020	-
03	HCM City Urban Environmental Company (Citenco)	32.0	5,200	95
04	Holcim Vietnam Cement Co.	720	-	5
05	Binh Duong Water Supply Sewerage Environment Co.	98.4	420	782
	合計	**862.8**	**8,700**	**1,132**

1.4. 固形産業廃棄物、有害廃棄物、医療廃棄物の収集、処理・処分費用

固形産業廃棄物、有害廃棄物、医療廃棄物の収集、処理・処分費用を表 1.17 に示す。

表 0.17. 固形産業廃棄物、有害廃棄物、医療廃棄物の収集、処理・処分費用

No.	処理方法	コスト (VND/kg)	備考
1	SONADEZI SERVICE JOINT STOCK COMPANY		
1.1	**非有害廃棄物**		
	衛生埋め立て	800 - 1,100	成分や性状、扱いやすさに応じて埋め立て前の前処理を行う。そのために廃棄物毎に単価は異なる。
1.2.	**有害廃棄物**		
1.2.1.	- 安全に埋設; - 固化後に安全に埋設; - 破砕、固化、安全に埋設	5,500 - 18,500	異なる製造プロセスの廃棄物の種類によってサンプルを分析して処理コスト算定のための基礎とする。
1.2.2.	焼却	5,500 - 18,500	
1.2.3.	物理化学生物学的方法	7,000 - 21,000	
2	TIEN TAI CO. LTD.		
2.1.	**非有害廃棄物**		
2.1.1.	衛生埋め立て	3,500	非有害汚泥
2.1.2.	焼却	6,000	可燃性廃棄物
2.2	**有害廃棄物**		
2.2.1.	焼却	6,500 - 35,000	成分や性状に応じて単価は異なる。
2.2.2.	固化後安全に埋設	9,000 - 35,000	成分や性状に応じて単価は異なる。
2.2.3.	ドラムや有害物質付着金属の洗浄	6,000	
2.2.4.	物理化学的微生物学的処理	3.000 - 5.000	成分や性状に応じて単価は異なる。
3	DAI LAM SON CO. LTD.		
	廃油リサイクル	1.000 - 1.500	成分や性状に応じて単価は異なる。
4	DONG NAI URBAN ENVIRONMENT SERVICES COMPANY LIMITED		
4.1	焼却		- 医療廃棄物を収集・処理できるグループのみ。 - 廃棄物発生源までの距離に応じて単価は異なる。
4.1.1.	医療廃棄物	12,279 - 13,944	
4.1.2.	医療廃棄物以外	30,399 - 32,063	

No.	処理方法	コスト (VND/kg)	備考
5	HOLCIM VIETNAM CO. LTD.		
5.1	セメントキルン		成分や性状に応じて適応技術が異なる。
5.1.1.	- 固形廃棄物	～6,000	
5.1.2.	- 液状廃棄物	～6,600	
6	MOI TRUONG XANH VN JOINT STOCK COMPANY		
6.1.	焼却	5,500 - 8,000	成分や性状に応じて単価は異なる。
6.2.	化学及び物理処理	6,000 - 7,000	
6.3.	グリースのリサイクル	3,000 - 4,000	
6.4.	固化後安全に埋設	6,000 - 11,000	
7	THANH LAP ENVIRONMENT PROCESSING TRADE CO., LTD.		
7.1.	焼却	6,000	
7.2.	固化後安全に埋設	3,000	
7.3.	ドラムや有害物質付着金属の洗浄	1,500	
7.4.	グリースのリサイクル	1,500	
7.5.	化学及び物理処理	1,000	
7.6.	他の技術	5,000	
8	SAO VIET ENVIRONMENTAL JOINT-STOCK COMPANY		
8.1.	廃溶剤	2,000	
8.2.	廃油、油性汚泥	2,000	
8.3.	廃鉛蓄電池	4,000	
8.4.	有害物質含有廃水	4,500	
8.5.	引火性廃棄物	5,000	
8.6.	汚泥	6,000	
8.7.	廃蛍光灯	12,000	
9	TUOI SANG ENVIRONMENTAL COMPANY LIMITED		
9.1.	有害物質含有廃水	6,000 - 9,000	
9.2.	廃電子機器	7,000 - 9,000	
9.3.	有害汚泥	7,000 - 10,000	
9.4.	有害物質含有吸着材	7,000 - 10,000	
9.5.	有害廃棄物付着梱包材	8,000 - 10,000	
9.6.	廃油	8,000 - 10,000	
9.7.	塗料汚泥	8,000 - 10,000	
9.8.	廃鉛蓄電池	8,000 - 12,000	
9.9.	廃インク	12,000 - 15,000	
9.10	廃蛍光灯	15,000-25,000	
10	BINH PHUOC XANH ENVIRONMENTAL TECHNOLOGY COMPANY LIMITED		
10.1.	有害廃棄物付着梱包材	5,000	
10.2.	引火性廃棄物、高発熱量廃棄物	6,000	
10.3.	廃耐火物	8,000	
10.4.	その他廃棄物	6,000 - 30,000	成分や性状に応じて単価は異なる。
11	QUOC VIET ENVIRONMENTAL SCIENCE AND TECHNOLOGY COMPANY LIMITED		
11.1.	製造工程、メッキ、洗浄、金属表面処理から発生する廃棄物	1,500 - 2,000	

第 2 章
2020 年及び 2025 年までの固形産業廃棄物、有害廃棄物、医療廃棄物の発生量予測

2.1. 2020 年及び 2025 年までの社会経済開発計画

南部の拠点経済地域は規模や効率性の両面において国内で最も開発が進んだ地域である：国内の投資の 40%以上；海外直接投資の 60%; GDP に対する投資額の割合が 50%で国内平均の 1.5 倍以上；経済成長率は国平均の 1.4～1.6 倍。南部拠点のダイナミックで多面的な開発に触発されて、特に南部省及び国全体の発展に勢いが増している。

ホーチミン市、ビンズン省、ドンナイ省、バリア・ブンタウ省、ロンアン省は南部拠点経済成長圏（Southern Key Economic-growth Areas）にある 8 省のうちの 5 省である。経済価値を生み出すための開発と平行して、開発活動によって、特に工業活動から大量の廃棄物が環境に放出されている。ホーチミン市及び周辺省の工業開発状況を簡単に以下に整理する。

2.1.1. ホーチミン市

2.1.1.1. 現状

現在までにホーチミン市には 17 工業ゾーンが建設されており、総計画面積は 2315.86 ha で、地区に分散している：Thu Duc District に 3 IPs-EPZ（151.04 ha）、7 District に 1 EPZ（300 ha）、Binh Tan District に 1 IP（面積 380.15 ha）、Tan Phu District に 1 IP（128.7 ha）、Binh Chanh District に 2 IPs（326.51ha）、Cu Chi District に 5 IPs（1,237.4 ha）、2 District に 1 IP（124 ha）、12 District に 1 IP（28 ha）。

表 0.1. ホーチミン市の工業団地及び輸出加工区一覧

No	工業団地（IP）/輸出加工区（EPZ）	面積（ha）	入居率(%)	地区（場所）
01	Tan Thuan IP	300	81	7
02	Linh Trung 1 IP	62	100	Thu Duc
03	Linh Trung 2 IP	61.7	100	Thu Duc
04	Tan Tao IP	380.15	87.7	Binh Tan
05	Tan Binh IP	128.7	100	Tan Phu
06	Le Minh Xuan IP	100	100	Cu Chi
07	Vinh Loc IP	203	100	Binh Chanh
08	Tan Thoi Hiep IP	28	100	12
09	Northwest Cu Chi IP	208	100	Cu Chi
10	Binh Chieu IP	27.34	100	Thu Duc
11	Hiep Phuoc (Phase I) IP	311.4	91.61	Nha Be
12	Hiep Phuoc (Phase II) IP	597	6	Nha Be
13	Cat Lai II IP	124	88.74	2
14	An Ha IP	123.51	23.22	Binh Chanh
15	Tan Phu Trung IP	542.64	24	Cu Chi
16	Dong Nam IP	286.76	27.68	Cu Chi
17	Hoa Phu IP	100	11.82	Cu Chi
合計		2,315.86		

ひとつの工業団地の平均面積は 136.2 ha である。最大の工業団地は Nha Be District の Hiep Phuoc Industrial Park Phase 2 で面積は 597 ha、最小は Binh Chieu Industrial Park で、面積は 27.34 ha である。建設以来、工業団地は 1947.67 ha をリースしており、入居率は 56.36% に達した。入居率が 100%の工業団地は 8 箇所ある（Linh Trung 1、Linh

Trung 2、Tan Binh、Le Minh Xuan、Vinh Loc、Tan Thoi Hiep、Tay Bac Cu Chi、Binh Chieu)。入居率 90%以上の工業団地は 1 箇所（Hiep Phuoc Industrial Park phase 1）で、70%以上の工業団地は 3 箇所ある（Tan Thuan、Tan Tao、Cat II）。

一般に、多くの工業団地では承認された詳細計画に基づいたインフラ整備を適切に行っているが、最近は金融経済危機が投資環境に大きな影響を与えている。しかし、投資建設会社やインフラ整備会社は提案されたインフラ整備事業、例えば、港や空港につながる市の幹線道路に直結した団地内の道路建設、上水道、電力・通信システムの整備、下水処理システム等の整備を進めており、国内外の投資を呼び込むのに必要な条件を整えている。

2.1.1.2. マスタープラン

平均経済成長率の目標は 2011～2015 年が 10～10.5%、2016～2020 年が 9.5～10%、2021～2025 年が 8.5 % - 9 %である。一人当たりの実質 GDP は 2015 年に 4,856～4,967 ドル、2020 年には 8,430～8,822 ドル、2025 年には 13,340～14,285 ドルを目指す。2011～2010 年の平均 GDP は国全体の伸び率よりも 1.5 倍高い。ホーチミン市の建設開発や工業開発事業では高付加価値の高いセクターに焦点が当てられてきた。高い科学技術分野と高付加価値のある 4 種類の産業グループの開発が行われた。平均の GDP 成長率は 2011 年から 2015 年までは 8.7% /年で、2016 年から 2020 年までは 8.7%/年、2021 年から 2025 年までは 8.5%/年となる。

2013 年 5 月 13 日のホーチミン市人民委員会決議 No. 03/2013/NQ-HDND（2020 年及び 2025 年を展望したホーチミン市の経済社会開発マスタープランについて）によると、ホーチミン市には 24 の工業団地が建設され、総面積は 6152.8 ha となる。それらは、Thu Duc District に 3 IPs-EPZ（151.09 ha）、7 District に EPZ（300 ha）、Binh Tan District に 3 IPs（583.33 ha）、Tan Phu District に 2 ゾーン（195.25 ha）、Binh Chanh District に 8 ゾーン（1327.97ha）、Cu Chi District に 7 ゾーン（1685.48 ha）、2 District に 1 ゾーン （124 ha）、12 District に 1 エリア（28.41 ha）、9 District に 1 ゾーン（114 ha）である。 IPs 及び EPZ の位置図を図 2.1 に示す。

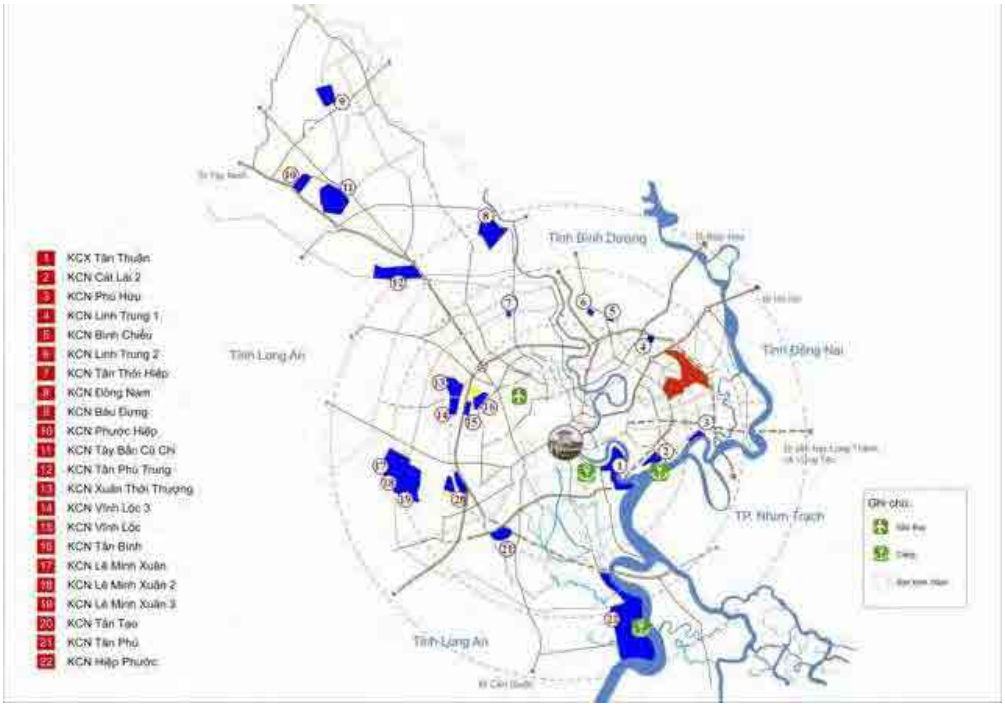

図 0.1. 2020 年までのホーチミン市の工業団地及び輸出加工区の位置図

計画されている工業団地及び輸出加工区を表 2.2 に示す。

表 0.2. ホーチミン市で 2020 年までに計画されている工業団地、輸出加工区一覧

No	工業団地（IP）/輸出加工区（EPZ）	場所 （地区）	計画面積（ha）
01	Tan Thuan EPZ	7 Dictrict	300.00
02	Sai Gon - Linh Trung EPZ	Thu Duc	62.00
03	Linh Trung 2 EPZ	Thu Duc	61.75
04	Binh Chieu IP	Thu Duc	27.34
05	Tan Tao IP	Binh Tan	175.57
	Tan Tao - expand IP	Binh Tan	204.58
06	Tan Binh IP	Tan Phu & Binh Tan	105.95
07	Le Minh Xuan - expand IP	Binh Chanh	120.00
08	Vinh Loc IP	Binh Tan	203.18
	Vinh Loc - expand IP	Binh Chanh	56.06
09	Tan Thoi Hiep IP	12 Dictrict	28.41
10	Northwest Cu Chi IP	Cu Chi	208.00
	Northwest Cu Chi - expand IP	Cu Chi	173.24
11	Cat Lai 2 - Phase 1 & 2 IP	Quận 2	124.00
12	Hiep Phuoc - Phase 1 IP	Nha Be	311.40
	Hiep Phuoc - Phase 3 IP	Nha Be	500.00
13	Tan Phu Trung IP	Cu Chi	542.64
14	Phong Phu IP	Binh Chanh	148.40
15	Phu Huu IP	9 Dictrict	114.00
16	Dong Nam IP	Cu Chi	286.76
17	Bau Đung IP	Cu Chi	175.00
18	Phuoc Hiep IP	Cu Chi	200.00
19	Xuan Thoi Thuong IP	Hoc Mon	300.00
20	Vinh Loc 3 IP	Binh Chanh	200.00
21	Le Minh Xuan 2 IP	Binh Chanh	338.00
22	Le Minh Xuan 3 IP	Binh Chanh	242.00
23	An Ha IP	Binh Chanh	123.51
24	Hoa Phu IP	Cu Chi	100.00
	合計		**6,152.80**

2.1.2. ビンズン省

2.1.2.1. 現状

現在までにビンズン省には 28 の工業団地があり、総計画面積は 9,093.25 ha である。それらは、Di An town の 6 工業ゾーン（854.1 ha）、Thuan An town の 3 工業ゾーン（694.18 ha）、Ben Cat District の 9 工業ゾーン（4,112.93 ha）、Tan Uyen district の 3 工業ゾーン（1,839.84 ha）、Thu Dau Mot town の 7 工業ゾーン（1,730.91 ha）である。工業団地の位置図を図 2.2.に示す。

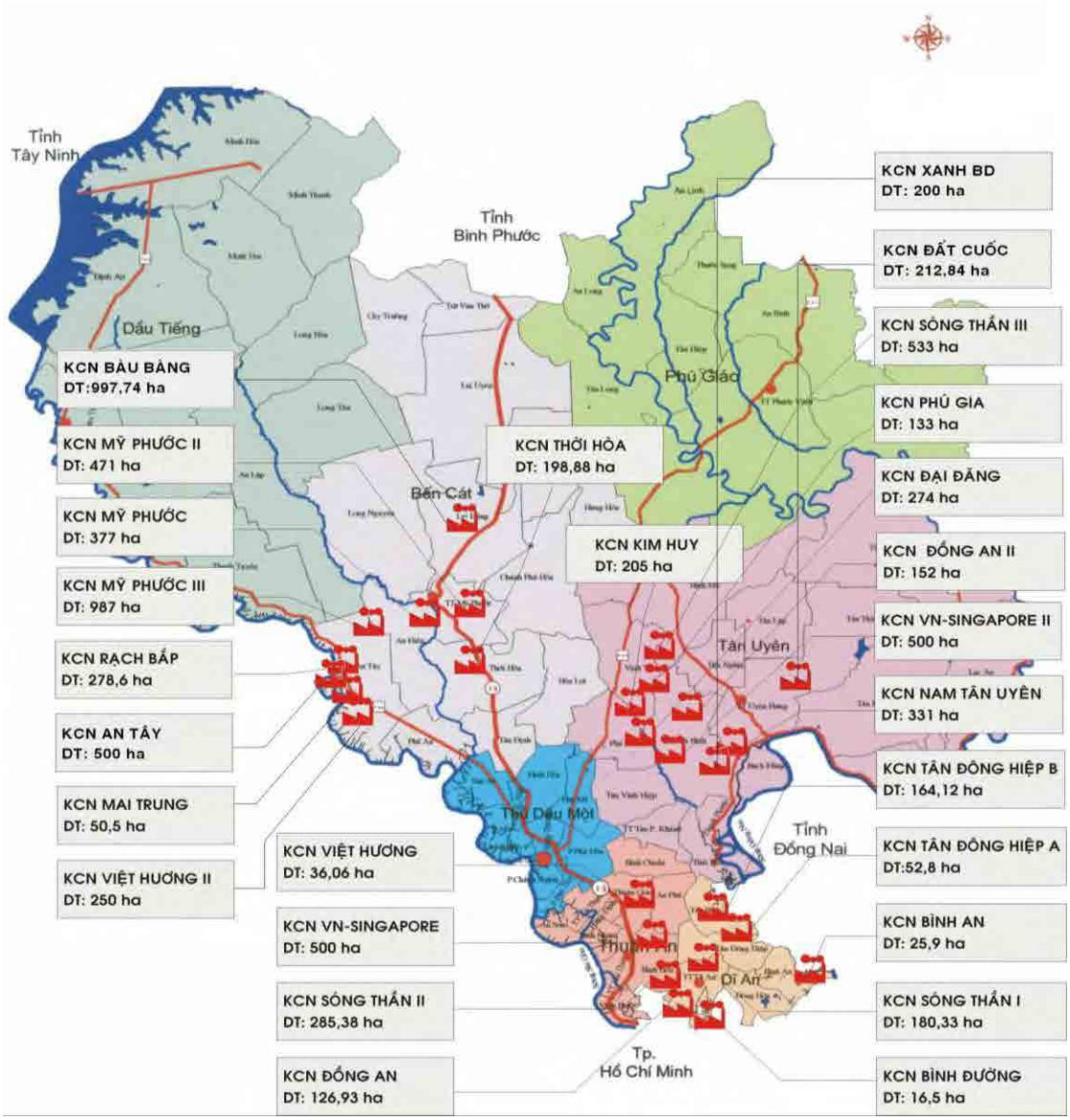

図 0.2. ビンズン省の工業団地の位置図

2000 年に始めて Song Than 工業団地（180.33 ha 、現在は 178 ha）が建設されて以来、2001～2005 年に 8 箇所の工業団地（1,438ha）が、また、2006～2010 年にさらに 7 箇所の工業団地（1,652ha）が建設され、さらに、13 の新たな工業団地が建設・拡張された（6,003.25ha）。これは、2001～2005 年に比べると 1.8 倍の伸びである。2000 年に比較すると、2010 年末には新たに建設された工業団地は数で 2.5 倍、面積で 5.3 倍に増えた。

現在、24 の工業ゾーンが稼働しており、総面積は 7308.85ha、残り 4 工業団地が建設中（Thoi Hoa、An Tay、Mapletree、VSIP II-A）で、総面積は 1,784.4ha である。様々な分野の 19 企業がインフラ整備やビジネスに参加している。それらは 100%国営企業 3 社、ジョイントベンチャー2 社、株式会社 9 社（そのうち、4 社は国営）、有限会社（Company Limited ）4 社（そのうち、2 社は 100%外資）及び 1 民間会社である。

工業ゾーンの規模は 1 工業団地の平均面積が約 324 ha である。最大の工業ゾーンは VSIP II-A（Tan Uyen district）で、面積は 1,008ha であり、最小は Binh Duong Industrial Zone（16.5ha）である。2005 年末に比較して工業ゾーンの規模は 1.5 倍に増えている（2005 年の 1 工業団地の面積は 206 ha）。操業中の 24 工業団地の総リース面積は 4,770ha である。建設以来、工業団地の総リース面積は 3,102 ha で、入居率は 65%である。入居率

が 100%の工業団地は 6 箇所（Song Than、Dong An、Viet Huong Tan Dong Hiep A、VSIP、My Phuoc 2）で、4 工業団地（Song Than 2、Binh Duong、Binh An、VSIP II）では 95%以上である。また、Nam Tan Uyen Industrial Park は 90%以上、4 箇所の工業団地（Dong An 2、Viet Huong 2、U.S. Phuoc Tan、Dong Hiep B）の入居率は 70%以上である。

一般に、ほとんどの工業ゾーンでは承認された計画に従ってインフラ整備が行われているが、最近では金融経済危機が工業団地にも影響を与えているものの、投資の呼び込みには影響はなく、インフラ建設会社、投資会社等は設定した計画に従って建設を進めている。これらには、省内の交通システム、港湾、空港につながる工業団地内の道路整備、水道や排水システム、電気・通信設備、中央排水処理施設、サービスセンターなどが含まれ、内外の投資を呼び込む必要条件を満たしている。今日までの総投資額は 7.758 十億 VND プラス 150 百万ドルで、承認された投資額の 81%以上（Binh Duong Industrial Zone）と 87%以上である（VSIP）。VSIP II-A は第 1 段階の計画の 70%が完了しており、投資額は約 100 百万ドル、Mapletree Industrial Park は 68 百万ドル以上の投資額である。

2.1.2.2. マスタープラン

さらに発展を続けるために工業製品の多様化に向けた投資が求められている中で、国内材料を用いたハイテク産業に焦点が当てられている。建設資材産業は高水準に達し、近代化が進み、製品は国内外で競争力を高めている。2020 年にビンズン省は国及び地域の主要な工業センターになる。工業製品の価値は 2006～2010 年に 30.6%/年、2011～2015 年に 26%/年、2016～2020 年に 24.1%/年となる。国内資源の使用割合は 2010 年の 55%から 2015 年には 60%、2020 年までには 70%となり、生産コストは下がる。ハイテク製品の割合は増えている。クリーンインダストリーの割合は 2010 年には 20%から 40%に増え、2015 年には 50%、2020 年には 60%となる。

中小産業や伝統的な産業の開発を進めることによって農村部の雇用問題が解決され、省外からの労働者にとって魅力となる。

地方の特性を生かして工業団地の効率を改善して強化することによって 2020 年までに省には 31 の工業団地（9,360.5 ha）と 23 の工業団地（ 2,704 ha）が期待されている。

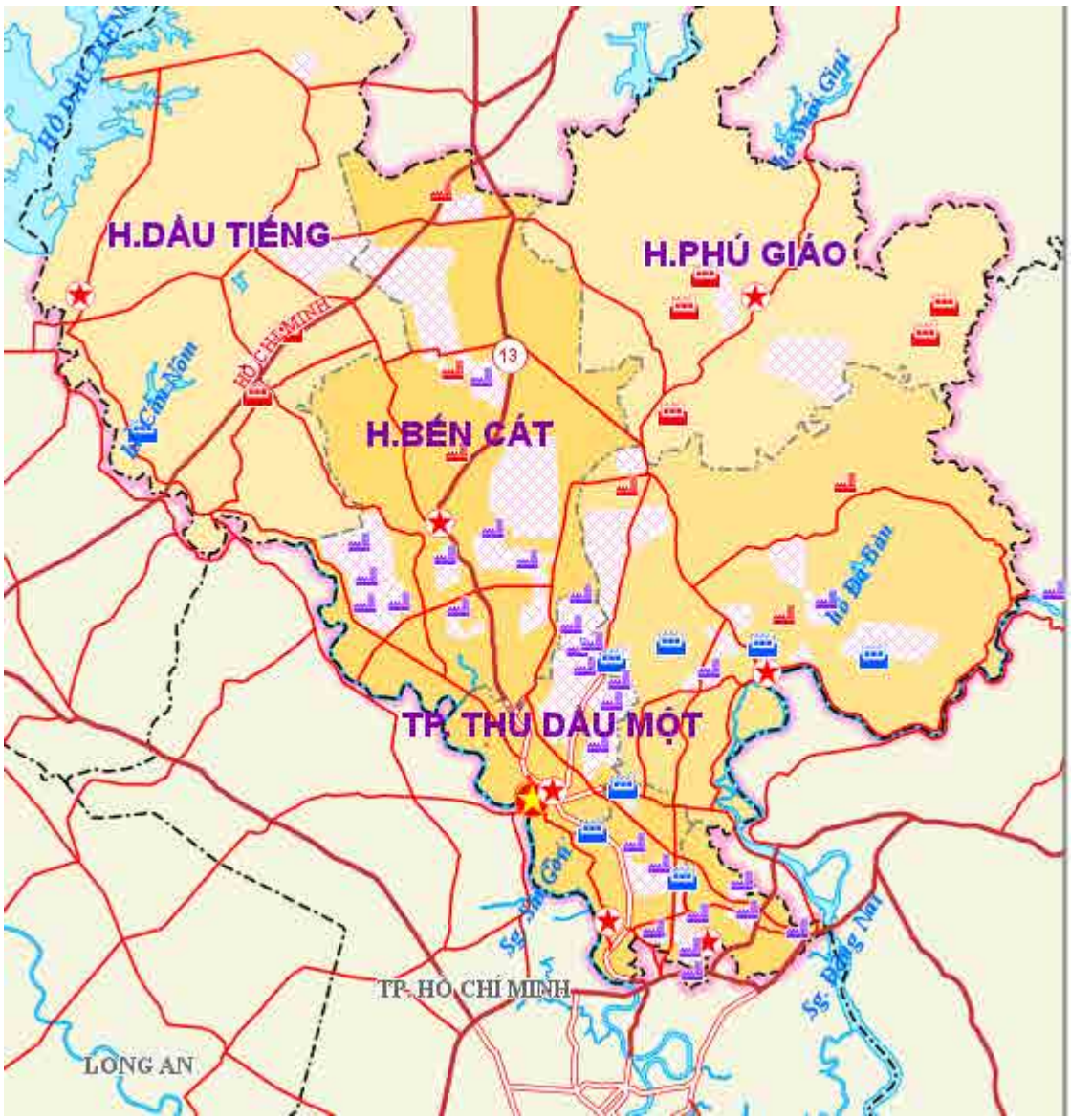

図 0.3. ビンズン省の工業開発ゾーンマップ

2.1.3. ドンナイ省

2.1.3.1. 現状

ドンナイ省には 2010 年 12 月時点で 30 の工業ゾーンがあり、35 ヵ国からの投資がある。その数は 1,124 事業、そのうち海外からの投資事業は 817 件、投資総額は 12,736 百万ドルで、国内投資事業は 307 件、31,227.69 十億 VND である。

表 0.3. ドンナイ省の計画工業団地

NO.	工業団地	全体計画面積 (ha)	詳細計画面積 (ha)	備考
I. 承認済工業団地				
01	Bien Hoa I	335	335	
02	Bien Hoa II	365	365	
03	Amata Phase 1	760	494	
	Amata Phase 2			

NO.	工業団地	全体計画面積 (ha)	詳細計画面積 (ha)	備考
04	Loteco	100	100	輸出加工区 13ha を含む
05	Go Dau	184	184	
06	Ho Nai Phase 1	526	226	
	Ho Nai Phase 2		271	
07	Song May Phase 1	471	250	
	Song May Phase 2		224	
08	Nhon Trach I	2700	430	
09	Nhon Trach II		347	
10	Nhon Trach III phase 1		337	
	Nhon Trach III phase 2		351	
11	Nhon Trach V		302	
12	Nhon Trach VI		315	
13	Det May Nhon Trach		184	
14	Nhon Trach II - Nhon Phu		183	
15	Nhon Trach II - Loc Khang		70	
16	Tam Phuoc	280	323	
17	An Phuoc	400	130	
18	Long Thanh	400	488	
19	Dinh Quan	50	54	
20	Xuan Loc	100	109	
21	Thanh Phu	186	177	
22	Bau Xeo	215	500	
23	Tan Phu	60	54	
24	Agtex Long Binh		43	
25	Long Đuc	450	283	
26	Ong Keo	800	823	
27	Long Khanh	300	264	
28	Giang Đien	500	529	
29	Dau Giay	300	331	
30	Loc An - Binh Son	500	497.77	
計			**9,573.77**	
II. 2015 年までの拡張、調整工業団地(2008 年 10 月 13 日付け PPC の通知 No.8522/UBND-CNN; 2009 年 6 月 5 日付け計画投資省通知 No.4056/BKH-QLKKT; 首相通知 No.964/TTg-KTN による)				
01	Dinh Quan (Phase 2)	120	107	There had on Decision 1107
02	An Phuoc (adjustment)	71		Phase to 2015
03	Aamata (expanded)	180		Phase to 2015
04	Xuan Loc (expanded)	200		Phase to 2015
05	Tan Phu (adjustment)	76		Phase to 2015
06	Long Duc (adjustment)	130		Phase to 2015

NO.	工業団地	全体計画面積 (ha)	詳細計画面積 (ha)	備考
計		764		
III. 5 新規追加工業団地 (2015-2020 年) (2008 年 10 月 13 日付け PPC の通知 No.8522/UBND-CNN; 2009 年 6 月 5 日付け計画投資省通知 No.4056/BKH-QLKKT; 2009 年 6 月 17 日付け首相通知 No.964/TTg-KTn)				
01	Industrial Park - Agricultural Donataba (freeway 25- Thong Nhat district)	250		首相追加承認有り
02	Long Thanh High-Tech Industrial Park, (Tam An ,Tam Phuoc social- Long Thanh district) (in downtown 1.922ha)	500		Phase to 2015
03	Phuocc Binh (Phuoc Long - Long Thanh)	190		Phase to 2015
04	Gia Kiem (Gia Kiem - Thong Nhat)	330		2015 年まで：150ha；2015～2020 年：180ha
05	Cam My (Thua Duc - Cam My)	300		2015～2020 年：100ha
06	Suoi Tre IP (Suoi Tre commune & Bao Vinh - Long Khanh)	150		Phase to 2015
計		1,720		
合計 36 工業団地		12,057.77		

出典: The Management Board of industrial zones in Dong Nai Province, 4/2011

30 工業団地の総面積は 9,573 ha で、3,724.89 ha が入居済、6,338.58 ha がリース用地で、その割合いは 59%である。これまで工業団地のインフラ整備に要した費用は約 3,897.14 十億 VND 及び 78.71 百万ドルである（工場建設費は含まず）。

現在の工業団地の総労働者数は約 370,000 人で、5,200 人の外国人労働者を含む。

表 0.4. ドンナイ省の工業団地のリース状況

No.	地区	面積 (ha)	リース用面積 (ha)	リース済み面積(ha)	現在の入居率
1	BIEN HOA CITY	1,337	958.76	873.25	0.91
1.1.	Amata	494	314.08	229.71	0.73
1.2.	Bien Hoa II	365	261.00	261.00	1.00
1.3.	Loteco	100	71.58	71.58	1.00
1.4.	Bien Hoa I	335	284.48	284.48	1.00
1.5.	Agtex Long Binh	43	27.62	26.48	0.96
2	NHON TRACH DISTRICT	3,342	2,248	1,656	0.74
2.1.	Nhon Trach I	430	311.25	279.41	0.90

No.	地区	面積 (ha)	リース用面積 (ha)	リース済み面積(ha)	現在の入居率
2.2.	Nhon Trach II	347	257.24	269.51	1.05
2.3.	Nhon Trach II - Nhon Phu	183	126.31	57.84	0.46
2.4.	Nhon Trach II - Loc Khang	70	42.54	27.00	0.63
2.5.	Nhon Trach III (Phase 1)	337	233.85	233.85	1.00
2.6.	Nhon Trach III (Phase 2)	351	227.55	94.63	0.42
2.7.	Textiles Nhon Trach	184	121.00	92.75	0.77
2.8.	Nhon Trach V	302	205.00	184.03	0.90
2.9.	Nhon Trach VI	315	220.29	0.00	0.00
2.10.	Ong Keo	823	502.82	416.83	0.83
3	**LONG THANH DISTRICT**	**1,906**	**1,345**	**572**	**0.43**
3.1.	Go Dau	184	136.70	136.70	1.00
3.2.	Long Duc	283	183.29	0.00	0.00
3.3.	Tam Phuoc	323	314.74	219.12	0.70
3.4.	KCN Long Thanh	488	282.74	215.98	0.76
3.5.	KCN Loc An - Binh Son	497.77	336.05	0.00	0.00
3.6.	KCN An Phuoc	130	91.00	0.00	0.00
4	**TRANG BOM DISTRICT**	**2,000**	**1,288**	**585**	**0.45**
4.1.	Song May IP (phase 1)	250	178.13	135.39	0.76
4.2.	Song May IP (phase 1)	224	155.87	0.00	0.00
4.3.	Ho Nai (Phase 1)	226	151.17	139.46	0.92
4.4.	Ho Nai (phase 2)	271	149.96	0.00	0.00
4.5.	Bau Xeo IP	500	328.08	306.53	0.93
4.6.	Giang Dien IP	529	324.63	4.00	0.01
5	**DINH QUAN DISTRICT**	**54**	**37.80**	**44.90**	**1.19**
5.1.	Dinh Quan IP	54	37.80	44.90	1.19
6	**XUAN LOC DISTRICT**	**109**	**63.88**	**30.85**	**0.48**
6.1.	Xuan Loc IP	109	63.88	30.85	0.48
7	**VINH CUU DISTRICT**	**177**	**124.15**	**58.15**	**0.47**
7.1	Thanh Phu IP	177	124.15	58.15	0.47
8	**TAN PHU DISTRICT**	**54**	**34.98**	**4.26**	**0.12**
8.1.	Tan Phu IP	54	34.98	4.26	0.12
9	**LONG KHANH TOWN**	**264**	**169.06**	**1.00**	**0.01**
8.1.	Long Khanh IP	264	169.06	1.00	0.01
10	**THONG NHAT DISTRICT**	**331**	**205.74**	**6.52**	**0.03**
10.1.	Dau Giay IP	331	205.74	6.52	0.03

No.	地区	面積 (ha)	リース用面積 (ha)	リース済み面積(ha)	現在の入居率
	合計 (kg/day)	9,574	6,475	3,832	0.59

出典: The Management Board of industrial zones in Dong Nai Province, 4/2011

一般に工業団地のインフラシステムはかなり整備されており、特に道路、倉庫、水、電気、運輸・通信、金融サービス、銀行・保険は標準レベルに達している。経済再建を加速する必要性から労働力体制が確立され、インフラシステムが改良されている。IPs や EPZs はそのための突破口となり、インフラ整備の適正モデルとなり、工業化や近代化に向けた経済再建プロセスを加速することにつながっている。

地方の工業団地での、特にドンナイ省やビンズン省、ホーチミン市等の南部拠点経済地域でのインフラ投資は協調的に行われており、地方の顔を変え、経済や社会インフラの近代化につながり、工業地域や輸出加工区への投資が促進するような好ましい条件が作られ、地域経済の結びつきが強まることになる。

2.1.3.2. マスタープラン

ハイテク製品への大きな期待と機械、電子等の主要産業の開発、情報技術や通信技術、クリーンで環境に優しい産業の開発、原料やエネルギーの節約、そして適正な計画が首相承認によって南部地域に求められている。サポート産業としての部品やアクセサリー産業、精密機械や装置が大企業を呼び込むための基本産業で、国内資材の利用割合を高め、国内外で生産される製品の附加価値を高め、欠損品の削減、生産の安定や企業の安定経営を目指す。

中央省庁、南東省、南部拠点経済地域とが協調してインフラ整備を加速させ、Long Thanh ハイテク工業地域と特別生産地域の機能を完成させること。

用地の確保の行政手続きを改革し、Long Thanh 地域で工業団地外のインフラ整備を行い大規模な工業、サービス産業、ハイテク産業の集積化を目指す。

2011～2015 年の平均の修正工業生産価値（Value94）の増加割合を 16.2%/年から 17.2%/年にし（前の計画では 17.5%/年)、2016～2020 年には 15～16%/年とする（前の計画では 16.5%/年)。

優先開発分野: 産業機械; 電子産業 - 情報技術; 産業バイオ技術と製薬産業; 化学工業; 産業繊維産業 - 繊維、皮革-靴; 農水産加工品産業; 建設資材産業; 産業電力及び産業用水

2020 年のドンナイ省の修正工業開発計画及び 2025 年までの展望結果を図 2.4 に示す。

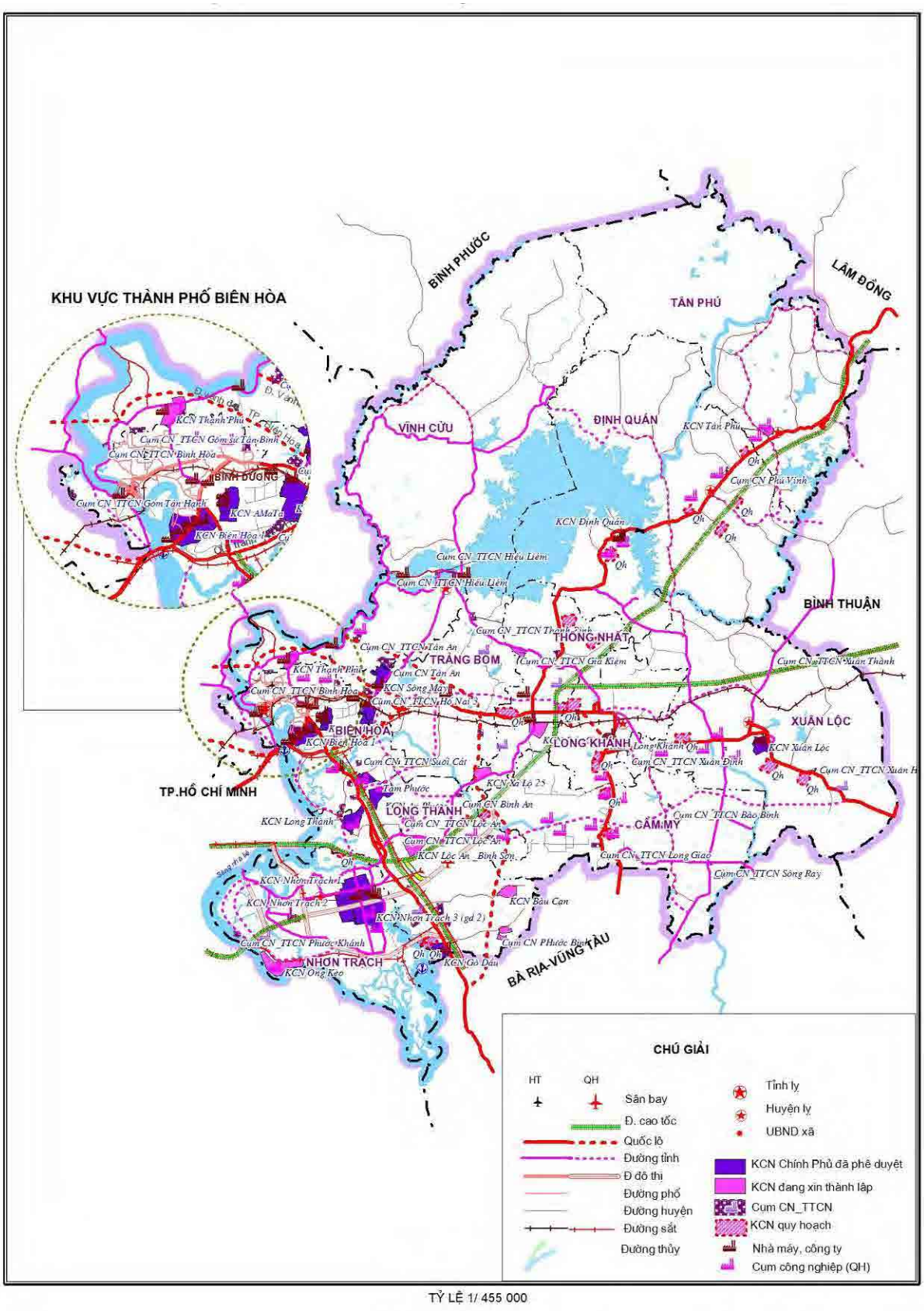

図 0.4. 2013 年のドンナイ省の工業団地分布図

(1). 工業ゾーン、特別セクター分野の開発

投資家達は工業ゾーンの改良や改善に長年携わっており、新規 IP には近代的なインフラが整備され、IP 外との調和に努めている。工業ゾーンにはゾーンサービス、ユーティリティ会社があり、ゾーン内の企業や労働者の活動を支援している。2015 年までに環境に配慮したグリーン工業団地の建設を目指して、100%の IPs では排水処理施設が稼働しており、排水基準を満たしている。都市開発や社会労働サービス提供労働者用住宅も工業ゾーンの開発と共に行われている。

修正された IP の開発計画によると、2020 年までに現在の 21 の操業中の IPs に加えて、9 カ所の IPs が基本建設を終え、さらに、Phuoc Binh – Long Thanh IP (190 ha)、Gia Kiem - Thong Nhat IP (330 ha)、Cam My IP (300 ha)、Suoi Tre – Long Khanh IP (150 ha)の新規 IP 建設に向けた投資を募集している。拡張計画がある工業団地としては Amata Industrial Park、An Phuoc Industrial Park、Xuan Loc Industrial Park、Dinh Quan Industrial Park、Tan Phu Industrial Park、Long Duc Industrial Park 及びその他発展を続けている多くの Ips である。さらに、優先的にインフラ整備の投資が行われて、投資家に魅力的なのが Long Thanh Industrial Park、Biotechnology Center (Cam My district)、アグロインダストリーコンプレックス DOFICO である (Xuan Loc 省及び Thong Nhat 省)。工業ゾーンの入居率を 2015 年に 65 %、2020 年までには 80 %にするよう努力している。

表 0.5. 2020 年までの工業団地 (IP) 開発計画

No.	工業団地	場所	2010 年面積 (ha)	土地利用計画(ha) (政府決議 No.69、2012 年 10 月 30 日)	2020 年追加工業団地面積
	合計		9.223	11.094	11.152
1	Bien Hoa 1	Bien Hoa	335		
2	Bien Hoa 2	Bien Hoa	365	365	365
3	Loteco	Bien Hoa	100	100	100
4	Amata	Bien Hoa	527	674	674
5	Agtex Long Bình	Bien Hoa	43	43	43
6	Tam Phuoc	Bien Hoa	323	323	323
7	Bau Xeo	Trang Bom	500	500	500
8	Giang Điên	Trang Bom, Bien Hoa	529	529	529
9	Ho Nai (Phase 1)	Trang Bom	226	226	226
	Ho Nai (Phase 2)	Trang Bom, Bien Hoa	271	271	271
10	Song May (Phase 1)	Trang Bom	250	250	250
	Song May (Phase 1)	Trang Bom, Vinh Cuu	224	224	224
11	Nhon Trach I	Nhon Trach	430	430	430
12	Nhon Trach II	Nhon Trach	347	347	347
13	Nhon Trach II - Nhon Phu	Nhon Trach	183	183	183
14	Nhon Trach II - Loc	Nhon Trach	70	70	70

No.	工業団地	場所	2010 年面積 (ha)	土地利用計画(ha) (政府決議 No.69、2012 年 10 月 30 日)	2020 年追加工業団地面積
	Khang				
15	Nhon Trach III (phase 1)	Nhon Trach	337	337	337
	Nhon Trach III (phase 2)	Nhon Trach	351	351	351
16	Textiles Nhon Trach	Nhon Trach	184	184	184
17	Nhon Trach V	Nhon Trach	302	302	302
18	Nhon Trach VI	Nhon Trach	237	315	315
19	Ong Keo	Nhon Trach	855	823	823
20	Go Dau	Long Thanh	344	184	184
21	Long Thanh	Long Thanh	488	488	500
22	Long Duc (*)	Long Thanh	283	534	580
23	An Phuoc	Long Thanh	130	201	201
24	Tan Phu	Tan Phu	54	130	130
25	Xuan Loc	Xuan Loc	109	309	309
26	Thanh Phu	Vinh Cuu	177	177	177
27	Dinh Quan	Dinh Quan	54	161	161
28	Long Khanh	Long Khanh	264	264	264
29	Dau Giay	Thong Nhat	331	331	331
30	Loc An - Binh Son	Long Thanh	-	498	498
31	Cam My	Cam My	-	300	300
32	Phuoc Binh	Long Thanh	-	190	190
33	Suoi Tre	Long Khanh	-	150	150
34	Gia Kiem	Thong Nhat	-	330	330

表 0.6. 2020 年までの特定地域開発計画

No.	特定地域	場所	土地利用計画(ha) (政府決議 No.69、2012 年 10 月 30 日)	2020 年追加工業団地面積(ha)
01	Long Thanh Hi-tech Industrial Park	Long Thanh	420	410
02	Agro-industrial complexes DOFICO	Thong Nhat, Xuan Loc	2,187	-
03	Centre for Biotechnology	Cam My	253	253

(2). 工業クラスター開発

工業クラスターの計画や建設への投資を呼び込み、支援するためには矛盾なく電力、水供給、排水、交通を IC 内外でリンクさせるためのインフラ整備が必要となる。環境汚染を引き起こしている中小工場やハンディクラフト産業は工業クラスターに優先的に移転する。

工業クラスター内の企業や工場にとって必要とされる条件は能力開発や生産性の拡大、製品の競争力の確保、環境保護のための汚染対策である。

省内の工業クラスターの 2025 年までの修正計画及びインフラ開発計画に関する 2012 年 3 月 2 日付け首相令（Directive No.07/CT-TTg）によると、省内には 37 の工業クラスターがあり、総面積は 1,943.2 ha である。36 の工業クラスター(1,913.2 ha)に計画が追加され、新たに環境汚染企業を移転させるために Long Khanh 町に Bau Tram（30 ha)が加わった。計画から削除されたのは 4 工業クラスター（209.8 hectares)で、Long Phuoc 2（34.8 hectares）は Long Thanh 国際空港の建設に伴って、Binh An（50 ha)はゴムプランテーションの土地補償の困難性から、Song Thao（50 ha)は水田の補償問題から計画が削除され、Gia Kiem Socklu 2（75 ha）は Gia Kiem - Socklu ICs 1（75 ha)の開発によって必要がなくなった。さらに、6 カ所のハンディクラフト家内工業用のクラスター（20.6 ha）が計画されている。

表 0.7. 2020 年まで及びそれ以降の工業クラスター（IC）開発計画

No.	工業クラスター（IC）	場所	土地利用計画（ha）（政府決議 No. 69、2012 年 10 月 30 日）	首相決定 No.07/CT-TTg による見直し	インフラ投資の進展状況
I	**2015 年開発計画：14 ICs(838.1 ha)、そのうち、5 工業 ICs(291.5 ha)がインフラ投資済、9 ICs（546.6 ha）がインフラ投資募集中**				
01	Construction Materials Ho Nai Ics	Ho Nai 3 communes, Trang Bom District	50	50	インフラ整備終了
02	Ceramics Tan Hanh	Tan Hanh communes, Bien Hoa District	54.5	54.5	インフラ整備終了
03	Phu Thanh - Vinh Thanh	Vinh Thanh communes Nhon Trach District	94	94	既に投資事業有り、インフラ整備中
04	Construction Materials Tan An	Tan An communes Vinh Cuu District	50	50	補償とインフラ整備合意中
05	Phu Cuong	Phu Cuong communes Dinh Quan District	43	43	補償合意中
06	Doc 47	Tam Phuoc communes, Bien Hoa City	98	97.6	インフラ整備募集中
07	Tam Phuoc 1	Tam Phuoc communes, Bien Hoa City	57	57	既に投資事業有り、インフラ整備中
08	Thien Tan-Thanh Phu	Thien Tan - Thạnh Phú communes, Vinh Cuu District	96.5	96.6	既に投資事業有り、インフラ整備中
09	Thien Tan	Thien Tan	75	75	計画書作成中

No.	工業クラスター（IC）	場所	土地利用計画（ha）（政府決議 No. 69、2012 年 10 月 30 日）	首相決定 No. 07/CT-TTg による見直し	インフラ投資の進展状況
		communes, Vinh Cuu District			
10	Tam An	Tam An communes Long Thanh District	60	59.9	インフラ投資中
11	Thanh Binh	Thanh Binh communes Trang Bom District	49	48.7	インフラ投資募集中
12	A Ho Nai 3 - Hung Thuan	Ho Nai 3 communes, Trang Bom District	40	40	補償合意中
13	Hung Loc	Hung Loc communes, Thong Nhat District	42	41.8	計画書作成中
14	Phu Thanh	Phu Thanh communes, Tan Phu District	30	30	計画書作成中
II	2016 - 2020 年：12ICs 及び追加 IC（Bau Tram IC）を含む工業コンプレックス 13（655.3ha）のインフラ整備投資継続。特に以下のグループを含む。				
15	Quang Trung	Quang Trung communes, Thong Nhat District	80	80	補償合意中
16	Gia Kiem - Socklu	Socklu communes, Thong Nhat District	75	75	計画書の準備
17	Tan An	Tân An communes, Vinh Cuu District	50	50	計画書の準備
18	Long Phuoc	Long Phuoc communes, Long Thanh District	75	75	インフラ投資募集中
19	Binh Son	Binh Sơn communes, Long Thanh District	57	57	既に投資事業有り、インフラ整備中
20	Long Giao	Long Giao communes, Cam My District	57	57	インフラ投資募集中
21	Tri An	Trị An communes, Vinh Cuu District	49	48.8	インフラ投資募集中
22	Construction Materials Phuoc Binh	Phuoc Binh communes, Long Thanh District	75	75	既に投資事業有り、インフラ整備中
23	Hung Thinh	Hung Thinh communes, Trang Bom District	35	35	インフラ投資募集中
24	Xuan Hung	Xuan Hung communes, Xuan Loc District	19	19	インフラ投資募集中
25	Suoi Cat	Suoi Cat communes, Xuan Loc District	20	20.5	インフラ投資募集中

No.	工業クラスター（IC）	場所	土地利用計画（ha）（政府決議 No. 69、2012 年 10 月 30 日）	首相決定 No. 07/CT-TTg による見直し	インフラ投資の進展状況
26	Phu Vinh	Phu Vinh communes, Dinh Quan District	33	33	インフラ投資募集中
27	Bau Tram	Bau Tram communes, Long Khánh District	30	30	インフラ投資募集中
III	2020 年後：10 ICs のインフラ整備（449.8 ha）、これには 6 ICs の計画及び残り 4ICs の計画を含む。				
28	An Vien ICs	An Vien communes, Trang Bom district	50	50	
29	Song Ray ICs	Song Ray communes, Cam My District	50	50	
30	Cọ Dau ICs	Xuan Dong communes , Cam My District	50	50	
31	Vinh An ICs	Vinh An communes, Vinh Cuu District	50	50	
32	Vinh Tan ICs	Vinh Tan communes, Vinh Cuu District	55	54.8	
33	Phu Tuc ICs	Phu Tuc communes, Dinh Quan District	50	50	
34	Gia Tan 1&2 ICs	Gia Tan communes, Thong Nhat District	-	75	
35	Phu Trung ICs	Phu Trung communes, Tan Phu District	-	30	
36	Phu Loc ICs	Phu Loc communes, Tan Phu District	-	20	
37	Phu Lap ICs	Phu Lap communes, Tan Phu District	-	20	
	合計		1,799	1,943.2	

2.1.4.ロンアン省

2.1.4.1.現状

2013 年 11 月時点での 2015 年から 2020 年までの計画では省内には 28 の工業ゾーンがあり（2020 年までのロンアン省の修正工業開発計画及び工業開発計画リストを承認した 2013 年 3 月 28 日付け首相通達 No. 463/TTg-KTN）、その総面積は 10,216.16 ha である。また、49 件の工業ゾーンの拡張投資事業と 39 件のインフラ投資事業があり（Duc Hoa III Industrial Park には 13 件の投資事業がある）、これらにはインフラを所有する 3 件の海外からの投資事業がある。

28 の工業ゾーンの内、19 の工業ゾーンが建設され、総面積は 5,805.76 ha ある。それらは Duc Hoa I Industrial Zone、Xuyen A、Tan Duc、Tan Do、Hai Son、Vinh Loc 2、Nhut Chanh、Phu An、Thanh Thinh Phat、Thuan Dao、Cau Tram、Phuoc Dong Pier、Tan Kim、Long Hau、Dong Nam A、An Nhut Tan、Long Hau - Hoa Binh、Phuc Long 及び多くの工業団地、Duc Hoa Industrial Park III （Duc Hoa III-Minh Ngan、Resco、Song Tan、Thai Hoa、Hong Dat、Anh Hong、Slico、Viet Hoa、Lien Thanh、Cali Long Duc、Muoi Day、Long

Viet）で、合計 24 の工業団地の投資許可が下りている。その総面積は 8242.49 ha で総投資額は 77.06 百万ドルである。工業団地の入居率は 20.04%で、民間の工業団地が稼働すれば入居率は 43.88%になる。

現在、同省には 16 の工業団地が稼働中であり、総面積は 3,996.43 ha である。それらは Duc Hoa I Industrial Zone、Xuyen A、Tan Duc、Thuan Dao、Nhut Chanh、Tan Kim、Long Hau、 Cau Tram、Phu An Thạnh、Vinh Loc 2、Thinh Phat、Tan Đo、Hai Son、Long Hau - Hoa Binh、Phuc Long 及び Duc Hoa Industrial Park III （Thai Hoa、Viet Hoa、Anh Hong、Hong Đat、 Resco）である。

これまでに 760 の投資事業の計画があり、1,226.47 ha の土地がリースされた。それらは 251 件の海外投資事業（総額 1,685.135 百万ドル）と 509 件の国内投資事業（総額 VND 27,228.9）である。これらのうち 127 事業では工業ゾーンの所有地をサブリースしており、その総面積は 387,973 m^2 である。

今日までに 360 の企業が操業しており、海外投資事業が 145 件、国内投資事業が 215 件である。これらは主として Duc Hoa I Industrial Zone、Tan Đuc、Xuyen A、Thuan Dao、Nhut Chanh、Long Hau、Phu An Thanh、Hai Son、Thinh Phat、Tan Do、Tan Kim、Cau Tram、Duc Hoa III-Thai Hoa、Duc Hoa III-Anh Hong、Đuc Hoa III- Hong Dat、Duc Hoa III-Viet Hoa に集中している。

表 0.8. ロンアン省の工業団地一覧

No.	工業団地名	設立年	場所	面積 (ha)	入居率 (%)
1	**Duc Hoa 1 工業団地 -Hanh Phuc: Duc Hoa Dong commune, Duc Hoa district**				
	第 1 期	1999	Duc Hoa district	70	100
	第 2 期	2005	Duc Hoa district	204.23	30.33
2	**Xuyen A 工業団地: My Hanh Bac commune, Duc Hoa district**				
	第 1 期	1997	Duc Hoa district	50	100
	第 2 期	2002	Duc Hoa district	255.9157	39.95
3	Thuan Dao 工業団地		Ben Luc District	113.9472	100
	Thuan Dao 工業団地拡張	2011	Can Duoc district	198.8430	0.75
4	**Tan Duc 工業団地: Duc Hoa Ha Commune, Duc Hoa district**				
	第 1 期	2004	Duc Hoa district	273	90
	第 2 期	2008	Duc Hoa district	270.3536	51.66
5	Tan Kim 工業団地	2004	Can Giuoc district	104.1	66.85
	Tan Kim 工業団地拡張	2013	Can Giuoc district	52.488	0
6	Vinh Loc 2 工業団地	2005	Ben Luc District	225.9850	20.17
7	Long Hau 工業団地		Can Giuoc district	141.85	97.83

No.	工業団地名	設立年	場所	面積 (ha)	入居率 (%)
	Long Hau 工業団地拡張	2009	Can Giuoc district	108.48	26.81
8	Cau Tram 工業団地	-	Can Duoc district	77.8227	15.71
9	Duc Hoa III 工業団地				
	Thai Hoa	2008	Duc Hoa district	100.2722	41.61
	Hong Dat	2008	Duc Hoa district	100.0293	16.69
	Anh Hong	2008	Duc Hoa district	55.2416	33.96
	Viet Hoa	2008	Duc Hoa district	83.2151	66.86
10	Nhut Chanh 工業団地	-	Ben Luc District	125.27	70.67
11	Phu An Thanh 工業団地	2009	Ben Luc District	307.23	22.06
12	Phuc Long 工業団地	2011	Ben Luc District	78.4146	21.24
13	Thinh Phat 工業団地	2011	Ben Luc District	73.3717	69.26
14	Long Hau - Hoa Binh 工業団地	2012	Thu Thua District	117.67	6.26
15	Hai Son 工業団地	2011	Duc Hoa district	366.4884	53.43
16	Tan DO 工業団地	2011	Duc Hoa district	208.0432	13.09

出典: Industrial Zone Management Board Long An Province in 2013

工業団地の位置を図 2.5 に示す。

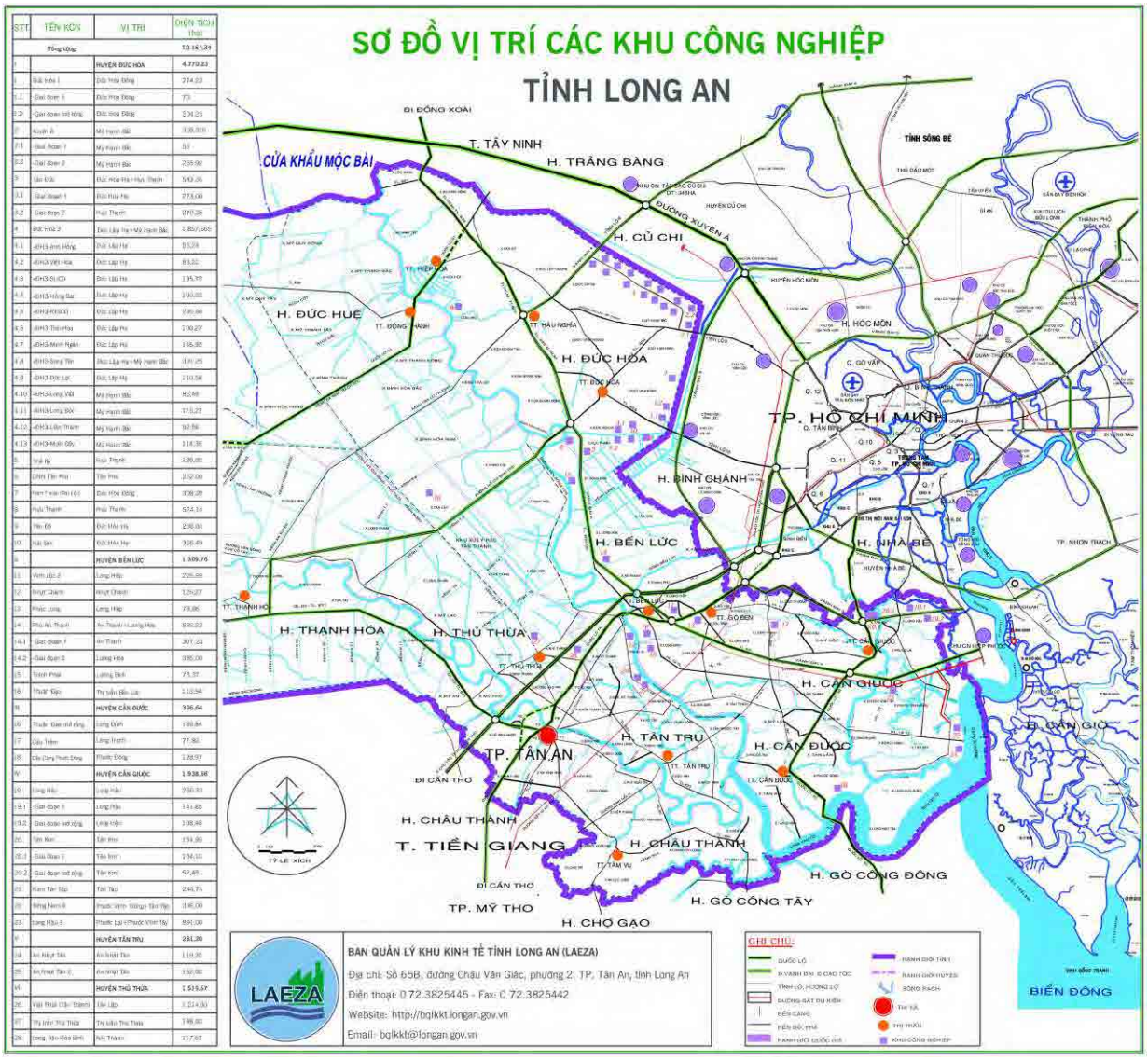

図 0.5. 2013 年のロンアン省における工業ゾーンの分布図

工業ゾーンには general infrastructure systems engineering economics rather complete,
特に道路、倉庫、発電所、水道、輸送、通信、金融サービス、銀行、保険等の基準。 経済再建の加速化や労働構造の整備がインフラシステム改善のために第 1 に求められる。工業団地や輸出加工区が突破口となり、インフラ整備の最適モデルとなり、経済再建の加速化や労働の近代化を加速する効果がある。

地方の工業団地では投資を完璧に行い、インフラ整備がシンクロナイズすれば地方の顔を変えることになり、社会経済のインフラシステムの近代化に貢献し、工業団地や輸出加工区への投資を促進するための好条件を提供することになり、特にドンナイ省、ビンズン省、ホーチミン市等の南部経済圏との結びつきを強めることになる。

2.1.4.2. マスタープラン

2020 年のロンアン省の社会経済開発総合計画報告書は省人民委員会が 2006 年 10 月 10 日に承認したもので（決議 No. 27/2006/NQ-HDND）、省の将来の開発計画が以下のように展望されている。

– ロンアン省は発展を続けており、省の目標は急速に達成に向かっている。産業の数、種類とも急増しており、資源を最大限利用して南部拠点経済地域内の省との開発レベルの距離

を縮めている。工業セクターや建設部門の発展を目指した経済の再建では、生産性や品質を向上させ、農業や林業、水産業の近代化を図り、商業セクター及びサービス産業の発展と調和を図る。産業発展及び工業化は今後の省の経済発展を促進するための主要な駆動力となる。

– 開発が最優先で、引き延ばしは禁物: 省は産業開発の前に投資を最優先に考えるべきである。なぜならば資金に限界があるからである。開発に成功した産業地域があれば、省予算への税収が期待され、省は開発が遅れている分野に投資の優先順位を変えることができる。

– 統合と市場との関連性： 競争力をつけることと、省内統合が効率性を図る手段である。

– 地域開発との関連性: 省の開発はホーチミン市や南部拠点経済地域の地域開発優先度と調和すべきである。地域開発に省の最大の優位性を見つけるべきである。ロンアン省の都市開発はホーチミン市の都市開発と一般に方向性を同じにすべきである。また、ロンアン省内ではサブ地域の開発と調和させる必要がある。

– 経済開発は文化的な生活や精神、社会的公平性をもって進める必要がある。開発の質を確保するために経済的な量的スケールに焦点をあてる必要がある。

– 社会経済開発は地域の安全と防衛政策と調和する必要がある。

– ゾーン開発や工業クラスターの開発の方向性：住宅地や都市部の混在、マングローブ林の配置、保存すべき河口生態系、国道、高速道路、省幹線道路との適正な距離を図ること。工業開発地域が限られた中で急速で持続可能性のある工業開発の方向性を保証するために必要な課題やセクターを明らかにする。

– ある重要地点の開発の必要性や Vam Co 川、Vam Co Dong 川、Vam Co Tay 川及び国境ゲート沿いの住民の生活向上や産業サービスに関連して始まっている開発を補うことを追求する。

+ Vam Co Dong の Vam Co 川東部： Can Duoc 地区約 7,000 ha、Ben Luc 地区約 3,000 ha, Duc Hoa 地区約 5,800 ha
+ Vam Co Dong 川西部と Vam Co Tay 川東部: Tan Tru 地区約 1,000 ha、Thu Thua 地区約 2,000 ha、Thanh Hoa 地区約 1,000 ha、Duc Hue 地区約 1,000 ha、Moc Hoa 地区約 600 ha
+ Vam Co 川南部、Thanh Hoa の Chau Thanh 地区（Thuan My, Thanh Vinh Dong の約 1,000ha）の都市人口及びサービス産業に関連した Vam Co Tay 開発ゾーン及び工業クラスター
+ 追加の IP 開発計画と上記工業クラスターに関して、省の政策履行メカニズムとしてインフラ投資には BT、BOT、BTO 方式を主として運輸、水道、電力、港湾事業に適用する。対象事業は ĐT 830 の拡張、ĐT 824 の拡張部、Long Son – Tan An、Can Đuoc – Chau Thanh、Can Đuoc –Tan Tru、Chau Thanh-Tan Tru、Tan Tru-Thu Thua、Thu Thua-Binh Thanh、Vam Co Tay 河川道路 (Thu Thua-Moc Hoa)、Vam Co Dong 河川道路 (Ben Luc-Đuc Hue)、平行道路 DT 830 (Ben Luc-Đuc Hoa)、Duc Hoa, Can Đuoc, Tan An の給水施設、Can Giuoc, Can Đuoc の発電所、Long An 港などである。

ロンアン省における 2020 年までの工業団地、工業クラスター開発計画を表 2.9 に示す。

表 0.9. 2020 年までのロンアン省における工業団地/工業クラスターの開発計画

No.	工業団地名	場所	2010 年までの承認計画面積 (ha)	追加面積 (ha) (Dispatch 1214/TTg-NN による)	2020 年までのゾーン修正 (ha)	2020 年までに開発される面積 (ha)	注

No.	工業団地名	場所	2010年までの承認計画面積(ha)	追加面積(ha)(Dispatch 1214/TTg-NNによる)	2020年までのゾーン修正(ha)	2020年までに開発される面積(ha)	注
01	Thanh Duc 工業団地	Ben Luc district	266.7		266.7	266.7	
02	My Yen 工業団地	Ben Luc district	132.7		132.7	132.7	
03	Vinh Loc 2 工業団地	Ben Luc district	459.8		459.8	459.8	
04	Khanh Dong 工業団地	Ben Luc district	70		70	70	
05	Luong Hoa, Tan Buu 工業団地	Ben Luc district		415	415	415	MR
06	Tan Phuoc IP	Can Giuoc district	56		56	56	
07	Phuoc Vinh Dong 工業団地	Can Giuoc district	110		110	110	
08	Truong Binh 工業団地	Can Giuoc district	320	70	390	390	
09	Dong Thanh 工業団地	Can Giuoc district	110		110	110	
10	Cau Tram 工業団地	Can Duoc district	100		100	100	
11	Phuoc Dong 工業団地	Can Duoc district	65.16		65.16	65.16	
12	Phuoc Dong MR 工業団地	Can Duoc district	140		140	140	
13	Thuan Dao MR 工業団地	Can Duoc district	879		879	879	MR
14	Caric port 工業団地	Can Duoc district		500	500	500	
15	Thuan Ngia Hoa 工業団地	Thanh Hoa district	250		250	250	
16	Nhon Thanh Trung 工業団地	Tan An city	80	120	200	200	
17	Nhon Thanh Trung MR 工業団地	Tan Tru district		168	168	168	

出典: Planning socio-economic development of Long An Province in 2020.

2.1.5 バリア・ブンタウ省

2.1.5.1. 現状

これまで、バリア・ブンタウ省には 14 の工業団地が建設されており、7 箇所の工業団地が操業している。それらは My Xuan A、My Xuan A2、Phu My I、Phu My II、Cai Mep、 My Xuan B1 – Conac、Dong Xuyen である。工業団地の位置を現状と 2020 年までの計画を含めて図 2.6 に示す。

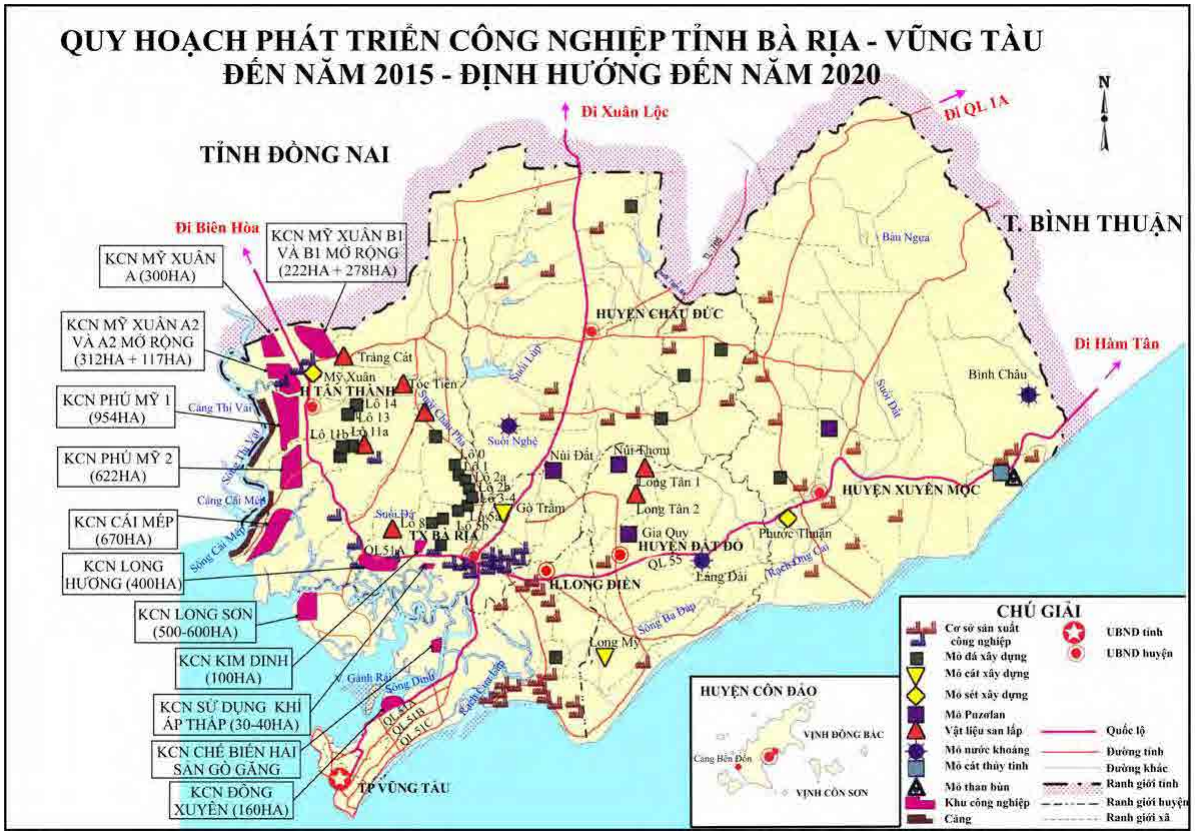

図 0.6. バリア・ブンタウ省の 2020 年までの工業団地開発計画

2.1.5.2. マスタープラン

省の能力を引き上げる事を基本にした主要産業の開発計画は、引き続き石油・ガス探査を強力に推進して採掘量を増やすこと、サービス産業開発や石油産業や石油を原料や燃料として使用する産業の支援、造船産業、工業港湾サービス、船舶運輸サービスの開発である。輸出用及び国内向けの水産加工産業の推進や国内資源を使用した建設資材産業の開発も含まれる。

十分なインフラ整備に焦点をあてて 9 工業団地が効率向上のために建設された。それらは 100ha の面積の Kim Dinh 工業ゾーンと Ba Ria 町のハイテクゾーンにある。工業団地の入居率は 60%以上である。バリア・ブンタウ省が投資する工業団地は Long Huong （400 ha）、Long Son （500 – 600 ha）、ターミナルと石油基地の Ben Dinh （100 ha）である。

バリア・ブンタウ省は中小企業や農水産業の開発、農村経済の開発、雇用創出に資するために工業クラスターや地区や町のハンディクラフト産業の開発に投資する。

天然資源の合理的利用、雇用や環境上の制約を考慮して工業団地や工業クラスターを適正に配置して開発する。

省は工業団地や工業クラスターの開発のために国内外の経済セクターの投資資金を活用し、同時に、技術的なインフラ整備と社会インフラ整備を調整してバランスのとれた開発を行う。

2.2. 2020 年及び 2025 年までの固形産業廃棄物、有害廃棄物、医療系廃棄物の発生量の予測

ホーチミン市及び周辺省での産業廃棄物、有害廃棄物の発生量の予測量を表 2.10 に示す。

表 0.10. 固形産業廃棄物及び医療系廃棄物の 2020 年の発生量予測値

No.	省	非有害廃棄物（トン/日）			有害廃棄物（トン/日）			合計（トン/日）
		ID	HC	計	ID	HC	計	
01	HCM City	5,184.0	34.6	*5,230.1*	908.0	11.5	*908.0*	***6,138.1***
02	Binh Duong	*2,280.0*	*18.8*	*2,298.8*	*456.0*	4.7	*460.7*	***2,759.4***
03	Dong Nai	2,845.9	8.6	*2,854.4*	273.0	2.7	*275.7*	***3,130.1***
04	Long An	1,405.5	8.2	*1,413.7*	306.0	2.7	*308.7*	***1,722.4***
05	BR-VT	3,325.1	5.3	*3,330.4*	1,450.9	1.3	*1,452.2*	***4,782.6***
合計		**15,040.5**	***86.9***	***15,127.4***	***3,393.9***	***11.4***	***3,405.3***	***18,532.7***

注： *ID: 工業活動*
HC: ヘルスケア

このように、省や都市が経済発展することによって産業及び有害廃棄物の発生量は 18,532.7 トン/日と推定される。ホーチミン市は最大の発生地域（6,138.1 トン/日）で、ロンアン省は家庭系及び産業活動に伴う廃棄物の発生量は最低である（1,722.4 トン/日）。

2020 年の産業系及び医療セクターのみから発生する固形廃棄物量は 18,532.7 トン/日で、廃棄物処理や環境問題に対する負荷は少なくはない。

第３章
固形廃棄物焼却事業提案へのアドバイス

3.1. 焼却炉の規模について

3.1.1. 焼却炉の最適規模についてのアドバイス

ホーチミン市及び周辺省で発生する可燃性廃棄物の量を表 3.1 に示す。

表 0.1. ホーチミン市及び周辺省で発生する可燃性廃棄物の量（2013 年)

省	非有害廃棄物（トン/日）				有害廃棄物（トン/日）			合計（トン/日）
	DA	ID	HC	*計*	ID	HC	*計*	
ホーチミン市	740.3	1,247.3	6.8	1,994.3	83.4	2.3	85.7	2,080.0
ビンズン省	284.1	510.6	1.3	796.0	141.1	1.0	142.1	938.1
ドンナイ省	408.3	697.4	1.2	1,106.9	104.3	1.3	105.6	1,212.6
ロンアン省	329.7	359.0	0.1	688.9	170.3	0.46	170.8	859.6
バリア・ブンタウ省	222.6	420.0	0.5	643.1	174.0	0.5	174.5	817.6
合計								**5,907.9**

注: *DA: 都市活動*
ID : 工業活動
HC: ヘルスケア

ホーチミン市及び周辺省で発生した可燃性廃棄物の総量は 5,907.9 トン/日で、ホーチミン市からは 2,080 トン、ビンズン省からは 938.1 トン、ドンナイ省からは 1,212.6 トン、ロンアン省からは 859.6 トン、バリア・ブンタウ省からは 817.6 トン発生した（2013 年）。

それゆえ、事業プロポーザルで選定している 300 トン/日の処理能力は妥当である。

3.1.2. 他の問題とアドバイス

提案しているプロジェクトサイトのロンアン省、Ben Luc 地区、Thuan Dao 工業ゾーンは適切である。しかしながら、ロンアン省の人民委員会及び天然資源環境部から法的な許可を取得する必要がある。

別の候補地としてロンアン省、Thu Thua 地区にある 1,760ha の High-Tech Solid Waste Complex がある。このコンプレックスは 2002 年から 7 億ドルを費やして計画されている。Vietnam Waste Solutions Company が開発事業者である。

3.2. 大型焼却炉の建設費と運転管理費

3.2.1. 焼却施設建設費の推定

3.2.1.1. ベトナムの焼却施設例とコスト

産業廃棄物及び有害廃棄物焼却炉の建設事例には以下のようなものがある:

南ビンズン省の固形廃棄物処理施設の能力 2,000kg/時の固形廃棄物焼却炉（Phu Hoa Chanh Commune, Ben Cat, Binh Duong）；

同上場所での他の焼却施設;

ホーチミン市の有害医療廃棄物焼却炉。建屋と主要設備の建設コストを 1 トン/日に換算した値を表 3.2 に示す。

1 トン/日規模に換算した建設コストは 1,943,365,079 VND であるので、建設コストの推定値は表 3.3 のようになる。

表 0.2. 焼却炉建設費

No	事業名	出費者	処理能力（トン/時）	処理量（トン/日）	総建設費（百万 VND）	単価（百万 VND/トン）
01	Nam Binh Duong Solid Waste Disposal Complex（2,000kg/h 産業廃棄物焼却炉） ビンズン省 Ben Cat District 、 Chanh Phu Hoa commune	BIWASE	2	16	7,300	456.250,
02	Nam Binh Duong Solid Waste Disposal Complex のその他焼却炉	BIWASE	4	32	39,672	1,239.750
03	ホーチミン市医療廃棄物焼却炉	CITENCO		21	86,816	4,134.095
	単価（VND/トン）			**1**		**1,943.365**

表 0.3. 150 トン/日焼却炉の推定総費用

処理能力（トン/日）	単価（VND/トン）	総費用（VND）	総費用（ドル）
150	1,943,365,079	291,504,761,905	13,881,179

このように、処理能力 150 トン/日の産業廃棄物焼却炉の建設費用は 291,504,761,905 VND と推定される。

3.2.1.2. Tsuneishi が提案している産業及び有害廃棄物焼却炉用の廃棄物の平均発熱量の推定

1kg の廃棄物を燃焼したときに発生する熱量（kcal/kg あるいは kJ/kg)は、固形及び液体燃料に対する Mendeleep の公式で計算される。

$$Q\ (kcal/kg) = 81C + 300H - 26\ (O - S) - 6(9A + W)$$

ここに、

+ C、H、O、S、A、W は廃棄物中の炭素、水素、酸素、硫黄、灰分、水分の含有量（重量%）；

+ Cl、F、N の含有量は少ないので発熱量の計算では無視。

Tsuneishi が設計、建設する焼却炉に必要な熱処理量は以下のように決定する:

(3). BIWASE の 2 トン/時規模の産業・有害廃棄物焼却炉

BIWASE の 2 トン/時の焼却炉建設における廃棄物発熱量を表 3.4 に示す。

表 0.4. South Binh Duong 固形廃棄物処理コンプレックスにおける産業・有害廃棄物の発熱量

No.	固形廃棄物	水分（%）	発熱量（kcal/kg）
01	紙	11.8	4,004
02	カートン	12.0	3,894
03	プラスチック	9.2	7,788
04	繊維	13.6	4,194
05	ゴム	9.5	5,563
	混合廃棄物	**11.22**	5,088

このように、BIWASE が計算した廃棄物の平均発熱量は 5,088 kcal/kg である。

(4). ハイフォン市の焼却炉

Mendeleep の公式を用いて廃棄物の化学分析結果から焼却炉に投入される廃棄物の発熱量を計算することができる。廃棄物の化学成分を表 3.5 に示す。

表 0.5. 医療系廃棄物の成分割合

No.	成分	割合（%）	焼却量（kg/時）
01	C	50.85	101.70
02	H	6.71	13.42
03	O	19.50	39.00
04	N	2.75	5.50
05	S	2.71	5.42
06	Cl	15.10	30.2
07	灰分	1.05	2.10
08	水分	1.50	3.00
09	Ca	0.10	0.20
10	P	0.08	0.16
	合計	**100**	**200**

これらによりハイフォン市の医療廃棄物焼却炉に投入される廃棄物の発熱量を計算すると 5,629.61kcal/kg となる。

(5). 廃棄物の種類毎の割合に基づく平均発熱量の計算

ビンズン省の固形産業廃棄物の組成分析結果をベースに、組成毎の発熱量から廃棄物の平均発熱量が計算される。廃棄物の組成毎の平均発熱量と組成分析結果を表 3.6 に示す。

表 0.6. 廃棄物の成分を基に計算した廃棄物の平均発熱量

No.	組成	含有量 (%)	発熱量 (kcal/kg)	廃棄物 1kg 当たりの の発熱量 (kcal)
01	梱包資材、ナイロン	5.28	7,835.2	413.7
02	排水処理汚泥	0.49	500.0	2.4
03	ゴムくず	0.86	6,051.1	51.9
04	段ボール、破砕紙	15.40	3,894.0	599.9
05	皮及び廃棄皮革製品	1.38	4,167.5	57.4
06	木くず、おがくず、削りくず、木製パレット	16.57	2,880.0	477.2
07	廃化学品	0.20	12,166.4	24.6
08	廃プラスチック	0.12	7,788.0	9.0
09	期限切れ品（食品、薬）	2.45	2,220.0	54.5
10	家庭系廃棄物	36.71	2,220.0	815.0
11	グリース	0.24	6,135.4	15.0
12	ボロ布	0.45	9,481.9	42.3
13	廃ガソリン、廃油	0.07	9,255.0	6.5
14	発泡スチロール	6.72	6,000.0	403.3
15	その他	13.06	3,500.0	457.1
合計		100		3,429.7

出典: Integrated Solid Waste Management, 1993.

以上のように平均発熱量は 3,429.7 kcal/kg と計算される。

(6). 提案された焼却炉で焼却される廃棄物の平均発熱量の推定値

平均発熱量は焼却される廃棄物の発生源、発生時間、廃棄物の組成等、廃棄物の成分によって左右される。他の焼却炉での参考値から、本事業の建設に必要な平均発熱量は 3,500～4,500 kcal/kg と推定される。

しかしながら、発熱量を正確に計算するために Tsuneshi は焼却対象の廃棄物成分をサンプリングして、熱処理方法を適用して分析する必要がある。

3.2.1.3. 埋立地建設コストの推定

衛生埋立地の建設単価は既存の 6 箇所の埋立地の例から表 3.7 に示すように推定できる。

表 0.7. 衛生埋立地の建設単価

No	埋立地	建設主体	総埋立量（トン）	総建設費（百万 VND）	建設単価 (VND/トン)

No	埋立地	建設主体	総埋立量（トン）	総建設費（百万 VND）	建設単価 (VND/トン)
01	非有害産業廃棄物（1,000 トン/日）及び家庭系廃棄物（700 トン/日）用衛生埋立地	KBEC VINA Company Limited	1,300,000	274,998.1	211,537
02	21.7ha 産業及び家庭系廃棄物埋立地（Vinh Tan commune, Vinh Cuu District, ドンナイ省）	ドンナイ省 URENCO	2,355,465	392,971.351	166,834
03	ホーチミン市 Tay Bac Cu Chi 固形廃棄物処理場 No2 衛生埋立地	ホーチミン市環境改善事業管理委員会	18,210,000	793,151	43,556
04	ホーチミン市 Phuoc Hiep 衛生埋立地	ホーチミン市 CITENCO	4,464,000	350,000	78,405
05	ホーチミン市 Tay Bac Cu Chi 固形廃棄物処理場 No3 衛生埋立地	ホーチミン市 CITENCO	6,500,000	976,000	150,154
06	バリア・ブンタウ省 Tan Thanh 地区、Toc Tien commune の中央固形廃棄物埋立地	KBEC VINA Company Limited	2,610,000	800,000	306,513
平均建設単価（VND/トン）					**159,500**

表 3.7 より埋立地の平均建設費は 159,500 VND/トンとなる。

灰やスラグを対象とする 1000,000 トン規模の埋立地の建設費は表 3.8 のように推定される。

表 0.8. 100,000 トン規模の灰、スラグ用の衛生埋立地の推定建設費

衛生埋立地規模（トン）	単価(VND/トン)	総費用（VND）	総費用（ドル）
100,000	159,500	15,949,982,949	759,523

計算結果から処理能力 1000,000 トンの焼却灰用の埋立地の平均建設費は 759,523 ドルである。

3.2.1.4. 事業の総建設費の推定

提案された事業の推定総建設費は表 3.9 のようになる。.

表 0.9. 提案事業の総建設費

No	プロジェクト構成要素	総建設費 (VND)	総建設費 (USD)
01	150 トン/日規模焼却炉	291,504,761,905	13,881,179
02	総処理量 100,000 トンの衛生埋立地	15,949,982,949	759,523
総建設費		**307,454,744,854**	**14,640,702**

このように推定されたプロジェクト建設費用は 14,640,702 ドルとなる。

しかしながら、実費用は焼却炉や埋立地の技術、土地取得費、付帯工事費等によって異なる。

3.2.2.提案された焼却炉の運転管理費の推定

3.2.2.1.人件費

全体の人件費は労働者の数とその資格から推定可能である。

人件費の推定に必要な法令等には以下のようなものがる：

– Decree No. 204/2004/ND-CP dated 14 December 2004 of the Government on the wage regime for officers, civil servants, officials and armed forces（役人、公務員、軍人の賃金体系）

– Joint Circular No. 119/2004/TTLT-BTC-TLDLDVN dated 08 December 2004 between the Ministry of Finance and the Vietnam General Labor Confederation guiding the fee’s pay for the labor union（労働組合料金）

– Decision 902/QD-BHXH dated 26 June 2007 of General Director of the Vietnam Social Insurance for management of social insurance, compulsory health insurance and collection（社会保険、義務化健康保険の管理と徴収）

– Decree No. 66/2013/ND-CP dated 27 June 2013 of the Government stipulated the base salary for cadres, civil servants, officials and armed forces（幹部職員、公務員、役人、軍人の基本給）

労働者の賃金を表 3.10 に示す。

表 0.10. 労働者賃金

No	職種/役割	給与/給与係数	基本給 (VND) (*)	諸経費 (19%) (**)	手取り額 (VND/月)	手取り額 (VND/日) (***)
01	主任研究員、准教授、PhD	6.78-8/8	7,797,000	1,481,430	9,278,430	356,863
02	PhD、主任研究者	6.10-6/8	7,015,000	1,332,850	8,347,850	321,071
03	レベル 6 エンジニア/研究員	3.99- 6/9	4,588,500	871,815	5,460,315	210,012
04	レベル 5 エンジニア/研究員	3.66- 5/9	4,209,000	799,710	5,008,710	192,643

No	職種/役割	給与/給与係数	基本給 (VND) (*)	諸経費 (19%) (**)	手取り額 (VND/月)	手取り額 (VND/日) (***)
05	技術スタッフ	3.09-9/12	*3,553,500*	871,815	4,228,665	162,641
06	事務員、秘書	2.79-9/12	*3,208,500*	799,710	3,818,115	146,851

注 :
(*) 基本給: 1,150,000 VND/月 (2013 年 6 月 1 日以降)
(**) 諸経費: 社会保健 (15%) 、健康保険 (2%) 、労働組合金 (2%)
(***) 月労時間 : 26 日

調査結果によると 2014 年時点の労働者の時間外手当を含む平均支給額は 3,728 百万 VND/月となる。

特に、No. 1 から No.4 の労働者支給額は各々、4,358、3,665、3,549、3,153 百万 VND/月となる。

3.2.2.2.提案された事業サイトと電力の状態及び対処法

現在、Ben Luc サブステーションから Long Thuan Dao 道路及び Long Kim 道路沿いの 15 KV- 22 KV の送電線を通じて 110/22 kV - 2 x 25 MVA が Thuan Dao Industrial Zone に電力が供給されている。

3.2.2.3.燃料代と購入支援 (A 及び B 重油、再生油)

政令 (Government Decree) No.84/2009/ND-CP と 2014 年 6 月 23 日付けの公式通知 No. 8328/BTC-QLG に基づく燃料代を表 3.11 に示す。

表 0.11. 燃料価格

No	価格根拠	単位		製品			
				ガソリン 92	DO 0.05S	灯油	FO 3,5S
*	世界価格 (2014 年 6 月 26 日)	ドル/バレル、トン		123.46	123.47	123.11	622.96
01	30 日平均の世界価格 (FOB)	ドル/バレル、トン		120.02	121.19	120.45	617.27
02	海外からベトナムのみとまでの輸送保険料 (IF)	ドル/バレル、トン		2.50	2.50	3.00	30.00
03	30 日平均売値 (Vietcombank 為替交換レート)	VND/ドル		21,260.73			
	売値(銀行組合の交換レート)	VND/ドル		21,036.00			
04	CIF 価格(4=1+2)	ドル/バレル、トン		122.52	123.69	123.45	647.27
	基本 CIF 価格	VND/リットル、kg		16,130	16,358	16,283	13,762
	輸出税及び物品税込みの CIF 価格	VND/リットル、kg		15,960	16,185	16,111	13,616
05	輸入税	割合	%	18%	14%	16%	15%
		量(VND)	VND/リットル、kg	2,873	2,266	2,578	2,042
06	物品税	割合	%	10%			

No	価格根拠	単位		製品			
				ガソリン 92	DO 0.05S	灯油	FO 3,5S
		量(VND)	VND/リットル、kg	1,883			
07	基準コスト	VND/リットル、kg		860	860	860	500
08	利益	VND/リットル、kg		300	300	300	300
09	価格安定基金（Price Stabilization Fund）への支払い	VND/リットル、kg		300	300	300	300
10	環境保護税	VND/リットル、kg		1,000	500	300	300
11	VAT	VND/リットル、kg		2,335	2,058	2,062	1,720
12	基本価格 (12=4+5+6+7+8+9+10+11)	VND/リットル、kg		25,681	22,642	22,683	18,924
13	現行小売り価格 (Petrolimex)	VND/リットル、kg		25,230	22,530	22,540	18,560
14	現行小売り価格と基本価格の差	%		-1,75%	-0,49%	-0,63%	-1,93%
		VND/リットル、kg		-451	-112	-143	-364
15	価格安定基金の利用料	VND/リットル、kg		300	0	0	300

3.2.2.4. ベトナムで購入することができる薬剤、化学薬品の単価

ベトナムでの薬剤、化学薬品の市場価格を表 3.12 に示す。

表 0.12. ベトナムの薬剤、化学薬品の市場価格

No.	化学薬品	単位	単価 (VND/単位)	単価（ドル/単位）
01	硫酸アルミニウム $Al_2(SO_4)_3.18H_2O$ - Al_2O_3 >14,5%	kg	5,100	0.24
02	硫酸第一鉄 $FeSO_4.7H_2O$ 96%	kg	2,800	0.13
03	塩化水素 HCl >30%	kg	2,900	0.14
04	塩化第二鉄 $FeCl_3$ > 80%	kg	25,000	1.18
05	水酸化アンモニウム NH_4OH 20%-25%	kg	4,000-4,700	0.19
06	Superfloc A110	kg	77,000	3.64
07	リン酸ナトリウム $Na_3PO_4.12H_2O$ 96-98%	kg	17,000	0.80
08	ヒドラジン水和物 Hydrazine hydrate 80%	kg	19,000	0.90
09	BP Turbinol X	kg	63,000	3
10	次亜塩素酸ソーダ NaClO 7% - 8%	kg	2,900	0.14
11	塩化ナトリウム NaCl 94-96%	kg	7,500	0.36
12	硫酸アルミニウム Aluminiu $Al_2(SO_4)_3.18H_2O$	kg	7,000	0.35
13	塩素水 99.5%	kg	19,700	0.94
14	PAC $(AlCl_3)n$ / PAC >30%	kg	6,700	0.32
15	硫酸	kg	3,800	0.18
16	ヒドラジン水和物 40%	kg	67,200	3.2

3.3. 企業が保有しなければならない産業廃棄物処分ライセンス及び許可に関する事項

3.3.1.MONRE の有害廃棄物処理ライセンス取得プロセス

3.3.1.1.有害廃棄物処理ライセンス発行に関連する法令

– Law on the Environmental Protection issued at November 29, 2005（環境保護法）

– Government Decree No. 80/2006/ND-CP issued at August 9, 2006 on detailing and guiding the implementation of some articles of the Law on Environmental Protection（環境保護法施行細則及び指針）

– Government Decree No. 59/2007/ND-CP issued at April 9, 2007 on solid waste management（固形廃棄物処理）

– Goverment Decree No. 174/2007/ND-CP issued at November 29, 2007 on environmental protection fees on solid wastes （固形廃棄物の環境保護料金）

– Goverment Decree No. 179/2013/ND-CP issued at November 14, 2013 on the handling of law violations in the field of environmental protection（環境保護分野における違反者の扱い）

– Government Decree No. 21/2008/ND-CP issued at May 02, 2008 on amending and supplementing a number of articles of Government Decree No. 80/2006/ND-CP dated 09 January 08, 2006 on detailing and guiding the implementation of some articles of the Law on environmental Protection（環境保護法施行細則及び指針の改訂と付則）

– Decision No 31/2014/QĐ-TTg of the Prime Minister dated at May 05, 2014 on supporting mechanisms to develop the power generation projects using solid wastes in Vietnam（ベトナムにおける廃棄物発電事業開発のための支援メカニズム）

– Circular No. 12/2011/TT-BTNMT issued at April 14, 2011 of the Ministry of Natural Resources and Environment on regulating the solid waste management（固形廃棄物規則）

3.3.1.2.取得方法

固形廃棄物管理に関する天然資源環境省回状（Circular No. 12/2011/TT-BTNMT issued at April 14, 2011 of the Ministry of Natural Resources and Environment on regulating the solid waste management）の第 17 条から第 24 条参照（Box 1 参照）。

Box 1: 有害廃棄物処理ライセンスの取得と取り消し方法及び関連手順

第 2 章　有害廃棄物管理ライセンスの取得と取り消し方法及び関連手順

第 17 条. 有害廃棄物処理登録

1.有害廃棄物処理を行うために登録する組織、個人は本回状（Circular）の付属資料 2（A 及び B）の様式に従って有害廃棄物処理登録関連書類を作成し、審査用に及び最初の有害廃棄物処理ライセンスを取得するために 2 部を直接あるいは郵便によって本回状第 4 条に示す関係許可当局に提出する。処理の登録を行う組織や個人は登録料金や手数料を支払ってはならない。

2. 有害廃棄物処理登録申請書類の受領

a/ 有害廃棄物処理登録書類の受領後 10 日以内に、許可当局は書類の内容や有効性を検討しなければならない。書類に不備があったり、有効でない場合、登録組織や個人に修正や補足を求めなければならない。

b/ 必要に応じて修正あるいは補足された書類を受領してから 5 日以内に許可当局は不備が

ないかあるいは有効であるかを再度検討しなければならず、必要に応じて修正や補足を依頼するものとする。このようなやりとりは、登録組織や個人が許可当局の要求に満足できない時あるいは十分に満足できない時以外は3回まででなければならない。
c/ 登録書類が完璧で有効ならば、許可当局は通知の必要は無く、登録書類は審査期限が来れば自動的に受領されなければならない。
d/ 許可当局が直近の登録書類の修正や補足を通知してから 6 ヶ月を超えてから書類を受けとる場合は、当局は最初から書類の審査を行わなければならない。

3. 有害廃棄物処理施設の試験操業
a/ 処理登録する組織や個人は、本回状付属資料 2(C)の様式にしたがって有害廃棄物処理施設の試験操業の計画をたて、計画書の 2 部を登録申請書類と同時にあるいは後日許可当局に提出しなければならない。
b/ 最初に提出された試験操業計画の検討期限は計画書を受領してから 10 日である（最初に登録申請書類を提出し、その後に計画書を提出する場合）。また、許可当局からの通知で計画が修正あるいは補足された場合は 5 日である。通知は 2 回まででなければならない。ただし、登録組織、個人が許可当局の要求を不満とするか、十分に満足できない場合はこの限りではない。
c/ 試験操業計画の審査が終了してから 10 日以内に許可当局はこの計画の承認を本回状の付属資料 2（D）の様式に従って書面で通知しなければならない。この中には承認済みの印鑑を押印した計画書 1 部が同封されなければならない。
d/ 許可当局から書面で承認を得てから登録組織や個人は一時的に有害廃棄物を収集し、処理施設の試験操業を行う。許可当局は特別に施設を査察し、試験操業中にコントロール試料をサンプルする。
e/ 試験操業終了後、登録組織や個人は有害廃棄物処理施設の試験操業結果の報告書を本回状付属資料 2（E)の様式に従って作成し、2 部を許可当局に提出しなければならない。書面で承認を受けてから 6 ヶ月を超えてからこの報告書が提出された場合には試験操業を再申請しなければならない。
f/ 有害廃棄物処理施設の試験操業結果の報告書に満足できずあるいは不完全な結果が示された場合には報告書受領後 10 日以内に許可当局は登録組織や個人に対して施設の修理や改造を通知しなければならない。

第 18 条. 有害廃棄物処理ライセンスの付与
1. 許可当局がベトナム環境総局（Environment Administration）の場合、省レベルの天然資源環境部に登録組織や個人の有害廃棄物処理施設が同省に存在し、ライセンスを取得したものであるかどうかについて書面でコメントを要請しなければならない。ライセンスを取得していない場合にはその理由やライセンス付与前に考慮すべき事項などがコメントに含まれる。省レベルの天然資源環境局からのコメントは本回状の第 17 条、3 節、c 項の試験操業の承認前に送付されなければならない。省レベルの天然資源環境部はベトナム環境総局からの要請を受領してから 25 日以内に書面で回答しなければならない。

2. 試験操業の結果が問題ないとした報告書を受領してから 25 日以内に許可当局は操業状況を検討し、最初の有害廃棄物処理ライセンスを本回状の付属資料 2(E)に示した様式を用いて付与する。有害廃棄物処理ライセンスは付与後 3 年間有効である。有害廃棄物処理ライセンスはこの回状の付属資料 6 で特定されるひとつの有害廃棄物処理 ID 番号を有することになる。許可当局によって承認印が押印された 2 部の登録書類が有害廃棄物処理ライセンスオリジナルの 2 部の一部を構成することになる（一部は直接あるいは郵便で有害廃棄物処理業者に渡され、残りの一部は許可当局が保管する)。

3.本条 2 節で記述した操業状態の検討後 25 日以内に必要に応じて許可当局は以下のようなサポート活動を選択しなければならない。

a/ 環境分野、廃棄物処理分野、処理技術の専門家からなる技術相談チームを結成し、有害廃棄物処理ライセンスの付与に関してアドバイスを求める。このチームは許可当局に対して提出された登録書類の検討、操業状態の評価、処理技術、試験試行操業結果、環境影響評価書の内容についてアドバイスと助言を行うほか、報告書や承認決定の際に含めるべきその他事項の必要性や内容についてアドバイスと助言を行う。
b/本節 c 項で定めることに関連して有害廃棄物処理施設や運搬業者の査察を 2 日を限度に行う。
c/ 技術相談チームの会議を登録組織あるいは個人の参加を得て開催し、有害廃棄物処理ライセンスを付与することに際して求める要件や提言に合意するかどうかを議論するなど、不明瞭な点あるいは（もしあれば）満足できない点を明らかにする。
d/ 技術相談チームが結成されない場合は関連当局や組織、個人からコメントを集める。

4. 登録組織、個人が満足な操業状態を実現できない場合あるいは技術相談チーム、関連当局、組織、個人からの要求を満たすことが出来ない場合、許可当局は要求を満足するように登録組織や個人に通知しなければならない。許可当局からの通知に記述された要請事項に応じた報告書を登録組織や個人から受理してから 20 日以内に、許可当局は適正に修正あるいは補足された登録書類と共にそれらを検討し、有害廃棄物処理ライセンスを付与しなければならない。

第 19 条. 有害廃棄物処理ライセンスの延長
1. 有害廃棄物処理ライセンスは、最初のライセンス及び前回更新のライセンスが失効する日から 3 年間、複数回更新できるものとする。ライセンスの更新登録は失効する少なくても 3 ヶ月前に行わなければならない。

2. ライセンスの更新登録のために必要な書類の作成や受領方法は本回状第 17 条、第 1、2 節の方法に従う。

3. 登録書類の審査を終えて 20 日以内に許可当局は本回状付属資料 2(E)に示された様式に従って有害廃棄物処理ライセンスを検討し、更新しなければならない。有害廃棄物処理 ID 番号は変わらない。更新回数は最初のライセンスとその後の更新回数を含む。許可当局の承認印を押印した有害廃棄物処理ライセンス更新登録書類 2 部及び登録に必要な全ての書類、前回の有害廃棄物処理ライセンスが更新された有害廃棄物処理ライセンスオリジナル 2 部の一部を構成することになる（1 部は直接あるいは郵便で有害廃棄物処理業者に渡され、1 部は許可当局に保管される)。

4.本回状第 3 節で示す有害廃棄物処理ライセンスの更新を検討する 20 日の期限内に許可当局は必要に応じて次のようなサポート活動を選択することができる。
a/ 有害廃棄物処理施設や運搬業社の査察を本節の b 項で規定する活動と相まって 2 日以内で行う。
b/ 有害廃棄物処理業者と関連する当局や組織、個人との会議を開き、不明点や満足できない点を直接議論する（もし、あればであるが）。
c/ （ライセンスがベトナム環境総局から発行されている場合）省レベルの天然資源環境部や関係部局、組織、個人から書面でコメントを集める。

5. 有害廃棄物処理業者が問題に直面し、第 II 章で特定した条件を完全に満足できなかったり、本回状第 26 条に規定した責任を全うできなかったり、会議で省レベルの天然資源環境部、関連部局、組織、個人から寄せられた要件を果たすことが出来ない場合、あるいは本条第 4 節で集められたコメントに対して満足な対応ができない場合、許可当局は有害廃棄物処理業者に対して（義務や約束の）履行を求めなければならない。許可当局が求めた通知内容の履行結果の報告を登録書類の修正や補足書類と共に受領してから 15 日以内に、許可当局

は有害廃棄物処理ライセンスを検討し、更新しなければならない。

第 20 条. 有害廃棄物処理ライセンスの変更

1. 有害廃棄物処理ライセンスは以下の場合には変更しなければならない。
a/ 廃棄物処理施設の種類や技術、規模や設計能力、場所あるいは有害廃棄物を扱う特殊車両や設備の数に変更や追加があった場合。
b/ 対象の有害廃棄物の種類や処理量が変わったり、追加があった場合。
c/ 操業場所が移転したり、拡張した場合（ライセンスの操業場所が 2 省あるいはそれ以上にまたがる場合に適用）。
d/ 有害廃棄物処理施設が移設せずに有害廃棄物処理業者が変わる場合、有害廃棄物処理業者が変わらず施設が移設する場合及び全ての特殊車両や設備が変わる場合。
e/ 有害廃棄物処理施設が追加される場合。
f/ 有害廃棄物運搬業者が変わったり、追加される場合。

2. 有害廃棄物処理ライセンスの変更登録と付与プロセスの手順は本回状第 17 条及び第 18 条で述べた最初のライセンス付与の時と同じである。全ての手続きが終了後、許可当局は本回状付属資料 2(E)に示された様式に従って、3 年間の有効期限をもって有害廃棄物処理ライセンスを付与しなければならない。有害廃棄物処理 ID 番号は移設の場合や施設の操業場所が拡張した場合には本回状付属資料 6 に従って変更しなければならない。ライセンス付与回数は 1 回目とそれに続く再付与の回数となる。許可当局による承認印が押印された変更有害廃棄物処理ライセンス登録書類 2 部と前回付与されたライセンス及び全ての登録書類が変更有害廃棄物処理ライセンスのオリジナル 2 部の一部を構成することになる（1 部は直接、または郵便で有害廃棄物処理業者に送られ、他の 1 部は許可当局が保管する）。

3. 本回状第 17 条、3 節の試験操業は以下の場合には必要ない。
a/ 本条第 1 節、c、d、f 項の場合。
b/ 有害廃棄物用の特殊車両や設備、駐車場や一時的な保管場所が追加されたり、有害廃棄物を予備的に処理する場合。
c/ 試験操業するライセンス取得済みの有害廃棄物に性状や処理計画が類似する有害廃棄物が追加される場合。
d/ 試験操業するライセンス取得済みの有害廃棄物の量が増えた時。

4. 許可当局がベトナム環境総局の場合、省レベルの天然資源環境部から書面でコメントを集める必要があるかどうかを検討しなければならない。

5. 有害廃棄物処理ライセンスは変更することは出来ないが、次の場合は本回状第 17 条及び 18 条のもとで初回の登録として再登録しなければならない。
a/ Circular No. 12/2006/TT-BTNMT に基づいてライセンスを取得していて、本回状に基づくライセンスに変更する場合。
b/ 省内で地方の許可当局からライセンスを得て操業していた業者が操業地域を拡張してベトナム環境総局からライセンスを取得する場合。
c/ 2～3 省にまたがる地域を操業地域とし、ベトナム環境総局からライセンスを取得していて、操業地域を 1 省に狭める場合。

有害廃棄物処理ライセンスの再取得手続きに必要な本回状第 17 条、第 3 節にある有害廃棄物処理施設の試験操業では Circular No. 12/2006/TT-BTNMT や本回状の下で行われたこれまでの試験操業で行わなかった項目のみが必要になる。

第 21 条 Circular No. 12/20067TT-BTNMT によって付与された有害廃棄物処理ライセンスの延長承認手続き

1. Circular No. 12/2006/TT-BTNMT に従って付与された有害廃棄物処理ライセンスが失効する少なくても 3 ヶ月前までに、有害廃棄物運搬業者や処理施設所有者は許可当局に、オリジナルライセンスと延長依頼を提出する日までの過去１年間の登録書類に記された事業内容や計画に関する報告書（１部）と共に、ライセンスの延長依頼を書面で 1 部提出しなければならない。

2. ライセンス延長依頼を書面で受け取ってから 20 日以内に、許可当局は内容を検討し、オリジナルの有害廃棄物処理ライセンスの延長承認箇所を認定しなければならない。延長は 2015 年 12 月 31 日を超えてはならない。前環境保護部（Environmental Protection Department）が付与した有害廃棄物処理ライセンスに対してはベトナム環境総局が承認しなければならない。

3. 必要に応じ、本条第 2 項の有害廃棄物処理ライセンスの延長を検討・承認するための期限 20 日以内に、許可当局は以下のような支援活動を選択しなければならない。
a/ 本節第 b 項に規定したこととを併せて 2 日を超えない範囲で事業者の査察を行う。
b/ 有害廃棄物運搬業者や処理施設所有者及び関連当局、組織や個人とで会議を行い、不明点や不十分な点を（もしあれば）直接議論して明らかにする。
c/ 省レベルの天然資源環境部や環境部（許可当局がベトナム環境総局だった場合）及び関連部局、組織、個人から書面でコメントを集める。

4. 有害廃棄物運搬業者や有害廃棄物処理施設所有者が問題に遭遇し、操業状態が満足できる状態ではなく、本回状の第 27 条、28 条に規定された責任を放棄し、あるいは省レベルの天然資源環境部、関連部局、組織、個人が求めた要件に応じられない場合は許可当局は有害廃棄物運搬業者や処理施設所有者にそのような条件や要件を満足するするように通知しなければならない。許可当局の通知に記された要件を満足したことを有害廃棄物運搬業者や処理施設所有者から報告を受けてから 15 日以内に、許可当局は有害廃棄物処理ライセンスの延長を検討し、承認しなければならない。

第 22 条. 有害廃棄物処理ライセンスの取り消し
1. 有害廃棄物処理ライセンスは以下のいずれかの場合取り消さなければならない。
a/政令（Government’s Decree） No. 117/ 2009/ND-CP の第 40 条、41 条、42 条で定義された管轄権者が許可当局に対してライセンスの取り消しを求める書面をその理由を説明した書類や検査記録、査察や調査の記録、検査、査察や調査結果、環境保護に関する違反に対する行政処分の決定、起訴書類や裁判所の判決などと共に送付したとき。
b/ 有害廃棄物処理業者が最初の有害廃棄物処理ライセンスを取得してから 1 年間操業していないとき。
c/ 有害廃棄物運搬業者が全ての有害廃棄物レシートと有害廃棄物処理施設所有者との処理契約を有しているか、あるいは有害廃棄物処理業者が契約を終了して新規契約にサインをしていないか、そして有害廃棄物運搬業者が同時に有害廃棄物処理施設の所有者で、Circular No. 12/ 2006/TT-BTNMT で許可を得ている場合を例外として、そのことを１ヶ月以内に許可当局に報告していないとき。
d/ 有害廃棄物運搬業者が本回状第 II 条、第 2 節、第 3 節で規定されたロードマップに従って操業状態を満足できない時あるいは許可当局に対してこれらの状態を満足すると決めた日から 2 ヶ月以内に許可当局に満足したことを書面で報告しなかったとき。
e/ Circular No. 12/2006/TT-BTNMT で付与された有害廃棄物処理ライセンスを本回状にしたがって１本に切り替えた場合あるいは切り替えない場合は 2016 年 1 月に取り消されなければならない。
f/ 有害廃棄物処理業社、運搬業者、処理施設所有者が有害廃棄物処理の業を終了するとき。

g/省内に操業場所を持つ組織や個人が本回状あるいは Circular No. 12/2006/TT-BTNMT によってベトナム環境総局から操業場所の拡大に伴う別のライセンスを取得する時、地方許可当局は有害廃棄物処理ライセンスを取り消す。
h/操業地域が 2 あるいは 3 以上の省にまたがる有害廃棄物処理ライセンスを所有している業社が本回状によって操業地域を 1 省に狭めた有害廃棄物ライセンスを地方の許可当局から取得した時はベトナム環境総局は（ベトナム環境総局が発行した）ライセンスを取り消す。

2. 許可当局は有害廃棄物処理業者にライセンス取り消しについて、取り消し理由を明確に示し、有害廃棄物処理 ID 番号、ライセンス取り消し決定の日付、取り消しを受ける組織や個人名を明記して取り消しの決定を発行しなければならない。

3. 有害廃棄物処理ライセンスを取り消された組織や個人は有害廃棄物処理を契約していた顧客やパートナーに対してライセンスの取り消しと契約を終了する旨を伝えなければならない。

第 23 条. 天然資源環境省が承認する有害廃棄物処理投資事業の環境影響評価報告書の審査と承認及びこれらの報告書の承認決定に際して求められる要件

1. 許可当局がベトナム環境総局の場合
a/環境影響評価報告書の提出、審査や承認及びこれらの報告書を承認するための決定をする際の要件の要求手続きは（環境保護対策や問題解決のための試験運転や本操業を行う場合を含む）は個別に行われるのではなく、本回状による有害廃棄物処理登録や有害廃棄物処理ライセンスの取得手続きの一部として行われなければならない。
b/ 本回状付属資料 2(E)に示された様式で作成された有害廃棄物処理ライセンスには環境影響評価報告書の内容証明やこれらの報告書を承認する際に要求した要件が含まれていること（環境保護対策や解決のための試験運転や本操業を含む）。
c/ Circular No. 12/2006/TT-BTNMT に基づいてベトナム環境総局が既に発行した有害廃棄物処理・処分ライセンスは環境アセスメント報告書の内容やこれらの報告書の承認決定の際に要求した要件を履行することを承認しているものとする。

2. 許可当局が地方機関の場合
a/ 有害廃棄物処理登録の組織や個人は地方の許可当局に対する有害廃棄物処理登録書類と環境影響評価報告書の内容やこの報告書承認に際して求められた要件を履行すること（環境保護対策の実行や解決策を含む）をベトナム環境総局から承認を受けるための書類を準備しなければならない。
b/ 有害廃棄物処理登録の組織や個人は環境影響評価報告書で提案された環境保護対策や解決策の試験操業を本回状第 17 条、第 3 節で規定された有害廃棄物処理施設の試験操業と統合して行わなければならない。
c/ 地方の許可当局とベトナム環境総局は本節に規定された二つの手続きを同時に行い、別々に有害廃棄物処理ライセンスを付与し、環境影響報告書の内容の履行やこれらの報告書の承認に際して求められた要件を履行することを承認しなければならない。

第 24 条. その他

1. 操業状態の満足度に関する報告と承認
a/ 本回状第 9 条、2 節、項目 b、c、d に示されたロードマップに従った操業状態が満足されているとき、有害廃棄物処理業者、運搬業者、処理施設所有者は許可当局に対してこれらの状態が満たされてから 2 ヶ月以内にその旨を報告しなければならない。
b/ 報告書を受領してから 20 日以内に、許可当局は操業状態の満足度を検討し、承認したことを書面で伝えなければならない。許可当局がこのような承認文書を作成する期限は有害廃棄物運搬業者が許可当局が検討過程で求めた要件（もしもある場合）を全て満足している旨の報告を受けてから 15 日以内とする。

c/ 必要に応じて、許可当局は施設や特殊車両や設備を本節 b 項で規定された 20 日を期限として 2 日間を限度とした査察しなければならない。

2. 許可当局は次の場合有害廃棄物処理業者、運搬車両や処理施設の所有者に操業の変更や一時中止を書面で伝えなければならない。
a/ 契約内容に変更があったり運搬業者が所有していない車両の譲渡契約があったとき、あるいはそのような契約が終了したとき、あるいは延長報告無しに契約期間が終了したとき。
b/ 許可当局が定期的な有害廃棄物管理報告書で示された実際の操業状態や査察、検査あるいは調査の結論、起訴書類や裁判所の判決を拠り所にするとき。

3.3.2. 埋立地設計に必要な法規制

– TCVN 6696:2000 - Solid waste - Sanitary landfill (固形廃棄物 - 衛生埋立地)

– TCXDVN 261:2001 - Solid waste landfill. Design Standard (固形廃棄物埋立地：設計基準)

– Joint Circular 01/2002/BKHCNMT-BXD : Environmental regulations for the siting, construction and operation of solid waste landfill (固形廃棄物の埋立地の立地、建設、運転のための環境規制)

– TCXDVN 261201, 2002 the design standards of solid waste landfills (固形廃棄物埋立地の設計基準)

– TCXDVN 320:2004 - Hazadous waste landfill. Design Standard (有害廃棄物埋立地：設計基準)

– Decision 13/2007/BXD Estimates Norm of collection, transportation and disposal of municipal solid waste (都市固形廃棄物の収集、輸送、処分費の推定基準)

– Estimates Norm of collection, transportation and disposal of solid waste in Hanoi, December 31th, 2008 (ハノイ市における固形廃棄物の収集、輸送、処分費の推定基準、2008 年 12 月 31 日)

– Document No. 2272/BXD-VP dated November 10, 2008 on issued estimating norms of collection, transportation and disposal of municipal waste landfill (収集、輸送、都市廃棄物の埋立処分費の公表推定基準)

– QCXDVN 01: 2008/BXD - National Standards of construction planning (建設計画国家基準)

– QCVN 25:2009/BTNMT - National technical regulations on wastewater solid waste landfills (固形廃棄物埋立地浸出水国家技術規制)

– TCVN 6696:2009 - Solid waste - Sanitary landfill - General requirements on environmental protection (固形廃棄物-衛生埋め立て-環境保護のための一般条件)

– TCVN 6705:2009 - Non-hazardous solid waste - Classification (非有害廃棄物-分類)

– TCVN 6707:2009 - Hazadous waste - Warning Sign (有害廃棄物－警告サイン)

– QCVN 07:2010/BXD - The construction of urban infrastructure (都市インフラストラクチャー建設)

3.3.3. 関連するその他の法規制

– Circular 12/2011/BTNMT August 20, 2011 for practicing procedures for hazardous waste management（有害廃棄物の管理手順）；

– Dispatch No. 2272/BXD-VP on published estimates norm for the collection, transportation and municipal waste landfills（収集、輸送、都市廃棄物の埋立処分費の公表推定基準）；

– Decision No. 31/2014/QD-TTg of the development support mechanisms of power generation projects using solid waste in Vietnam（ベトナムにおける固形廃棄物利用の発電事業の支援メカニズムの開発）；

– Decision No. 3307/QD-UBND June 30, 2011 on issued the interim norms for the solid waste handling activities at Landfill No. 2 - Phuoc Hiep waste treatment complex zone, Cu Chi District（Cu Chi District、Phuoc Hiep 廃棄物処理コンプレックス No.2 埋立地の廃棄物処分の暫定基準）；

– Decision No.13/2007/QD-BXD on promulgating ″the estimate norm of collection, transportation and disposal of municipal waste landfill″（都市廃棄物の収集、輸送及び埋立処分費の推定基準）

3.4.マーケッティング戦略

政府決定（Decision No. 31/2014/QD-TTg dated 5 May, 2014：ベトナムにおける固形廃棄物利用の Waste-to-Energy 事業の支援メカニズム）によると、政府の支援内容は以下のように記述されている。

第 14 条. 廃棄物発電の支援電力価格
１．電力の買い手は廃棄物発電によって作られた全ての電力を以下の価格（VAT 別）で購入する責任がある。

– 廃棄物の直接焼却による発電：2,114 VND/kWh（10.05 米セント/kWh）。

– ごみ埋立地回収ガスの燃焼による発電：1,532 VND/kWh（7.28 米セント/kWh）

2. 本条第 1 項で示した廃棄物利用の発電事業の電力価格には現行の規制による支援価格メカニズムは適用されない。買電価格は VND/USD の為替レートの変動によって調整される。

3. ごみ発電事業での電力購入価格はベトナム電力庁が提案し、当局から承認された年間電力価格の全てのインプットパラメーターを基準にして計算される。

さらに、ごみ焼却処理料金は事業主に支払われるものとする。

事業主は Sonadezi J/S Service Co、Vietnam Waste Solution Co.Ltd、HCM City Urban Environmental Company (Citenco)、Holcim Vietnam Cement Co、Binh Duong Water Supply Sewerage Environment Co 等の廃棄物収集・輸送業者と win-win の原則で協働することができる。

3.5.提案事業の資本分担

ベトナム企業には 300 トン/日規模の廃棄物発電事業の経験はないので、日本側 51%、ベトナム側 49%の資本比率のジョイントベンチャー事業とする方が良い。

関連法によると天然資源環境省はパートナーとして事業には参加できない。

しかし、ホーチミン市やドンナイ省、ビンズン省、バリア・ブンタウ省、ロンアン省等の周辺省の都市環境会社は投資会社になれる。

日本企業のパートナーは、Sonadezi J/S Service Co、Vietnam Waste Solution Co.Ltd、HCM City Urban Environmental Company (Citenco)、Holcim Vietnam Cement Co、Binh Duong Water Supply Sewerage Environment Co 等の主力収集/輸送業者とジョイントベンチャーを形成する事が出来るかも知れない。

第 4 章
結論と提言

4.1. 結論

ホーチミン市及び周辺省（ビンズン省、ドンナイ省、ロンアン省、バリア・ブンタウ省）の廃棄物の発生源を明らかにして廃棄物の発生量を求めた。これらから発生する固形廃棄物量は 16,623.1 トンで、このうち、都市廃棄物は 9,843.4 トン、産業廃棄物及び有害廃棄物は 6,779.7 トンである。

現在、ホーチミン市及び周辺省の廃棄物の処理・処分割合は 78.9%で、21.1% は発生源が郊外に分布すること、金属スクラップが売却されていること、河川や空き地に投棄されていること等から収集されていない。このことは南部経済拠点の廃棄物管理の大きな問題となっている。

現在、ホーチミン市及び 4 周辺省で発生する固形廃棄物は収集後、ほとんどが埋め立てられている（80%）。焼却や固化などの他の方法で処理されるのは 20%である。

ホーチミン市や周辺省の経済開発計画によると、2020 年の産業廃棄物及び有害廃棄物の発生量は 18,532.7 トン/日と予測されている。大量に発生する廃棄物は、もし、廃棄物が依然として埋め立てによって処理し続けられるとすると環境に対して大きな影響を与えることになる。

ベトナム、特にホーチミン市と周辺省の廃棄物問題を見越して、Tsuneishi は 150 トン/日の産業廃棄物及び有害廃棄物焼却炉及び埋め立て容量 100,000 トンの焼却灰の埋立地を建設するために調査を行った。施設建設総費用は 14,640,702 ドルと推定される。

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4.2. 提言

ロンアン省 Ben Luc District に建設される処理能力 150 トン/日の焼却施設にはボイラー用水 300～400 m^3/日が必要となる。この地域は表流水が豊富な地域であり、Vam Co Dong 川を始め、河川や水路が多数流れている。しかし、この地域は潮汐に影響され、表流水の酸度が影響を受ける。それゆえ、適当な深さの地下水を利用すべきである。

水資源を正確に評価することはプロジェクトサイトの決定に重要で、水資源の利用前に水源を調査し、分析することが必要である。

添付資料

添付資料 1: 業務内容

添付資料 2: 企業及び病院からの廃棄物発生量調査結果

添付資料 3: 固形廃棄物収集・処理会社の調査結果

添付資料 4: TSUNEISHI とのパートナー企業の選定

添付資料 5: 固形廃棄物総発生量

3-3 ESTIMATE SHEET
INDUSTRY WASTE INCINERATOR FACLITY 150 TON/DAY

ESTIMATE SHEET

INDUSTRY WASTE INCINERATOR FACILITY
150 TON/DAY

(RK+STOKER)

11 - Sep - 14

(주)에스지이에너지
SGE ENERGY CO., LTD.

CONTENTS

ESTIMATE SHEET

Messrs.

Below is the estimate regarding the making, erection, and service of the specification attached you requested.

(주) 에스지이에너지

SGE Energy Co., ltd.

1527-Ho, Keumkang Penterium IT B Tower,282, Kyung-ki-Do, South Korea. Hak-ui-Ro, Dong-An-Gu, An-yang-City,

TEL +82-31-450-0600 / FAX +82-31-450-0610

http:// www.sgeenergy.com

工 事 名 Project Name	:	Incinerator(RK+STOKER) making, installation construction
納 期 Delivery	:	Within 12 months after contract(consultation)
引 導 場 所 Site	:	KOREA PORT (But, insite installation construction included.)
支 佛 方 法 Payment Method	:	Down payment 30%, Middle payment 60%, Balance 10%
見積有效期間 Validity	:	Within 30 days from estimate date

見 積 番 號 Estimate No.	:	SGE-2014-004-01
見 積 日 Estimate Date	:	11-Sep.-2014
擔 當 者 Prep'd By	:	Young woon-Kim, Deputy head

合 計 金 額 Amount Total : 金壹百四拾億四阡九百四拾萬원整 (₩14,049,400,000)-(V.A.T 別途)-

番號 No	品 名 Description	規 格 Standard	單 位 Unit	數 量 Q'ty	單 價 Price	金 額 Amount	備 考 Remarks
	<SUPER HEATER STEAM>						
1	WASTE CRANE	2㎥	LOT	1		220,000,000	
2	INCINERATOR	150ton/day	LOT	1		2,749,000,000	
3	WASTE HEAT BOILER	26ton/hr	LOT	1		2,926,300,000	
4	FLUE GAS TREATMENT FACILITY		LOT	1		1,453,868,000	
5	FAN & STACK		LOT	1		341,000,000	
6	AIR SUPPLY FACILITY		LOT	1		124,600,000	
7	AUXILIARY BURNER FACILITY		LOT	1		79,000,000	
8	DUCT		LOT	1		105,000,000	
9	PIPING		LOT	1		160,000,000	
10	INSULATION		LOT	1		220,000,000	
11	PAINT		LOT	1		45,000,000	
12	TMS SYSTEM		LOT	1		200,000,000	
13	2'ND ELECTRIC & INSTRUMENT		LOT	1		560,000,000	
14	CORPORATE PROFIT		LOT	1		716,232,000	
15	< CONDENSING TURBINE SYSTEM >					4,149,400,000	
	Amount Total					**₩ 14,049,400,000**	

特記事項

*** Out of scope ***

1. Items not on the estimate, excluded
2. Civil work, Construction work, excluded.
3. 1'st Electric & Power substation & water, excluded.
4. Test-runnning UTILITY(Chemicals, fuel, electrictiy, water etc.) excluded
5. Conection work to National grid (1m)
6. Electricity supply during the construction, excluded.(Supplied by the ordering party)
7. Licensing excluded. (But, document and task support included.)
8. Value added tax(VAT), excluded.
9. Package, Transportation, excluded(KOREA PORT)

內 譯 書

NO	EQUIPMENT	DESCREPTION	UNIT	Q'TY	U/PRICE	AMOUNT	REMARK
1	**INSERTING SYSTEM**						
1-1	OVER HEAD CRANE	2㎥	SET	1		220,000,000	
	TOTAL					**₩ 220,000,000**	
2	**WASTE COMBUSTION FURNACE**	150 ton/day, HL 4,500kcal/kg					
2-1	FEEDING FACILITY						
	FEEDING HOPPER		LOT	1		25,000,000	
	SLIDING CHUTE		LOT	1		20,000,000	
	RAM PUSHER		LOT	1		35,000,000	
	STRUCTURE & WALK WAY		LOT	1		42,000,000	
	KILN FRONT WALL	¢ 4,736 x 550H	LOT	1		52,000,000	
2-2	ROTARY KILN FURNACE	3.45 ton/hr					
	BODY	¢ 3,500(I.D) x 10,000L	LOT	1		310,000,000	
	RING TIRE	¢ 4,858 x 380W	SET	2		85,000,000	
	GIRTH GEAR	¢ 5,320 x 200W	SET	1		55,000,000	
	PNION GEAR	¢ 620 x 290W	SET	1		20,000,000	
	SUPPORT ROLLER etc.		LOT	1		150,000,000	
	DRIVING MOTOR	CYCLO MOTOR	LOT	1		27,000,000	
	REDUCER	gears of transmission	LOT	1		40,000,000	
	WATER STORAGE TANK	30㎥	LOT	1		25,000,000	
	WATER PUMP	3㎥ /HR x 50mh	SET	2		3,000,000	
	KILN REFRACTORY	100㎥	LOT	1		290,000,000	
2-3	STOKER FURNACE	2.8 ton/hr					
	1st FURNACE	100㎥	LOT	1		460,000,000	
	2'ND FURANCE	200㎥	LOT	1		220,000,000	
	REFRACTORY	300㎥	LOT	1		550,000,000	
	MOVING GRATE	18㎡	LOT	1		95,000,000	
	HYDRO UNIT	160ℓ/min	LOT	1		45,000,000	
	ASH HOPPER		LOT	1		10,000,000	
	FLY ASH HOPPER		LOT	1		10,000,000	
2-4	BOTTOM ASH TREATMENT SYSTEM						
	FLOW CONVEYOR		SET	2		38,000,000	
	APRON CONVEYOR		SET	1		80,000,000	
	BELT CONVEYOR		SET	1		24,000,000	
	MAGNETIC SEPARATOR		SET	1		38,000,000	
	TOTAL					**₩ 2,749,000,000**	
3	**WASTE HEAT BOILER - 35k/30k, Evaporation 26ton/hr(360℃), RAW WATER TEMPERATURE 50℃**						
3-1	2nd FURNACE & BOILER	2-DRUM, 22ton(acctual using steam)					
3-2	BODY	oper 30kg/㎠.g	LOT	1		1,250,000,000	

內　譯　書

NO	EQUIPMENT	DESCREPTION	UNIT	Q'TY	U/PRICE	AMOUNT	REMARK
3-3	ECONOMIZER		LOT	1		145,000,000	
3-4	SUPER-HEATER		LOT	1		240,000,000	
3-5	DE-SUPER HEATER		LOT	1		22,000,000	
3-6	STRUCTURE & WALK WAY		LOT	1		150,000,000	
3-7	REFRACTORY		LOT	1		60,000,000	
3-8	SOOT BLOWER	LONG TYPE	SET	4	11,000,000	44,000,000	
3-9	SOOT BLOWER	FIXED TYPE	SET	6	6,000,000	36,000,000	
3-10	PANLE		LOT	1		18,000,000	
3-11	RING BLOWER	5㎥/HR×2500mmAq	SET	2	900,000	1,800,000	
3-12	ROTARY VALVE	400SQ x 540H	SET	2	3,500,000	7,000,000	
3-13	FLOW CONVEYOR	1ton/hr	SET	1		25,000,000	
3-14	DUST BOX		SET	1		3,500,000	
3-15	WATER TANK	40㎥	SET	1		40,000,000	
3-16	BOILER FEED WATER PUMP	30㎥/hr x 390mH	SET	2	36,000,000	72,000,000	
3-17	DEAERATOR FEED WATER PUMP	30㎥/hr x 70mH	SET	2	6,000,000	12,000,000	
3-18	DEAERATOR	30㎥/hr	SET	1		65,000,000	
3-19	CHEMICAL SYSTEM		LOT	1		18,000,000	
3-20	STEAM HEADER		LOT	1		12,000,000	
3-21	STEAM SILENCER		LOT	1		22,000,000	
3-22	BLOW DOWN TANK	1㎥	LOT	1		4,000,000	
3-23	BLOW DOWN EXCHANGER		LOT	1		15,000,000	
3-24	3-ELEMENT DRUM L/C		LOT	1		45,000,000	
3-25	DEAERATOR CONTROL SYSTEM		LOT	1		24,000,000	
3-26	DE-SUPER HEATER CONTROL SYSTEM		LOT	1		15,000,000	
3-27	TOP BLOW DOWN SYSTEM		LOT	1		15,000,000	
3-28	BOTTOM BLOW DOWN SYSTEM		LOT	2		10,000,000	
3-29	STEAM VENT SYSTEM		LOT	1		25,000,000	
3-30	LEVEL LOWER ALRAM		LOT	1		4,000,000	
3-31	PIPING		LOT	1		160,000,000	
3-32	INSULATION		LOT	1		66,000,000	
3-33	ERECTION AND INSTALLATION		LOT	1		300,000,000	
	TOTAL					**₩ 2,926,300,000**	
4	**FLUE GAS TREATMENT FACILITY**	62,520 Sm³/hr					
4-1	SNCR	(SELECTIVE NON-CATALYTIC REDUCTION)					
	UREA STORAGE TANK	20㎥	LOT	1		25,000,000	SUS304
	UREA DILUTION WATER TANK	5㎥	LOT	1		10,000,000	FRP
	UREA SPRAY PUMP	110L/Hr x 70mH	SET	2	4,000,000	8,000,000	
	SPRAY NOZZLE	200ℓ/hr	SET	4	2,000,000	8,000,000	

內　譯　書

NO	EQUIPMENT	DESCREPTION	UNIT	Q'TY	U/PRICE	AMOUNT	REMARK
	MIXER	5ℓ	SET	1		2,000,000	SUS304
	UREA DILUTION WATER PUMP	1.5㎥/Hr x 70mH	SET	2	1,200,000	2,400,000	
	CONTROL VALVE	32A	SET	1		2,500,000	
	AIR REDUCING VALVE	40A	SET	1		800,000	
	PURGE BLOWER	1.4㎥/HR x 1500mmAq	SET	1		1,000,000	
	PIPING		LOT	1		30,000,000	
	SUB-T0TAL					**89,700,000**	
4-2	SEMI DRY REACTOR	Ø5120					
	CASING	1,042N㎥/min	LOT	1		230,000,000	SS400
	STRUCTURE & WALK WAY		LOT	1		75,000,000	
	SLIDE GATE	600A × 150H	SET	2	3,500,000	7,000,000	
	VIBRATOR	0.2kW	SET	4	300,000	1,200,000	
	SPRAY NOZZLE	500L/hr	SET	4	4,000,000	16,000,000	
	LIME SLURRY STORAGE TANK	35㎥	SET	1		30,000,000	
	AGITATOR	Φ1300×5.5kw	LOT	1		13,500,000	
	LIME FEED PUMP	6㎥/hr x 30mH	SET	2	4,000,000	8,000,000	
	LIME SPRAY PUMP	1.3㎥/hr x 80mH	SET	2		12,000,000	
	MIXING TANK	5㎥	SET	1		11,000,000	
	AGITATOR	Ø550×3.7KW	SET	1		4,000,000	
	PURGE BLOWER	27㎥/min x 300mmAq	SET	1		1,000,000	
	PENT HOUSE					out of scope	
	SUB-T0TAL					**408,700,000**	
4-3	DRY VENTURI DUCT						
	CASING	1042N㎥/min	LOT	1		7,000,000	
	SUB-T0TAL					**7,000,000**	
4-4	LIME SILO						
	CASING	35㎥	LOT	1		22,000,000	
	STRUCTURE & WALK WAY		LOT	1		50,000,000	
	AIR KNOCKER	AK80	SET	2	450,000	900,000	
	AREA PAD		SET	6	150,000	900,000	
	SHUT OFF GATE	200A	SET	1	500,000	500,000	
	METERING FEEDER	0 ~ 300kg/Hr	SET	1	5,000,000	5,000,000	
	BAGFILTER for VENT	10㎥/min	SET	1	2,500,000	2,500,000	
	SUB-T0TAL					**81,800,000**	
4-5	ACTIVATED CARBON SILO						
	CASING	5㎥	LOT	1		8,000,000	
	STRUCTURE & WALK WAY		LOT	1		28,000,000	
	AIR KNOCKER	AK60	SET	2	350,000	700,000	
	SHUT OFF GATE	150A	SET	1	500,000	500,000	
	METERING FEEDER	0 ~ 20kg/Hr	SET	1	5,000,000	5,000,000	
	MONO RAIL HOIST	1TON	SET	1		8,000,000	

內　譯　書

NO	EQUIPMENT	DESCREPTION	UNIT	Q'TY	U/PRICE	AMOUNT	REMARK
	SUB-T0TAL					**50,200,000**	
4-6	BAG FILTER	15*14*6CHAMBER, ACR 0.6m/min					
	CASING	1042N㎥/min	LOT	1		450,000,000	
	STRUCTURE & WALK WAY		LOT	1		110,000,000	
	IN-LET DAMPER	Φ600 x 350H	SET	6	2,500,000	15,000,000	
	POPET DAMPER	Φ600 x 350H	SET	6	4,000,000	24,000,000	
	ROTARY VALVE	400SQ x 400H	SET	2	3,000,000	6,000,000	
	FLOW CONVEYOR	1 TON	SET	2	20,000,000	40,000,000	
	AIR KNOCKER	AK80	SET	12	450,000	5,400,000	
	FILTER BAG	Φ156 x 4,100L	EA	1260	85,000	107,100,000	
	BAG CAGE	Φ156 x 4,100L	EA	1260	34,000	42,840,000	
	VENTURI	Φ152	EA	1260	3,800	4,788,000	
	DIAPHRAGM VALVE	CA-50A	EA	90	110,000	9,900,000	
	TIMER KIT	15POINT	EA	6	240,000	1,440,000	
	PENT HOUSE		LOT	1		out of scope	
	SUB-T0TAL					**816,468,000**	
	TOTAL					**₩ 1,453,868,000**	
5	**FAN & STACK**						
5-1	I.D FAN	2200CMMx600mmAq×320kw	LOT	1		74,000,000	
5-2	KILN COOLING FAN	150CMMx700mmAq×22kw	SET	1		11,000,000	
5-3	1st F.D FAN(RK)	450CMMx400mmAq×52.5kw	SET	1	16,000,000	16,000,000	
5-4	2nd F.D FAN	300CMMx300mmAq×30kw	SET	1	14,000,000	14,000,000	
5-5	3rd F.D FAN	150CMMx300mmAq×15kw	SET	1	12,000,000	12,000,000	
5-6	4th F.D FAN	350CMMx330mmAq×37.5kw	SET	1	14,000,000	14,000,000	
5-7	STACK	Ø2000×30mH	LOT	1		130,000,000	
	STRUCTURE & WALK WAY		LOT	1		70,000,000	
	TOTAL					**₩ 341,000,000**	
6	**AIR SUPPLY FACILITY**	200HP					
6-1	AIR COMPRESSOR	28.3㎥/min	SET	2	39,000,000	78,000,000	
6-2	AIR RECEIVE TANK	5㎥	SET	2		22,000,000	
6-3	AFTER COOLER	32㎥/min	SET	1		3,000,000	
6-4	AIR DRYER	29㎥/min	SET	1		8,500,000	
6-5	PRE - FILTER	75㎥/min	SET	1		1,500,000	
6-7	LINE - FILTER	72㎥/min	SET	1		1,800,000	
6-8	COALESCENT - FILTER	42㎥/min	SET	1		1,800,000	
6-9	HOOD DUCT		LOT	1		8,000,000	
	TOTAL					**₩ 124,600,000**	

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NO	EQUIPMENT	DESCREPTION	UNIT	Q'TY	U/PRICE	AMOUNT	REMARK
7	**AUXILIARY BURNER FACILITY**						
7-1	OIL BURNER	3,000,000 kcal/hr	SET	1	20,000,000	20,000,000	
7-2	OIL BURNER	4,500,000 kcal/hr	SET	1	22,000,000	22,000,000	
7-2	OIL BURNER AUTO REMOVAL	RAIL	SET	2	4,000,000	8,000,000	
7-3	CONTROL PANEL		SET	2	6,500,000	13,000,000	
7-4	OIL PUMP UNIT	1600L/hr	SET	2	4,000,000	8,000,000	
7-5	OIL TANK	5㎥	LOT	1		8,000,000	
	TOTAL					**₩ 79,000,000**	
8	**DUCT**	SS400	**LOT**	**1**		**₩ 105,000,000**	
9	**PIPING**		**LOT**	**1**		**₩ 160,000,000**	
10	**INSULATION**	ROCK WOOL 100/75/50t	**LOT**	**1**		**₩ 220,000,000**	
11	**PAINT**	SA #21/2, ZINC PRIMER	**LOT**	**1**		**₩ 45,000,000**	
12	**TMS SYSTEM**		**LOT**	**1**		**₩ 200,000,000**	
13	**2'ND ELECTRIC & INSTRUMENT**	PLC SYSTEM	**LOT**	**1**		**₩ 560,000,000**	
14	**CORPORATE PROFIT**		**%**	**8**		**₩ 716,232,000**	
	TOTAL					**₩ 9,900,000,000**	
	< CONDENSING TURBINE SYSTEM >	make : INDIA					
	STEAM TURBINE	4.5MWh(acctual 4MWh)	SET	1		1,572,900,000	
	GENERATOR	1800rpm, 6.6kv	SET	1		350,000,000	
	GENERATOR PANEL	GCP, VCB, NGR	SET	1		190,000,000	
	CONDENSER	13,000,000kcal/hr, -0.9kg/㎠.g	SET	1		551,250,000	
	COOLING TOWER	3200RT	SET	1		350,000,000	
	Reverse Osmotic Water Facility	4t/h	LOT	1		150,000,000	
	HMI SYSTEM		LOT	1		40,000,000	
	POWER SUBSTATION EQUIPMENT	TR, VCB, MOF etc.	LOT	1		out of scope	
	STEAM SEPARATOR & STRAINER	200A	LOT	1		20,000,000	
	PIPING & INSULATION		LOT	1		300,000,000	
	ERECTION AND INSTALLATION		LOT	1		115,000,000	
	PERMISSION & INSPECTION		LOT	1		10,000,000	
	DESIGN COST		LOT	1		40,000,000	

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NO	EQUIPMENT	DESCREPTION	UNIT	Q'TY	U/PRICE	AMOUNT	REMARK
	TURBINE SPARE PARTS	2 YEAR	LOT	1		110,250,000	
	GENERAL ADMINISTRATIVE COSTS		LOT	1		200,000,000	
	CORPORATE PROFIT		LOT	1		150,000,000	
	TOTAL					**₩ 4,149,400,000**	

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
1	投入設備					
	OHC -	OVER HEAD CRANE	1. TYPE : 2 GRIDER 1TROLLEY		LOT 1	
			2. BUCKET CAPACITY : 1.5 ㎥ (0.3 ton/㎥)			
			3. RATED LOAD : 1.05 TON			
			4. LIFT : 16.5 m 基準			
			5. SPAN : 18 m 基準			
			6. TRAVEL LENGTH : 36 m 基準			
			7. SPEED & MOTOR : HOISTING(巻上) - 30 m/min	30.0 kw ,6P, 380V	SET 1	
			TREVERSING(横行) 30 m/min	0.75 kw ,4P, 380V	SET 2	
			TRAVELLING(主行) 30 m/min	1.5 kw ,4P, 380V	SET 2	
			BUCKET -	15.0 kw ,4P, 380V	SET 1	
2	燃焼設備					
	INC -	INCINERATOR	1. TYPE : ROTARY KILN + MOVING GRATE STOKER		LOT 1	
			2. CAPACITY : 6.3 ton/hr			

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			3. 低位発熱量 : 4009 kcal/kg			
	INC -	ROTARY KILN	1. TYPE : ROTARY KILN		LOT 1	
			2. CAPACITY : 3.4 ton/hr			
			3. R/K SIZE : 3,500 Ø × 10000 L			
			4. R/K 容積 : 95 ㎥			
			5. 火炉熱負荷率 : 180000 kcal/㎥hr			
			6. R/K INCLINE : 29/100			
			7. OPERATION TEM'P : 1,020 ℃			
			8. MATERIAL : SM490A + 耐火物			
		RING TIRE	1. TYPE : RING TIRE		LOT 2	
			2. CAPACITY : 4858 Ø(O.D) × 346/380 W			
			3. HARDNESS : 230 Hb 以上			
			4. MATERIAL : SCM - 440			
		GIRTH GEAR	1. TYPE : INVOLUTE-SPUR		LOT 1	
			2. MODULE : M20			
			3. PRESSURE ANGLE : 20 度			
			4. NO. OF TOOTH : 266 NT			
			5. PCD : 5320 Ø			
			6. WIDE OF TOOTH : 200			

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			7. HARDNESS : 190 Hb 以上			
			8. MATERIAL : SCMn-2A			
		PNION GEAR	1. TYPE : INVOLUTE-SPUR		LOT 1	
			2. MODULE : M20			
			3. PRESSURE ANGLE : 20 度			
			4. NO. OF TOOTH : 31 NT			
			5. PCD : 620 Ø			
			6. WIDE OF TOOTH : 290			
			7. HARDNESS : 230 Hb 以上			
			8. MATERIAL : SCM-440			
		SUPPORT ROLLER	1. TYPE : 910 Ø(O.D) × 430 W		LOT 4	
			2. HARDNESS : 230 Hb 이상			
			3. MATERIAL : SC49			
		THRUST ROLLER	1. SIZE : 450 Ø(O.D) × 300 H		LOT 4	
			2. BEARING : 23032, 23038			
			3. MATERIAL : S45C			
		DRIVING MOTOR	1. TYPE : CYCLO MOTOR(無断変速)	22 kw ,4P, 380V	LOT 1	
			2. MODEL : BHHM20A			
			3. SPEED : 335-1340 RPM			
			4. MAKER : SUMITOMO			

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT	Q'TY	備考
		REDUCER	1. TYPE : キアー変速		LOT	1	
			2. MODEL : PX 8075-R4-LL-30				
			3. MAKER : SUMITOMO				
		WATER STORAGE TANK	1. TYPE : 垂直円筒形		SET	1	
			2. CAPACITY : 30 ㎥				
			3. SIZE : 3000 Φ × 4246				
			4. MATERIAL : SS400 6T				
			5. 付属物 : LEVEL GAUGE				
			LADDER & HANDRAIL				
			MANHOLE				
		R/K COOLING FAN	1. TYPE : TURBO BLOWER	22 kw 380V	SET	1	
			2. CAPACITY : 150 ㎥/min × 700 mmAq				
			3. MATERIAL : CASING - SS400				
			IMPELLA - SS400				
			SHAFT - S45C				
		WATER PUMP	1. TYPE : 立型多段式	1.1 kw ,4P, 380V	SET	2	
			2. CAPACITY : 3 ㎥/hr × 50 m.H				
	FD -	1'ST F.D FAN (R/K)	1. TYPE : TURBO BLOWER	52.5 kw 380V	SET	1	VVV-F
			2. CAPACITY : 450 ㎥/min × 400 mmAq				
			3. MATERIAL : CASING - SS400				

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			IMPELLA - SS400, SHAFT - S45C			
	BU -	1'st BURNER	1. TYPE : 炉付着型	7.5 KW 380V	LOT 1	
			2. CAPACITY : 2,500,000 kcal/hr			
			3. FUEL : LNG			
			4. CONTROL METHOD : 比例制御			
			5. ACCESSORY : コントロールパンネル, バーナー着脱装置(自動レール, 自動シャッター)			
	INC -	STOKER	1. TYPE : MOVING GRATE STOKER		LOT 1	
			2. CAPACITY : 2.8 ton/hr			
			3. 低位発熱量 : 4009 kcal/kg			
			4. 火上面積 : 18 ㎡			
			5. 1次燃焼室の容積 : 100 ㎥			
			6. 火上負荷率 : 180 kg/㎡.hr			
			7. 火炉熱負荷率 : 150000 kcal/㎥hr			
			8. FLOW RATE : 59,067 Nm³/hr			
			9. OUTLET TEMP. : 1,020 ℃			
			10. MATERIAL : SS400 6t + 耐火物, H-200 x 200 x 9/14t			
	BU -	2nd BURNER	1. TYPE : Gun Type (送風機一体型)	7.5 KW 380V	LOT 1	
			2. CAPACITY : 4,500,000 kcal/hr			
			3. FUEL : LNG			
			4. CONTROL METHOD : 比例制御			

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			5. ACCESSORY : コントロールパンネル, バーナー着脱装置(自動レール, 自動シャッター)			
	HU -	HYDRO UNIT	1. CAPACITY : 70 ℓ/min, 110 ℓ/min,		LOT 1	
			2. PUMP : VENE PUMP	40.0 kw 380V	SET 2	
			3. TANK CAPACITY : 1000 LIT			
			4. DESIGN PRESS : MAX 140 kg/㎠			
			OPER 80 kg/㎠			
			5. ACCESSORY : FAN OIL COOLER	1.5 kw 380V	SET 1	
			: HEATER	5 kw 380V	SET 1	
			: HYDRO CYCLINDER			
			- 1'ST GATE Ø80 × 1400 ST		EA 1	
			- 2'ND GATE Ø80 × 1400 ST		EA 1	
			- RAM PUSHER Ø125 × 1600 ST		EA 1	
			- GRATE Ø140 × 260 ST		EA 3	
	FD -	2'ND F.D FAN (STOKER)	1. TYPE : TURBO BLOWER	30.0 kw 380V	SET 1	VVV-F
			2. CAPACITY : 300 ㎥/min × 300 mmAq			
			3. MATERIAL : CASING - SS400			
			IMPELLA - SS400, SHAFT - S45C			
	FD -	3'RD F.D FAN (STOKER)	1. TYPE : TURBO BLOWER	15.0 kw 380V	SET 1	VVV-F
			2. CAPACITY : 150 ㎥/min × 300 mmAq			
			3. MATERIAL : CASING - SS400			
			IMPELLA - SS400, SHAFT - S45C			

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT	Q'TY	備考
	FD -	4'TH F.D FAN (STOKER)	1. TYPE : TURBO BLOWER	37.5 kw 380V	SET	1	VVV-F
			2. CAPACITY : 350 ㎥/min × 350 mmAq				
			3. MATERIAL : CASING - SS400				
			IMPELLA - SS400, SHAFT - S45C				
		REFRACTORY	1. ROTARY KILN : CASTING BLOCK 施工				
			2. STOKER燃焼室 : FIRE BRICK - 230t 施工		LOT	1	
			: INSULATION BRICK - 114t 施工 (B-5)				
			: SILICA BORAD - 100t				
			3. CASTABLE : CRESTO - 75t 施工		LOT	1	
			: CRESTO -60 施工				
			: KOSACAST -60S 施工				
			: SUPPORT - SUS 304 9t				
		GRATE & SCRAPER	1. MOVING GRATE : SIZE 295W × 510L × 120H		SET	100	예비품 10EA
			: MATERIAL SCH 22種 or 同等品				
			2. FIXING GRATE : SIZE 295W × 510L × 120H		SET	90	
			: MATERIAL SCH 22種 or 同等品				
			3. SCRAPER : SIZE 295W × 120L × 13t		SET	30	
			: MATERIAL SCH 13種 or 同等品				

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
3	再処理設備					
	FC - 106A/B	FLOW CONVEYOR	1. TYPE : FLOW CON'V	2.2 kw 380V	SET 2	減速比 1/120
			2. CAPACITY : 1.0 ton/hr			
			3. SPEED : 4.36 m/min			
			4. MATERIAL : SS400 × S45C			
			5. SIZE : 300 W × 8400 L			
	AC - 107	APRON CONVEYOR	1. TYPE : APRON TYPE	3.75 kw 380V	SET 1	減速比 1/120
			2. CAPACITY : 1.0 ton/hr			
			3. SPEED : 1.78 m/min			
			4. MATERIAL : SS400			
			5. SIZE : 1200 W × 9000 L × 1600 H			
	BC - 108	BELT CONVEYOR	1. TYPE : BELT TYPE	1.5 kw 380V	SET 1	減速比 1/90
			2. CAPACITY : 1.0 ton/hr			
			3. SPEED : 11.0 m/min			
			4. MATERIAL : SS400			
			5. SIZE : 900 W × 9400 L × 2000 H			
	MS - 109	MAGNETIS SEPARATOR	1. TYPE : ELECTRO MAGNETIC		LOT 1	
			2. SIZE : 1140 W × 2620 L × 925 H			
			3. 電磁石 :	4.5 kw ,4P, 220V	SET 1	
			4. モーター :	2.2 kw ,4P, 380V	SET 1	減速比 1/30
4	燃焼カス冷却設備					
	BL - 201	2nd FURNACE & BOILER	1. TYPE : 水管式 2-DRUM		LOT 1	

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			2. GAS VOL.IN : 59,067 Nm³/Hr			
			3. INLET TEMP. : 1,020 ℃ ± 50			
			4. OUTLET EMP. : 300 ℃ ± 20			
			5. DESIGN CAPACITY : 26 ton/hr (利用可能量 22 ton/hr)			
			6. DESIGN PRESS : 35 Kg/㎠			
			7. OPERATING PRESS : 30 Kg/㎠			
			8. WATER TEMP. : 165.6 ℃			
		ECONOMIZER	1. TYPE : SHELL TUBE		LOT 1	
			2. GAS TEMP : 300 ℃ → 230 ℃			
			3. WATER TEMP : 130 ℃ → 171.7 ℃			
			4. MATERIAL : STBH 340-E			
	SB - 206A/D	SOOT BLOWER	1. TYPE : LONG RETRACTABLE	1.1 kw 380V	SET 3	
			2. MATERIAL : A216WCB+STS304			
			3. MAKER : DIAMOND POWER (CHINA)			
	SB - 206E/F	SOOT BLOWER	1. TYPE : FIXED ROTATING	0.4 kw 380V	SET 8	
			2. MATERIAL : A216WCB+STS304			
			3. MAKER : DIAMOND POWER (CHINA)			
	PF - 212	PURGE FAN	1. TYPE : RING BLOWER	2.2 kw 380V	SET 2	
			2. MATERIAL : 5 m³/hr × 2000 mmAq			
	RV - 202A/B	ROTARY VALVE	1. TYPE : MULTI BLADE	1.5 kw ,4P, 380V	SET 3	減速比 1/30
			2. SIZE : ㅁ400 x 400H			
			3. MATERIAL : BODY - GC 200, BLADE - STS304			

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	FC - 203	FLOW CONVEYOR	1. TYPE : FLOW CHAIN TYPE	3.7 kw ,4P, 380V	SET	1	減速比 1/120
			2. CAPACITY : 1.5 ton/hr				
			3. MATERIAL : SS400				
		DEAERATOR	1. TYPE : 円筒立型式		LOT	1	
			2. CAPACITY : 30 ㎥/hr				
			3. DESIGN PRESS : 5 kg/㎠.g				
			4. OPERATING PRESS : 2 kg/㎠.g				
			5. STEAM INLET TEMP : 360 ℃ (at 3 kg/㎠)				
			6. WATER TEMP : 50 ℃ → 130 ℃				
			7. 溶存酸素 : 0.1 mg/Lit				
			8. MATERIAL : SS400				
			9. CONTROL SYSTEM : LEVEL CONTROL : PID				
			PRESSURE CONTROL : 4~20mA				
	PP -	DEAERA FEED WATER PUMP	1. TYPE : 多段タービン立型	11.5 kw ,Ø3, 380V	SET	2	
			2. CAPACITY : 30.0 ㎥/hr × 60 mh				
			3. TEMPERATURE : 20 ℃				
			4. MAKER : GRUNDFOS				
	PP - 218A/B	BOILER FEED WATER PUMP	1. TYPE : 多段タービン立型	45.0 kw ,Ø3, 380V	SET	2	
			2. CAPACITY : 30.0 ㎥/hr × 270 mh				
			3. TEMPERATURE : 130 ℃				
			4. MAKER : OSNA				

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT	Q'TY	備考
	TK - 217	WATER STORAGE TANK	1. TYPE : 円筒形		SET	1	
			2. CAPACITY : 40 ㎥				
			3. SIZE : 3250 Ø × 4824 H				
			4. MATERIAL : STS304				
	TK - 219	COMPOUND DOSING TANK	1. TYPE : 立型円筒形		SET	1	
			2. CAPACITY : 400 L				
			3. SIZE : 790 Φ × 816.5 H				
			4. MATERIAL : P.E 6T				
			5. 付帯施設 : AGITATOR, LOCAL PANEL, LEVEL S/W	0.4 kw 380V	SET	1	
	PP - 220A/B	COMPOUND DOSING PUMP	1. TYPE : 定量注入式	0.2 kw ,Ø1, 220V	SET	2	
			2. CAPACITY : 100 cc/min , 40 kgf/㎠				
			3. MATERIAL : CASING - GFPP, DIAPHRAGM - PTFE				
	ST - 204A	STEAM HEADER	1. TYPE : 円筒横形式		SET	1	
			2. SIZE : 450 Ø × 2500 L				
			3. 設計圧力 : 35 Kg/㎠				
			4. MATERIAL : STPG38, SCH#80				
	SL - 205	SILENCER	1. TYPE : 平形		SET	1	
			2. SIZE : 820 Ø × 3100 L, 150 A				
			3. 騒音基準 : 90 DB 以内				
			4. MATERIAL : 岩棉 & SS400				

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT	Q'TY	備考
	TK - 208	BLOW DOWN TANK	1. TYPE : 円筒形		SET	1	
			2. CAPACITY : 1000 L				
			3. SIZE : 880 Ø × 1645 H				
			4. MATERIAL : SS400				
	BD - 207A	TOP BLOW DOWN SYSTEM	1. TYPE : AUTO T.D.S CONTROL	220V	SET	1	
			2. SIZE : DN 25				
			3. VALVE : MV5291-V				
			4. PRESSURE : PN 40				
			5. CONTROLLER : FAR 1 , 4~20mmA				
			6. MAKER : SPIRAXSARCO				
	BD - 207B	BOTTOM BLOW DOWN SYSTEM	1. TYPE : MANUAL VALVE & SET TIMER CONTROL	220V	SET	1	
			2. SIZE : DN 50				
			3. CONTROL : 1078-1 CONTROL UNIT				
			4. VALVE : PV 6291				
			3. MAKER : RTK				
		DEAERATOR CONTROL SYSTEM	1. LEVEL CONTROL : 差圧式		SET	1	
			2. PRESSURE CONTROL : PID CONTROLER				
			3. WATER CONTROL : GLOBE VALVE				

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT	Q'TY	備考
		自動圧力調節 SYSTEM	1. TYPE : RF 3452-G DIGITAL CONTROLLER		SET	1	
			DR 1226 SENSOR UNIT				
			NG 1534 POWER UNIT				
			MV 5411 CONTROL VALVE				
			2. SIZE : DN 150 A				
			3. MAX PRESSURE : PN 40				
			4. MAKER : RTK				
			5. CONTROL : 4-20mmA				
		自動給水調節 SYSTEM	1. TYPE : DRUM 3-ELEMENT LEVEL CONTROL		SET	1	
			2. STEAM FLOW METER : ORIFICE - DN 150				
			3. DIFE. PRESSURE TRNSMI : 0-1000 mmH2O				
			4. WATER FLOW METER : ORIFICE - DN 50				
			5. WATER CONTROL VALVE : 50 A				
		STEAM VENT SYSTEM	1. TYPE : AUTO VENT CONTROL	220V	SET	1	
			2. SIZE : 150 A				
		STEAM SEPARATOR	1. TYPE : UNIT CYCLONE		SET	1	
			2. SIZE : 350 A × 200 A				
		低水位警報装置	1. TYPE : ELK 4		SET	1	
			2. MAX PRESSURE : 40 kg/㎠				
			3. MAKER : GALAXY				

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
		極低水位警報装置	1. TYPE : SG2411 CONTROLLER		SET 1	
			NI 1331 SENSOR			
			2. MAX PRESSURE : PN 40			
			3. MAKER : RTK			
5	粉塵および有害カス処理設備					
5-1.	SNCR (UREA 噴射装置)					
	TK - 111	UREA STORAGE TANK	1. TYPE : VERTICAL		SET 1	
			2. CAPACITY : 20 ㎥			
			3. SIZE : 2800 Φ × 3250 H (3,500H)			
			4. MATERIAL : FRP			
			5. ACCESSORY : FLANGE HEATER 50 A (STS304)	5 kw 380V	SET 1	
			TEM'P SENSOR			
			LEVEL TRANS MITTER			
	PP - 112A/B	UREA SPRAY PUMP	1. TYPE : HYDRA-CALL	0.75 kw 380V	SET 2	VVV-F
			2. CAPACITY : 60~110 L/hr × 70 mH			
			3. MATERIAL : PUMP HEAD - SUS316			
			GEAR - PPS			
	TK - 113	UREA MIXING TANK	1. TYPE : VERTICAL		SET 1	
			2. CAPACITY : 5 L			
			3. SIZE : 114 Φ × 490.1 H (540H)			
			4. MATERIAL : 4″ PIPE , (SCH40)			

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
	SN - 114A/D	UREA SPRAY NOZZLE	1. TYPE : 二流体		SET 4	
			2. CAPACITY : 280 L/hr			
			3. MATERIAL : STS316L			
	TK - 1303	UREA DILUTION	1. TYPE : VERTICAL		SET 1	
		- WATER TANK	2. CAPACITY : 3 ㎥			
			3. SIZE : 1400 Φ × 1950 H (2,300H)			
			4. MATERIAL : FRP			
			5. ACCESSORY : LEVEL TRANS MITTER			
	PP - 1304A/B	UREA DILUTION	1. TYPE : GRUNDFOS PUMP	0.75 kw 380V	SET 2	
		- WATER PUMP	2. CAPACITY : 1.5 ㎥/hr × 70 mH			
			3. MATERIAL : CASING -GC200, SHAFT - STS304			
			IMPELLA - SUS304			
	PF - 312	PURGE FAN	1. TYPE : RING BLOWER	0.5 kw 380V	SET 1	
			2. CAPACITY : 1.4 ㎥/hr × 1500 mmAq			
			3. MATERIAL : GC200			
5-2. SEMI DRY REACTOR						

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT	Q'TY	備考
	SD - 301	SEMI DRY REACTOR	1. TYPE : CYLINDER CAL		LOT	1	
			2. CAPACITY : 59,067 Nm³/hr				
			3. INLET TEMP. : 230 ℃				
			4. OUTLET EMP. : 180 ℃				
			5. VELOCITY : 1.5 m/s				
			6. RETENTION TIME : 10 sec				
			7. 냉각수 소모량 : 1,012 kg/hr				
			8. SIZE : 5,120 Ø × 16.39 mH				
			9. MATERIAL : SS400 9t				
	SG - 302A/B	SLIDE GATE	1. TYPE : AIR CYLINDER TYPE		SET	2	
			2. CAPACITY : 600 A × 150 H				
			3. MATERIAL : BODY - GC 200, BLADE - STS304				
			4. AIR CYLINDER : 140 Ø × 600 ST × 2 SET				
	VB - 303A/D	VIBRATOR	1. TYPE : VIBR. MOTOR	0.2 kw ,2P, 380V	SET	4	
	EHT - 304	E-HEATER	1. TYPE : MI CABLE	3 kw 380V	SET	1	
	TK - 306	LIME SLURRY STO. TANK	1. TYPE : VERTICAL		SET	1	
			2. CAPACITY : 30 m³				
			3. SIZE : 2910 Φ × 4513 H (6,096H)				
			4. MATERIAL : SS400				

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			5. 構造 : LEVEL TRANS MITTER			
	AG - 307	LIME STO. TANK AGITATOR	1. TYPE : PADDLE	5.5 kw 380V	SET 1	
			2. CAPACITY : 30 RPM			
			3. SIZE : 1350 Ø × 5600 L			
			4. MATERIAL : STS304			
	TK - 309	L/ SLURRY MIXING TANK	1. TYPE : VERTICAL		SET 1	
			2. CAPACITY : 3 ㎥			
			3. SIZE : 1552 Φ × 1587 H (2,200H)			
			4. MATERIAL : SS400			
	AG - 310	L/S M/TANK AGITATOR	1. TYPE : PADDLE	3.75 kw 380V	SET 1	
			2. CAPACITY : 60 RPM			
			3. SIZE : 550 Ø × 2000 L			
			4. MATERIAL : STS304			
	PP - 308A/B	L/SLURRY FEED PUMP	1. TYPE : CENTRIFUGAL	1.5 kw ,4P, 380V	SET 2	
			2. CAPACITY : 6 ㎥/hr × 10 mH			
			3. MATERIAL : PUMP CASING & SHAFT - SUS304			
			IMPELLER - Hi-Cr 강, DOUBEL M/SEAL			
	PP - 311A/B	L/SLURRY SPRAY PUMP	1. TYPE : HYDRA CALL	1.5 kw ,4P, 380V	SET 2	
			2. CAPACITY : 1.5 ㎥/hr × 70 mH			

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			3. MATERIAL : PUMP HEAD - CAST - IRON			
			4. DIAPHRAGM - BUNA-N			
			CHECK V/V - CERAMIC			
	SN - 305A/D	SPRAY NOZZLE	1. TYPE : 二流体		SET 4	
			2. CAPACITY : 375 L/hr			
			3. MATERIAL : STS304 + RBSIC			
	PF - 309	PURGE BLOWER	1. TYPE : RING BLOWER	1.75 kw 380V	SET 1	
			2. CAPACITY : 4.1 ㎥/min × 2000 mmAq			
			3. MATERIAL : GC200			
5-3. DRY VENTURI						
¥	DV - 401	DRY VENTURI	1. TYPE : VENTURI DUCT' TYPE		LOT 1	
			2. CAPACITY : 60,462 Nm³/hr			
			3. INLET TEMP. : 180 ℃			
			4. INLET /THROAT VELOCITY : 20m/s 60m/s			
			6. MATERIAL : SS400			
			7. SIZE : 1450 Φ, 800 Φ, 5160H			
			8. NOZZLE : ACTIVATED CARBON - 100 A			
			LIME - 100 A			

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT	Q'TY	備考
	TK - 1101	LIME SILO	1. TYPE : 垂直円筒形		LOT	1	
			2. CAPACITY : 30 ㎥				
			3. MATERIAL : SS400				
			4. SIZE : 2910 Φ × 4,513H (6,096H)				
			5. VENT FILTER : PULSE AERATION TYPE				
			100 Ø × 250 H				
	SH - 1105	SHUT OFF GATE	1. TYPE : SLIDE GATE		SET	1	
			2. SIZE : 200A				
			3. MATERIAL : SS400				
	VF - 1106	LIME VOLUMETRIC FEEDER	1. TYPE : SCREW 定量供給型	1.5 kw 380V	SET	1	
			2. CAPACITY : 50~100 kg/hr				
			3. SIZE : 200 A				
			4. MATERIAL : SS400				
	EHT - 1102	E-HEATER	1. TYPE : MI CABLE	3 kw 380V	SET	1	
			2. MATERIAL : SUS 304				
	AK - 1103A/B	AIR KNOCKER	1. TYPE : AIR PISTEON TYPE		SET	2	
			2. MODEL : AK - 80				
			3. OPERATING PRESS : 3~5 kg/㎠				
			4. MATERIAL : SS400				
			5. 構造 : SOLENOID V/V 1/4″ × 2 SET				

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No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
	AP - 1104	AIR PAD	1. TYPE : PULSE AERATION		SET 6	
			2. OPERATING PRESS : 3 kg/㎠			
			3. SIZE : 3/8″ (135 × 280 × 14㎜)			
			4. 構造 : SOLENOID V/V 3/8″ × 3 SET			
			5. MATERIAL : BASE - SUS304			
			: SIEVE - TEFLON COATED , POLYESTER			
		VENT FILTER	1. TYPE : AIR JET PULSING		SET 1	
			2. CAPACITY : 10 ㎥/min			
	TK - 1201	ACTIVATED CARBON SILO	`1. TYPE : 垂直円筒形		LOT 1	
			`2. CAPACITY : 3 ㎥			
			`3. SIZE : 1552 Ø × 1587 H (2,884H)			
			`4. MATERIAL : SS400			
	SH - 1204	SHUT OFF GATE	1. TYPE : SLIDE GATE		SET 1	
			2. SIZE : 200 A			
			3. MATERIAL : SS400			
	VF - 1205	A/C VOLUMETRIC FEEDER	1. TYPE : SCREW 定量供給型	0.75 kw 380V	SET 1	
			2. CAPACITY : 20~50 kg/hr			
			3. SIZE : 200 A			
			4. MATERIAL : SS400			
	EHT - 1202	E-HEATER	1. TYPE : MI CABLE	3 kw 380V	SET 1	

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			2. MATERIAL : SUS 304			
	AK - 1203A/B	AIR KNOCKER	1. TYPE : AIR PISTEON TYPE		SET 2	
			2. MODEL : AK - 60			
			3. OPERATING PRESS : 3~5 kg/㎠			
			4. 구조 : SOLENOID V/V			
			5. MATERIAL : SS400			
	HO - 1206	HOIST	1. TYPE ELECTRIC HOIST	0.75 kw 380V	SET 1	
			2. CAPACITY 1 ton			
			3. LIFT HEAD 15 m			
			4. MATERIAL SS400			
5-4.	**BAG FILTER**					
	BF - 501	BAG FILTER	1. TYPE : AIR JET PULSING		LOT 1	
			2. CAPACITY : 60,462 Nm³/hr			
			3. INLET TEMP. : 171 ℃			
			4. A.C.R : 0.70 m/min			
			5. PRESSUR DROP : Max. 200mmAq			
			6. ろ過布規格 : 156 Ø × 4100 L			
			7. ろ過布数量 : 1260 EA (15 ea × 14열 × 3 Ch)			
			(15 ea × 14열 × 3 Ch)			
			8. MATERIAL : STS304 + SS400			
	DP - 502A/D	IN-LET DAMPER	1. TYPE : MANUAL		SET 6	
			2. SIZE : 760 Ø × 300 H × 3 Z			

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			3. MATERIAL : SS400			
	DP - 503A/D	OUT-LET DAMPER	1. TYPE : POPET DAMPER		SET 6	
			2. SIZE : 730 Ø 400 H			
			3. MATERIAL : SS400, SGP			
			4. AIR CYLINDER : 140 Ø × 325 ST × 6 SET			
			AIR UNIT × 6 SET			
	DP - 503	BY-PASS POPPET DAMPER	1. TYPE : POPET DAMPER		SET 1	
			2. SIZE : 1050 Ø			
			3. MATERIAL : SS400, SGP			
			4. AIR CYLINDER : 140 Ø × 1250 ST × 1 SET			
			AIR UNIT × 1 SET			
	RV - 505A/B	ROTARY VALVE	1. TYPE : MULTI BLADE	1.5 kw ,4P, 380V	SET 2	감속비 1/30
			2. SIZE : 400A			
			3. MATERIAL : BODY - GC200, BLADE - SS400			
	FC - 504A/B	FLOW CONVEYOR	1. TYPE : FLOW CON'V	2.2 kw ,4P, 380V	SET 2	감속비 1/120
			2. MATERIAL : SS400 × S45C			
			3. SIZE : 400 W × 7700 L			
	EHT - 507A/B	E-HEATER	1. TYPE : MI CABLE	3 kw 380V	SET 2	
			2. 位置 : BAG FILTER HOPPER, FLOW CONVEYOR			

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
	AK - 508A/H	AIR KNOCKER	1. TYPE : AIR PISTION TYPE		SET 12	
			2. SIZE : AK - 80 (2SET × 4CH)			
			3. OPERATION PRESS : 3 ~ 5kg/㎠			
			4. 構造 : SOLENOID VALVE			
			: AIR FILTER W/REGULATOR			
		FILTER BAG	1. SIZE : 156 Ø × 4100 L		SET 1260	
			2. MATERAIL : G/F + TEFLON MEMBRANE			
			3. WEIGHT : 750 g/m2			
		BAG CAGE	1. SIZE : 156 Ø × 4100 L(¢4 × 20선)		SET 1260	
			2. MATERIAL : SS400 + SWRM			
		VENTURI	1. SIZE : 152 Ø		SET 1260	
			2. MATERIAL : AL			
		DIA PHRAGM VALVE	1. TYPE : CA- 50 A		SET 90	
			2. MATERIAL : AL			
		BLOW TUBE	1. TYPE : 50 A		SET 90	
			2. MATERIAL : STS304			
		TIMER KIT	1. TYPE : 20 POINT		SET 6	
6	**通風施設**					
	ID - 601	I.D FAN	1. TYPE : TURBO	320 kw ,4P, 380V	LOT 1	VVV-F
			2. CAPACITY : 2200 ㎥/min × 600 mmAq			

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			3. 構造 : COUPLING 直結駆動			
			4. MATERIAL : CASING - SS400, SHAFT - S45C			
			IMPELLA - SUS304			
	STA - 1001	STACK	1. TYPE : 強制垂直円筒形		LOT 1	
			2. CAPACITY : 60,875 Nm³/hr			
			3. TOP(AIR+GAS) : 178,275 Nm³/hr			
			4. INLET TEMP. : 163 ℃			
			5. VELOCITY : 9 m/s			
			6. SIZE : 2000Ø 35mH			
			7. MATERIAL SS400+CASTABLE			
		TMS	1. TYPE : ディジタル伝送			
			2. 測定項目 : O2, CO, NOX, SO2, HCL, DUST, 流速, 温度			
7	**圧縮空気設備**					
	ACP - 1401A/B	AIR COMPRESSOR	1. TYPE : SCREW COMPRESSOR	150 kw 380V	SET 2	
			2. CAPACITY : 28 m³/min × 8.5 kg/㎠			
			3. 구조 : COOLING SYSTEM - AIR COOLED			
			STARTING - STAR DELTA TYPE			
			DRIVING - DIRECT COUPLED DRIVE			

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			4. DIS' CONNECTION SIZE : 65 A			
	TK - 1402A/B	AIR RECEIVER TANK	1. TYPE : VERTICAL TYPE		SET 2	
			2. CAPACITY : 5 ㎥			
			3. 構造 : DRAIN TRAP.			
			4. IN/OUT CONNECTION : 100 A			
	AFC - 1403	AFTER COOLER	1. CAPACITY : 32 Nm³/min	0.8 kw 220V	SET 1	
			2. CONNECTION SIZE : 80 A			
	AD - 1404	AIR DRYER	1. TYPE : REFRIGERATED TYPE	4.5 kw 220V	SET 1	
			2. CAPACITY : 29 Nm³/min			
			3. DIS' CONNECTION SIZE : 80 A			
		PRE - FILTER	1. CAPACITY : 75 Nm³/min(SOLID 5㎛)		SET 1	
			2. CONNECTION SIZE : 80 A			
		LINE - FILTER	1. CAPACITY : 72 Nm³/min(SOLID 1㎛)		SET 1	
			2. CONNECTION SIZE : 80 A			
		COALESCENT - FILTER	1. CAPACITY : 42 Nm³/min(SOLID 0.01㎛)		SET 1	
			2. CONNECTION SIZE : 80 A			
8	DUCT工事					
		F.D FAN - 焼却炉	1. TYPE : 円筒形		SET 1	
			2. SIZE : 500 Ø			
			3. MATERIAL : SS400 4.5t			

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			4. 付属品 : DAMPER			
		BOILER-SEMI DRY REACTOR	1. TYPE : 円筒形		SET 1	
			2. SIZE : 1,580 Ø			
			3. MATERIAL : SS400 6t			
			4. INSULATION : ROCK WOOL #80 × 75t			
		S.D.R-DRY VENTURI	1. TYPE : 円筒形		SET 1	
			2. SIZE : 1,450 Ø			
			3. MATERIAL : SS400 6t			
			4. INSULATION : ROCK WOOL #80 × 75t			
		D.V-BAG FILTER	1. TYPE : 円筒形		SET 1	
			2. SIZE : 1,450 Ø			
			3. MATERIAL : SS400 6t			
			4. INSULATION : ROCK WOOL #80 × 75t			
		BAG FILTER-I.D FAN	1. TYPE : 円筒形		SET 1	
			2. SIZE : 1,400 Ø			
			3. MATERIAL : SS400 6t			
			4. INSULATION : ROCK WOOL #80 × 75t			
		I.D FAN-PACKED TOWER	1. TYPE : 円筒形		SET 1	
			2. SIZE : 1,400 Ø			

No	TAG No.	EQUIPMENT	DESCRIPTION	POWER	UNIT Q'TY	備考
			3. MATERIAL : FRP			
		COOLING FAN-GAS CONDENSOR	1. TYPE : 円筒形		SET 1	
			2. SIZE : 1,680 Ø			
			3. MATERIAL : SS400 4.5t			
			4. INSULATION : ROCK WOOL #80 × 75t			

POWER CONSUMPTION LIST

工事名：ベトナム産業廃棄物焼却設備の製作、設置工事(150トン/日)

No.	TAG No.	ITEM NAME	定格容量	総容量		起動容量		VOLTAGE	Spec.	REMARK
			KW	KW	SET	KW	SET			
1	OHC -	OVER HEAD CRANE								
		HOISTING MOTOR	30.00	30.00	1	30.00	1	380V × 3φ		VVV-F
		TRAVERSING MOTOR(횡)	0.75	1.50	2	1.50	2	380V × 3φ		
		TRAVELLING MOTOR(주)	1.50	3.00	2	3.00	2	380V × 3φ		
		GRAB HYDRO MOTOR	15.00	15.00	1	15.00	1	380V × 3φ		
		SUB TOTAL		49.50		49.50				
2	INC -	ROTARY KILN								
		DRIVING MOTOR	22.00	22.00	1	22.00	1			VVV-F
		R/K COOLING FAN	22.00	22.00	1	22.00	1			
		WATER PUMP	1.10	2.20	2	1.10	1			
		1'ST F.D FAN (R/K)	52.50	52.50	1	52.50	1			VVV-F
		1'st BURNER	7.50	7.50	1	7.50	1			
		SUB TOTAL		106.20		105.10				
3	INC -	STOKER								
	BU -	2nd BURNER	7.50	7.50	1	7.50	1	380V × 3φ		
	HU -	HYDRO UNIT PUMP	40.00	80.00	2	40.00	1	380V × 3φ		
		HYDRO UNIT FAN COOLER	1.50	1.50	1	1.50	1	380V × 3φ		
		HYDRO UNIT E.HEATER	5.00	5.00	1	5.00	1	380V × 3φ		
	FD -	2'ND F.D FAN (STOKER)	30.00	30.00	1	30.00	1	380V × 3φ		VVV-F
	FD -	3'RD F.D FAN (STOKER)	15.00	15.00	1	15.00	1	380V × 3φ		VVV-F
	FD -	4'TH F.D FAN (STOKER)	37.50	37.50	1	37.50	1	380V × 3φ		VVV-F
	FC -	FLOW CONVEYOR	2.20	4.40	2	2.20	1	380V × 3φ		
	AC -	APRON CONVEYOR	3.75	3.75	1	3.75	1	380V × 3φ		VS
	BC -	BELT. CONVEYOR	1.50	1.50	1	1.50	1	380V × 3φ		
	MS -	MAGNET COLD	4.50	4.50	1	4.50	1	220V × 1φ		
		MAGNETIC SEPERATOR	2.20	2.20	1	2.20	1	380V × 3φ		

POWER CONSUMPTION LIST

工事名 : ベトナム産業廃棄物焼却設備の製作、設置工事(150トン/日)

No.	TAG No.	ITEM NAME	定格容量	総容量		起動容量		VOLTAGE	Spec.	REMARK
			KW	KW	SET	KW	SET			
		SUB TOTAL		**192.85**		**150.65**				
4	**BL**	**BOILER**								
	SB -	SOOT BLOWER(LONG RETRACTING)	1.10	3.30	3	1.10	1	380V × 3φ		
	SB -	SOOT BLOWER(고정식)	0.40	3.20	8	0.40	1	380V × 3φ		
	PF -	PURGE FAN	2.20	4.40	2	2.20	1	380V × 3φ		
	RV -	ROTARY V/V	1.50	4.50	3	4.50	3	380V × 3φ		
	FC -	FLOW CONVEYOR	3.70	3.70	1	3.70	1	380V × 3φ		
		DEAERA FEED WATER PUMP	11.50	23.00	2	11.50	1	380V × 3φ		
	PP -	BOILER FEED WATER PUMP	45.00	90.00	2	45.00	1	380V × 3φ		
		COMPOUND DOSING TANK AGITATOR	0.40	0.40	1	0.40	1	380V × 3φ		
	PP -	COMPOUND DOSING PUMP	0.20	0.40	2	0.20	1	220V × 1φ		
		SUB TOTAL		**132.90**		**69.00**				
5	**SNCR**	**SNCR**								
		FLANGE HEATER	5.00	5.00	1	5.00	1	380V × 3φ		
	PP -	UREA SPRAY PUMP	0.75	1.50	2	0.75	1	380V × 3φ		VVV-F
	PP	UREA DILUTION WATER PUMP	0.75	1.50	2	0.75	1	380V × 3φ		
	PF -	PURGE FAN	0.50	0.50	1	0.50	1	380V × 3φ		
		E.HEATER	5.00	5.00	1	5.00	1	380V × 3φ		
		SUB TOTAL		**13.50**		**12.00**				
6	**SDR**	**SEMI DRY REACTOR**								
	SG -	SLIDE GATE		0.00	2	0.00		DC24V		
	VB -	VIBRATOR	0.20	0.80	4	0.20	1	380V × 3φ		
	EHT -	E.HEATER	3.00	3.00	1	3.00	1	380V × 3φ		
	AG -	L/S S/TANK AGITATOR	5.50	5.50	1	5.50	1	380V × 3φ		
	AG -	L/S M/TANK AGITATOR	3.75	3.75	1	3.75	1	380V × 3φ		
	PP -	LIME FEED PUMP	1.50	3.00	2	1.50	1	380V × 3φ		
	PP -	LIME SPRAY PUMP	1.50	3.00	2	1.50	1	380V × 3φ		VVV-F

POWER CONSUMPTION LIST

工事名：ベトナム産業廃棄物焼却設備の製作、設置工事(150トン/日)

No.	TAG No.	ITEM NAME	定格容量	総容量		起動容量		VOLTAGE	Spec.	REMARK
			KW	KW	SET	KW	SET			
	PF -	PURGE FAN	1.75	1.75	1	1.75	1	380V × 3φ		
		SUB TOTAL		**20.80**		**17.20**				
7	**TK**	**LIME SILO**								
	VF -	VOLUMETRIC FEEDER	1.50	1.50	1	1.50	1	380V × 3φ		VVV-F
	EHT -	E.HEATER	3.00	3.00	1	3.00	1	380V × 3φ		
	AK	AIR KNOCKER		0.00	2	0.00	1	DC24V		
	AP	AERA PAD		0.00	6	0.00	1	DC24V		
		TIMER KITS		0.00	1	0.00	1	220V × 1φ		
		SUB TOTAL		**4.50**		**4.50**				
8	**TK**	**A/C SILO**								
	VF -	VOLUMETRIC FEEDER	0.75	0.75	1	0.75	1	380V × 3φ		VVV-F
	EHT -	E.HEATER	3.00	3.00	1	3.00	1	380V × 3φ		
	AK -	AIR KNOCKER		0.00	2	0.00	1	DC24V		
	HO -	HOIST	0.75	0.75	1	0.75	1	380V × 3φ		
		SUB TOTAL		**4.50**		**4.50**				
9	**BF**	**BAG FILTER**								
		POPPET DAMPER			7			DC24V		
	RV -	ROTARY V/V	1.50	3.00	2	3.00	2	380V × 3φ		
	FC -	FLOW CONVEYOR	2.20	4.40	2	2.20	1	380V × 3φ		
	EHT -	E.HEATER	3.00	6.00	2	6.00	2	380V × 3φ		
		E.HEATER	5.00	20.00	4	20.00	4	380V × 3φ		
	AK -	AIR KNOCKER			12		16	DC24V		
		TIMER KITS			6		8	220V × 1φ		
		SUB TOTAL	**11.70**	**33.40**		**31.20**				
10	**ID -**	**I.D FAN**	320.0	320.00	1	320.00	1	380V × 3φ		VVV-F

POWER CONSUMPTION LIST

工事名：ベトナム産業廃棄物焼却設備の製作、設置工事(150トン/日)

No.	TAG No.	ITEM NAME	定格容量	総容量		起動容量		VOLTAGE	Spec.	REMARK
			KW	KW	SET	KW	SET			
		SUB TOTAL	320.00	320.00		320.00				
11	ACP	AIR COMPRESSOR								
	ACP - 1401A/B	AIR COMPRESSOR	150.00	300.00	2	150.00	1	380V × 3φ		
	AFC - 1403	AFTER COOLER	0.80	0.80	1	0.80	1	220V × 1φ		
	AD - 1404	AIR DRYER	4.50	4.50	1	4.50	1	380V × 3φ		
		SUB TOTAL		305.30		155.30				
	GRAND TOTAL			1077.25		813.85				

3-4 ロンアン省からのサポートレター

ロンアン省からのサポートレター

ỦY BAN NHÂN DÂN **TỈNH LONG AN**	**CỘNG HÒA XÃ HỘI CHỦ NGHĨA VIỆT NAM** **Độc lập - Tự do - Hạnh phúc**
Số: 3561/UBND-KT	*Long An, ngày 04 tháng 10 năm 2012*

V/v xử lý chất thải công nghiệp tại tỉnh Long An

Kính gửi: Ông Koichi Shinohara
Chủ tịch Công ty Tsuneishi Kamtecs
1083 Tsuneishi, Numakuma-cho,
Fukuyama, Hiroshima 721-0313 - Japan

UBND tỉnh đã nhận được thư ngỏ của quý công ty đề ngày 28/9/2012 về việc xử lý chất thải từ các xí nghiệp tại tỉnh Long An.

Trước hết chúng tôi chân thành hoan nghênh sự quan tâm của quý công ty đối với việc liên kết cùng Công ty Cổ phần Đồng Tâm, Công ty Kobelco Eco-Solutions cũng như các thành viên khác trong vấn đề xử lý chất thải công nghiệp tại tỉnh Long An.

Chúng tôi luôn hiểu rằng việc quản lý chất thải rắn là một trong những nhiệm vụ quan trọng trong mục tiêu hài hòa giữa nhiệm vụ công nghiệp hóa và bảo vệ môi trường trong vùng. Vì vậy chúng tôi luôn sẵn lòng hỗ trợ quý Công ty trong việc thực thi đề án nghiên cứu thực tiễn đối với dự án đang được hỗ trợ bởi JICA lần này, bằng cách cung cấp cho quý công ty những thông tin cần thiết, phục vụ cho sự thành công của công trình nghiên cứu, cũng như thành công của dự án về sau.

Chúng tôi tin tưởng rằng, việc triển khai dự án xử lý chất thải nêu trên sẽ góp phần đẩy mạnh công nghiệp hóa tại Long An phát triển ổn định, bền vững và thân thiện với môi trường. Chúng tôi rất mong quý Công ty tiếp tục hỗ trợ - làm cầu nối, giới thiệu nhiều nhà đầu tư của Nhật Bản đến đầu tư sản xuất kinh doanh tại các khu công nghiệp trên địa bàn tỉnh Long An.

Trân trọng kính chào !

TM. ỦY BAN NHÂN DÂN
KT. CHỦ TỊCH
PHÓ CHỦ TỊCH

ỦY BAN NHÂN DÂN TỈNH LONG AN

Nguyễn Thanh Nguyên

Nơi nhận:
- CT, PCT.UBND tỉnh$_{SX}$;
- Như trên;
- Sở Kế hoạch và Đầu tư;
- Sở Tài nguyên và Môi trường;
- Cty CP KCN Đồng Tâm;
- Phòng NC-KT;
- Lưu: VT, Nh;

TSUNEISHI -DA XL CHAT THAI

添付資料

ロンアン省人民委員会　　ベトナム社会
主義共国
No. 3561/UBND-KTN　　独立－
自由—幸福

ロンアン、2012 年
10 月 4 日

件名： ロンアン省における産業廃棄物処理事業について
宛先： ツネイシ カムテックス
　　社長 篠原 幸一様

首題に関する 2012/9/28 付御社レターを拝受致しました。

ロンアン省における産業廃棄物処理事業の為、御社が、Dong Tam グループ、神戸環境ソリューション、及びその他参加メンバー各社とのJV会社設立をご検討されている件に付き、感謝致します。

かような固形廃棄物の管理は、当該地域における産業化と環境保護との調和を図る為の最重要課題の一つであり、当人民委員会としてはJICAサポートによる当該事業のFS調査を進んで支援し、当該FS調査およびプロジェクトが成功するよう、必要ないかなる情報も提供する等全面的に協力致します。

当人民委員会は、上記の産業廃棄物処理事業が、持続可能かつ環境に配慮した発展を基礎として、ロンアン省の工業化を促進することに多大な貢献をするものと確信しております。
御社におかれましては、今後も引き続き日本とロンアン省の架け橋となって頂き、ロンアン省内工業団地への
製造・交易関連事業の投資誘致に対する御支援を頂きます様、希望致します。

敬具