

Management of Hazardous Waste in Indonesia

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Abstract. Indonesia needs to build four Treatment Centrals for 229,907 tons per year produced hazardous waste. But almost all hazardous waste treatment is managed by just one company at present, namely PT. PPLI (Prasada Pamunah Limbah Industri). This research is based on collected data which identifies payback period of 0.69 years and rate of return 85 %. PT PPLI is located within the Cileungsi District of the Bogor Regency of West Java Province. Records from nearest rainfall station at Cibinong indicate that annual average rainfall for the site is about 3,600 mm. It is situated on hilly terrain and is characterized by steep slopes as well as has a very complex geological structure. The Tertiary sequence was folded to form an assymetric anticline with axis trend in an East–West direction. Three major faults cut the middle of the site in a North–South direction with a vertical displacement of about 1.5 meters and a zone width of 1 meter. The high concentration of Chemical Oxygen Demand (COD) 2500 ppm in Secondary Leachate Collection System (SLCS) indicate a possible failure of the Primary Leachate Clection System (PLCS), which need correct action to prevent groundwater contamination.

Keywords: groundwater contamination, hazardous waste, leachate collection system, treatment centrals

1. Introduction

Industries in Indonesia generate hazardous wastes about 229,907 tons per year. Unfortunately, Indonesia has only one treatment plant with international standard now, namely PT. PPLI. It is obviously foreseen that there is not enough plant to receive an annual amount of about 68,000 tons of hazardous wastes from West Java. Therefore, it is impossible to treat, store and dispose these wastes safely. As a result, there is seriously potential environmental contamination to occur which causes health hazards.

The plant is located between two cement plants, PT. Indo Cement is 3 Km west of the site and PT. Semen Cibinong is 2.5 Km northeast of the site, in Cileungsi District of the Bogor Regency of West Java Province, about 35 Km south of central Jakarta. The Surrounding area is largely rural land with villages forming the population centres. The area has monsoonal rains during the months of October to April and a drier season between May and September. The nearest rainfall station at Cibinong records that annual average rainfall for the site is about 3,600 mm. It is on hilly terrain and characterized by steep slopes and has complex geological structures. Topographic elevations vary between about 80 m and 140 m above sea level.

This research aim to:

- asses the probability risk of ground water contamination from site plant waste
- asses the feasibility of hazardous waste deposal facility according to geological structures
- analyse the finance and management of hazardous waste deposal plant



- evaluate the current efforts and future requirements

2. Research Method

Below are the data obtained from field research and questionnaire:

- 1) Types and amounts of hazardous wastes were obtained from the 215 PT. PPLI costumers.
- 2) Facilities, instrumentations, laboratory, processing of the waste in the rotary kiln for the organic chemical, netralization plant, detoxification plant, precipitation plant and dewatering plant.
- 3) Each instrument price taken from Catalog.
- 4) Cost-benefit analysis based on report of hazardous waste treatment from Independent Auditors [1], [2], [3]
- 5) Landfill design category
- 6) The influence of geologic structures and lithology on groundwater

3. Results and Discussion

Hazardous waste landfill in Indonesia is classified in three types. Type I has two geomembranes, type II has one geomembrane, and type III has no geomembrane. PT. PPLI has a licence to manage landfill type I (Figure 1).

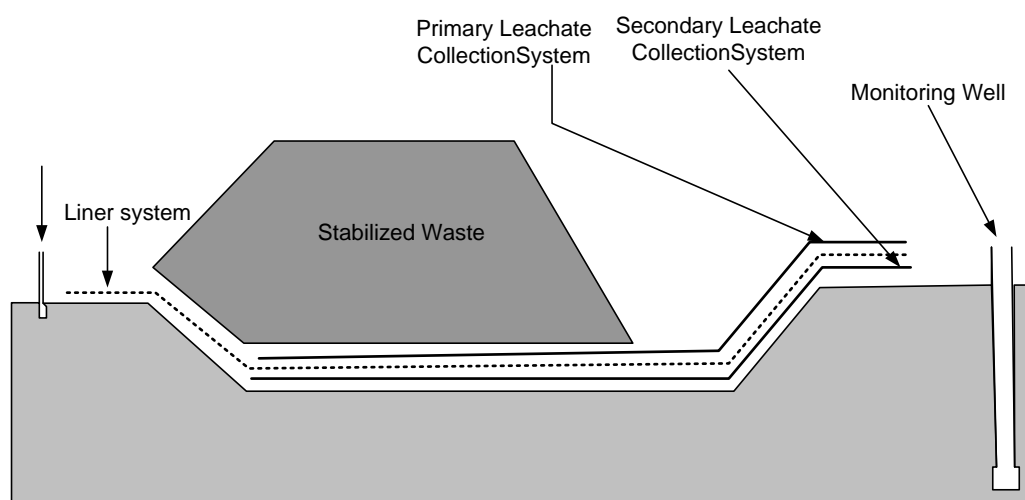


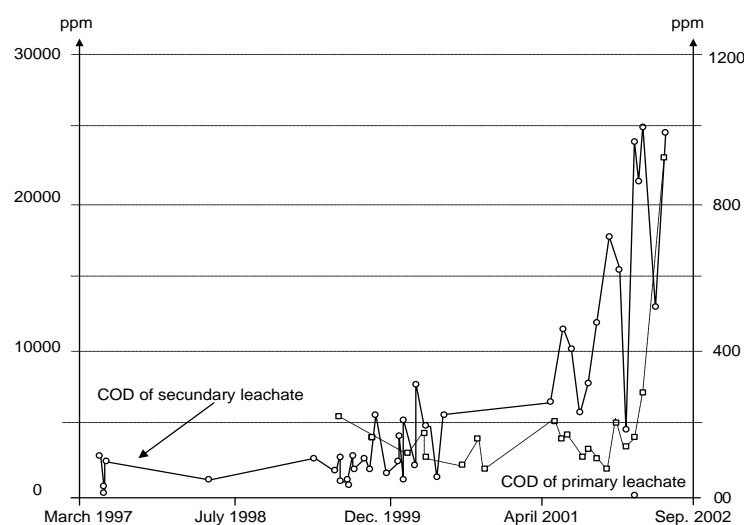
Figure 1. Liner system of landfill type I with Primary Leachate Collection System (PLCS) and Secondary Leachate Cillection System (SLCS).

On 6 January 2003, a group of residents who live near PT. PPLI complained about the odour and filed a class-action lawsuit over the release of various hazardous substances that they claimed had created a severe health risk and had contaminated their properties. Five employees who were medically examined indicated no personal exposure (Table 1).

Table 1. Air and personal monitoring analysis at PT. PPLI .

Parameters (mg/m ³)	Main	Cecep	Anim	Dian	Syafi'i	NAB (mg/m ³)
Metyl Etyl Keton	4,1566	3,0966	22,2700	3,8500	4,4433	590
Aceton	3,8353	4,0423	5,2105	4,7205	3,5771	1780
Dichloro Etilin	79,8230	67,6659	91,2376	72,8650	68,2132	793
Total Hydrocarbon	0,0849	0,0390	0,1730	0,0235	0,0695	1
Xylene	7,3657	1,7442	58,7142	3,6371	16,3326	434
Toluene	8,1549	4,6375	5,3926	1,6197	4,0528	188
Ether	6,1769	ttd	4,7511	8,1180	ttd	49
TCE	11,1200	ttd	8,5533	14,6146	ttd	269
Ethyl Acrylate	6,8467	5,9273	6,9124	5,6847	5,6761	20
Isoprophyl Alcohol	6,2397	5,6109	8,1763	6,3325	5,3615	983
Ethyl Acetate	6,4781	16,2785	97,9948	27,1668	8,6015	1440
Styrene	5,2254	2,206	1,9306	1,3833	2,2042	85
Buthyl Acetate	3,5608	4,4755	5,2105	4,7205	3,5771	713
Methylene Chloride	68,4588	57,8341	77,9809	62,2778	58,3019	174
Buthyl Acrylate	8,7687	7,5866	8,8528	7,2805	7,2695	52

The negative correlations between COD concentrations in the PLCS and SLCS, and the high concentration of COD 2500 ppm in SLCS indicate a possible failure of the PLCS (Figure 2), which need correct action to prevent groundwater contamination.

**Figure 2.** COD concentrations in primary and secondary leachates.

3.1. Geology

The geological mapping and drilling provided useful information on the lithology and structure of the sedimentary sequence beneath the site. The site is underlain by folded and faulted sedimentary rocks of Tertiary (Miocene) age. Tertiary rocks are covered by less than 5 m thick unconsolidated deposits of quaternary age. Tertiary sequence forms an asymmetric anticline with a fold axis which trends in an east-west direction (Figure 3).

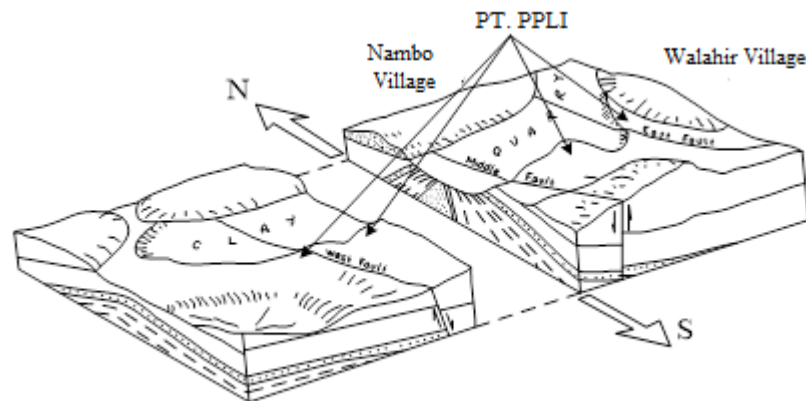


Figure 3. Evidence of faulting involving throws of a few metres was found on site indicating the presence of fault blocks.

The southern limb of the anticline dips southwards at a low angle of about 20°. The northern limb dips northward at a low angle in west and at high angle, approaching 90°, in east. The tertiary sedimentary sequence underlying the site forms a complex multi-layered aquifer system comprising mudstones, sandstones and limestones. The tertiary aquifer system is recharged by rainfall. Ground water discharges in lower lying areas in the north-eastern part of the site occurs from springs in the depth of water table increases with rising topographic elevation (less than 5 m in the lower areas). Groundwater flows from the southwest and southeast along the valleys towards the northeast. Groundwater generally has pH 6.2-6.8.

3.2. Economic Analysis

Hazardous waste trading is one of the best ways to increase regional revenue. Indonesia produces 229,907 tons of wastes yearly [4]. Based on this figure, Indonesia Government decided to construct four hazardous waste treatment centres: Jakarta and surrounding areas (Jabotabek) for 75,741 tons per year, Surabaya and its vicinity (Gerbang Kertosusilo) for 147,760, East Kalimantan for 46,256 tons per year, and Lhoksumawe 29,150 tons per year. Unfortunately, only one of the four treatments centres (Jabotabek, owned by PT. PPLI), could be realized. That means almost all hazardous waste in Indonesia should be processed by PT PPLI.

The largest amount of waste processed in 1997 could be interpreted as better law enforcement of government control program than more awareness of the industrialists to environmental issues. To support this assumption a comparative study was made in East Java.

Table 2. Estimation of volume, price and treatment of hazardous waste.

No.	Volume (%)	Servisces	Rate /ton/m ³ (USD)	Average (USD)
1	70%	Stabilization +LF	\$ 380/ton	$0.7 \times 380 = 266$
2	20%	Direct Landfill/LF	\$ 175/ton	$0.2 \times 175 = 35$
3	5%	Fuel Blending *	\$ 425/m ³	$0.05 \times 425 = 21.25^*)$
4	5%	Storage	\$ 150/ton	$0.05 \times 150 = 7.50$
	100%			Average = 329.75

*)USD.85 per 200 liters.

Feasibility study for a treatment plant in East Java described payback period of 0.69 years and rate of return 85 % as shown on revenue and cash flow analysis (Table 3). The pricing based upon US\$296.7

/ton hazardous waste or Rp 2,670,975/ton (1 USD = R 9,000) or 10 % lower than the average price of processing services in PPLI (US \$329.75/ton or m³; see Table 2).

Estimation of product

1st year = 5000 ton = Rp 13,354,875,000.00
 2nd year = 10000 ton = Rp 26,709,750,000.00
 3rd year – 25th year = 30,000 ton = Rp. 80,129,250,000.00

Annual revenue

= Rp { 13,354,875,000.00 + 26,709,750,000.00 + (80,129,250,000.00 × 22) } : 25
 = Rp 72,116,325,000.00

Average operation cost

= { (4.9 + 18.7 + 22.2 + 19.4 + 16.4 + 12.01 + (11.2 × 19)) } : 25
 = 12.242 billion

a) Average rate of Return

Revenue	72.11
OPR cost	12.24
Depreciation	3

Profit BT	56.87
Company tax	14.79

Profit AT	42.87
Rate of return/year	$(42.87 : 50) \times 100 \% = 85.74 \%$

b) Payback Period 50 : 72.11 = 0.69 years

Table 3. Financial analysis.

Year	Product capacity (ton)	Revenue 2,37/ ton	Cost	AT Profit 30%	Outstanding loan	Repayment loan	Interest 20%	Cash available /	Capital accumulation
1	5000	13.35	4.90	5.91	50	0	0	5.91	5.91
2	10000	26.70	18.70	5.60	60	5	10	0.60	6.51
3	30000	80.13	22.20	40.55	66	25	11	15.51	22.06
4	30000	80.13	19.40	42.51	49.2	25	8.2	17.51	39.57
5	30000	80.13	16.04	44.86	29.04	25	4.84	19.86	59.43
6	30000	80.13	12.01	47.71	4.85	4.85	0.81	43.67	102.29
7	30000	80.13			0				

Based on this financial analysis, it is feasible to develop the hazardous treatment plant in East Java with the capacity of 5,000 tons in the 1st year, 10,000 tons in the 2nd year, and 30,000 tons in the next 3rd year – 25th year. After six years all the outstanding loan to be zero and the Capital accumulation Rp. 102.29 billion (see Table 3). The investment of Rp. 50 billion is spent for feasibility study, funding

for 30 hectares of land compensation, construction, equipment, training and operation (salary, overhead, maintenance, insurance, socialisazion program, and marketing)

4. Conclusion

This study reveals that groundwater and rainfall are potential to transport contaminants leached from the facility offsite to agricultural area downstream and create potential health hazards. Therefore, PPLI needs special engineering barriers to isolate waste stored in the landfill.

The negative correlations of the COD concentrations of primary and secondary leachates indicate a possible failure of primary leachate liner system, which requires correct action to prevent groundwater contamination. Negative impacts of waste treatment plants to surrounding areas comes from over capacity, insufficient knowledge of geological structure, risk of existing faults, groundwater flow system to quifers.

Hazardous business simulation identifies Payback Period of 0.69 years and Rate of Return 85 %. High profit and monopoly practice quickly resulted in the new development of treatment plant in Cileungsi by PPLI.

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