

# **Gampong Jawa Landfill of Banda Aceh: A Case Study of Dumpsite Rehabilitation to a Sustainable Landfill**

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## **Abstract**

*Gampong Jawa dumpsite was established in 1994 as part of Banda Aceh Municipality (BAM) efforts to participate in Adipura Award for the category of clean and green city. The 12 ha area was a dumpsite for most of wastes from BAM and Aceh Besar District. When earthquake/tsunami hit Banda Aceh in December 2004, it was completely destroyed and all the wastes were swept away.*

*This paper is aimed to present the lessons of how a dumpsite is rehabilitated to a landfill. Some issues and challenges are discussed, i.e. the development process; land acquisition; technical consideration i.e. DED, leachate and LFG management, geotechnical aspects; social aspects contributes to minimise waste production; and other supporting facilities.*

*After the tsunami, the dumpsite was used as a final disposal area for tsunami wastes collected from BAM and Aceh Besar. In 2006, BAM expanded the area by purchasing the surrounding 9 ha non-productive fish ponds. In 2008, the Agency for Rehabilitation and Reconstruction (Badan Rehabilitasi dan Rekonstruksi / BRR) initiated the rehabilitation by constructing a new sanitary landfill which was initially operated in January 2009.*

*The landfill operation is currently supported with necessary equipments and sufficient budget. BAM allocates IDR 1.3 billion annually for O&M. A number of new facilities are recently being provided, e.g. weighing bridge and MRF facilities. Moreover, it is being upgraded to a transfer station while Blang Bintang Regional Landfill is under construction during 2012. Currently the total of waste disposal is 155 tons/day, 15% of the waste is sorted for any recyclable and compost materials.*

*It is expected that Gampong Jawa Landfill will contribute useful information for local governments, either in Aceh or other districts in Indonesia, mainly for the policy makers involved in urban planning, specifically solid waste management sector, to include a sustainable urban solid waste management, especially landfill development as integrated part of it.*

**Keywords:** dumpsite rehabilitation, sanitary landfill, municipal solid waste management.

## **1. Introduction**

Gampong Jawa (GJ) is the name of a village in Kutaraja subdistrict and was selected as the final location among several dumpsites. The 12 Ha area was operated with open dumping method, into which the waste was dumped in the open space. It was also used as one of the central area for Tsunami Recovery Waste Management Programme (TRWMP) of UNDP in Banda Aceh. In 2008, BRR or the Agency for Rehabilitation and Reconstruction for Aceh and Nias initiated the rehabilitation by closing the inappropriate existing cell and constructing a new sanitary landfill which was initially operated in January 2009.

## **Demography of Banda Aceh**

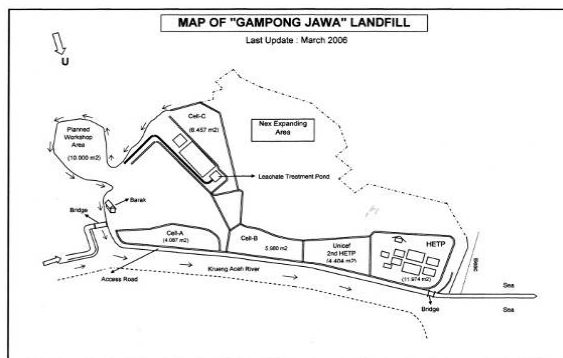
Banda Aceh is a growing city. It is the capital of Aceh Province, the western most province in Indonesia. Civil Registry Office recorded that Banda Aceh Municipality (BAM) in 2010 had a total population of 223,446 people, spread over 9 sub-districts and 90 villages. Given the average waste generation of 0.7 kg per capita, BAM generates waste about 155 tons per day. Spatial Planning of 2011-2029 forecasts that its population until 2029 will be as many as 482.131 people. This projection has been considered by *Dinas Kebersihan dan Keindahan* (DK3) as the basis for allocating the number of solid waste facilities and infrastructure needs in the future.

**Solid Waste Generation**

Out of 156 tons per day of waste generated, 78% transported to GJ comes from the village, main streets, traditional markets, business area, schools, offices, bus terminal/ports, hotel, restaurants and other public facilities, while the remaining 17% was recycled (both managed by DK3), and 5% more are being dumped in the backyard or openly burned by the people, especially in the villages.

**TPA of Gampong Jawa: Its Development**

TPA (final disposal site) of GJ was opened in 1994 on an area of 12 ha. The Detail Engineering Design (DED) was provided by Ministry of Public Works (PU), which was already met with technical provisions of a sanitary landfill. Only after the construction, the landfill operations did not follow the criteria of sanitary landfill O&M where the problems (lack of funding) led it to become only a controlled landfill. The soil cover was not put in regular basis, thus cases of fire were often taken place. Similarly, the leachate ponds were also available, but not in a proper operation. The leachate must be pumped periodically from the control box to the leachate pond, which is costly.



**Figure 1.** Location Map of GJ Landfill (2006)

After the tsunami, it was considered critical to immediate design a regional landfill. In 2006, a master-plan was developed to replace GJ as its capacity was insufficient. However, before the construction, as anticipation for landfill need, in 2006 BAM did land acquisition around the landfill area of 9 ha, bringing the total of GJ to 21 ha. The Feasibility Study and DED was then prepared by Arcadis and UNDP, and Gampong Jawa Landfill (GJL) was constructed by the government through BRR. The construction was not done in accordance with the DED. However, GJL was built in 2008 and went into operation in early 2009.

The transition of controlled landfill into sanitary landfill was conducted to anticipate the provisions in National Act no. 18/2008 on Solid Waste Management, which in Article 44 requires all districts to provide open-dumping closure plan no later than 1 (one) year after the enactment of the Act, and to close the open dumping at the maximum of 5 (five) years after the enactment of the Act.



**Figure 2.** Rehabilitation of GJL in 2008



**Figure 3.** Tsunami waste recyclables in GJL

**GJL and Spatial Planning**

Based on Banda Aceh spatial planning document, GJL is a non-residential development area, thus the presence of GJL has fulfilled the requirements of future planning of Banda Aceh. If there is a growing residential area close to GJL, means the spatial planning is not being complied.

## 2. Technical Considerations

Several technical aspects will be discussed below behind the success of GJL.

### Detail Engineering Design (DED)

DED of GJL was prepared by Arcadis International Consulting, which was involved during Aceh Reconstruction period after the tsunami. The DED consists of main engineering design and calculations, includes supporting facilities for Leachate Treatment Plant (LTP), Landfill Gas (LFG) Vents, workshop facility, and access roads.

### Leachate Treatment and Landfill Gas Management

GJL has a leachate treatment system which consists of three ponds: anaerobic, aerobic, and maturation ponds. The processing is done naturally by gravity principle with the retention process of chemical contents in the ponds. However, it still needs to improve its effectiveness, either by expansion, creating deeper anaerobic ponds, expanding aerobic ponds, or providing additional treatment to one of the ponds. Nevertheless, the effluent quality is still above the minimum standard.

To control LFG, at a certain distance, vertical HDPE pipes are installed, and the height is added continuously following waste pile height. The horizontal HDPE pipes for leachate and gas collection were already in place since the construction.

GJL is divided into two cells, one of which was closed and another is the active cell. In the closed cell, the produced gas has not yet been exploited. But BAM has allocated the budgeted in 2013 for gas utilization unit, which will run a small electricity generator. The active cell still has not produced gas yet. Later on when it is sufficient, the piping will be connected to the gas utilization unit.



Figure 4. LFG Vent



Figure 5. Leachate Treatment Ponds

### Geotechnical Aspect

GJL has been implementing the closure of landfill cell for its sustainability. It has been planned and treated regularly, following the standard procedure, thus it does not fall back into an open dumping when the soil cover is not maintain in a regular basis.



The waste is compacted and covered with regular soil using heavy equipment, and directing the bottom slope towards the flow of collector drainage. This is to ensure that run-off water does not flow to the leachate collector channel. Land covering and compacting process are conducted in stages, cell by cell. Soil cover also has a slope towards the collection point.

The final cover consists of several layers indicated respectively from bottom to top:

- On the top of waste: regular soil cover.

- Gravel layer with the diameter of 30 to 50 mm and 20 cm thickness is put as a horizontal gas collection.
- Clay layer 20 cm thick or organic waste/shredded wooden waste.
- Under-drain gravel layer with diameter 30-50 mm and 20 cm thickness, into the drainage system.
- Soil layer with a minimum thickness of 60cm.

### 3. Social Aspects

#### Land Acquisition and Ownership

The process of land acquisition was performed very carefully such that the community had a full understanding about the important of landfill expansion. In addition, people considered that the fish ponds were no longer productive after the tsunami. Most of land owners were affected and the land sold by their family members who still remains. The budget for land acquisition was provided through BRR. The land was released as a community ownership, thus some did not have certificates, but it had been taken care of and all are included in the certificate and become a valid asset of BAM.

#### Public Acceptance

Since the beginning of GJL operation, there was never been any complaint nor objection from the community on the environmental impacts that arose out of GJL. No complained from the adjacent ponds about the died fish. The only complaint addressed to DK3 was a request that waste trucks passing to the landfill access road through the village should drive slowly and safely in order to keep the safety of the villagers.

### 4. Supporting Facilities and Infrastructures

#### Weighbridge

Weighbridge at GJL is a weigh station with a capacity of 40 ton, and started operating since February 2012. With the weighbridge, the waste entering the landfill has been recorded more accurately (in kg). Prior to the weigh station availability, the amount of waste entering the landfill was calculated based on estimation only in units of volume (m<sup>3</sup>).

#### Access Road

The access road to GJL has been increased to a hot mix asphalt road in 2010 and considerably adequate for trucks to the landfill. Although the road is passing the residential areas, however, it still works properly, hence the people along the access road still feel safe and comfortable. There are two entrance doors to the landfill, the main entrance and the backside gate as an escape way during emergency situation.

#### Landfill Boundaries and Fences

GJL is an enclosed area and have clear boundaries, where the landfill is surrounded by the mouth of the river and ponds (of regional tidal). Landfill area that is adjacent to the river has already has a concrete fences, while others are still with the barbed wire fences.

#### Workshop

To support the operation of waste management in BAM, DK3 owns and manages a workshop or garage for vehicle and heavy equipment maintenance. The workshop is located inside GJL complex and has so far been able to handle 100% maintenance of all equipments. Mechanical workshop was constructed by UNDP/ MDF and started to function since 2010. The workshop is supported by complete facilities/equipments.



**Fig. 7.** Improved maintenance in DK3: truck washing before go out of landfill



## Heavy Equipments

Table 1.1 provides the overview of existing operation vehicles and other heavy equipments.

Table 1.1 Vehicles and heavy equipments supporting GJL activities.

No	Equipment	Unit	Purpose	Present Condition
1.	Dump Truck	34 unit	Waste transport	Good
2.	Compactor Truck	4 unit	Waste transport	Good
3.	Small truck (pick up)	17 unit	Waste transport	Good
4.	Three wheeler cart	30 unit	Waste transport	Good
5.	Arm-roll Truck	6 unit	Waste transport	Good
6.	Bulldozer	3 unit	Operational in landfill	Good
7.	Excavator	3 unit	Operational in landfill	Good
8.	Watering Truck	1 unit	Operational in landfill	Good
9.	Wheel Loader	2 unit	Composting in landfill	Good
10	Mobile Waste Shredding Machine	1 unit	Composting in landfill	Good
11.	Container	60 unit	Waste collection	Minor damage
12.	Grass cutting machine	19 unit	Grass cutting	Good
13.	Mower	2 unit	City park maintenance	Good

Source : DK3 Banda Aceh (March 2012)

## Composting Unit

Waste sorting and processing in GJL has been done long time. Composting for instance, it has been initiated even before the tsunami. After the tsunami, it was expanded and managed in cooperation with the local NGO (Aceh Recycling Foundation). DK3 also has its own composting facility in landfill area. A 250 m<sup>3</sup> composting house with a 16 ton per day mobile waste shredding machine is processing 15 m<sup>3</sup> of green waste every day. There is also a unit of small crusher and screener. Most of the milling product is used as a substitute material for waste cover (daily cover), which also functions as a bio-filter.



Figure 8. Pile of woods and organic waste, used for compost and cell cover.

## Recycling Unit

Besides the recycling of organic waste, GJL is a sorting centre of non-organic waste, particularly plastic bottles/cups, cans/metal and cardboard/paper. Waste from trucks is unloaded and sorted. Plastic bottles/caps are mainly purchased to further process in plastic processing plant run by DK3 that is located 10 km from GJL. Other types of recyclable materials are then sold to the junk shops.

## 5. Other Supporting Matters

### Tsunami Waste

During emergency response period (weeks after the tsunami hit), the government's main target was to remove all tsunami debris from the city as immediate as possible. The only choice was to dispose them in GJL, which was also destroyed by the tsunami. More than 350,000 m<sup>3</sup> of tsunami wastes, which consisted mainly of sludge, debris, and wood, had been transported and disposed to GJL. In the landfill, they were sorted to detach the sludge from materials which can still be used, mostly rubbles which later were used for road construction and woods for furniture.

### Transfer Station with MRF Facility

As part of the Blang Bintang Regional Landfill (BBRL) Project, which is a partnership between the government of Aceh, Aceh Besar and BAM, GJL will be developed as a transfer station before the wastes are sent to BBRL. All the wastes collected from BAM and the border regions will be brought to GJL, sorted and processed in Material Recovery Facility (MRF) facility, while the remaining unused materials will be transported by bulk compacting trucks to BBRL. Thus, in the future, GJL will be more functioning as a transfer station.

### **3R and Public Awareness**

GJL plays an important role in the development of waste recycling in BAM. As waste sorting at source is still a challenging fact in BAM, the role of waste sorting are enormous. All wastes are sorted according to recyclable and non-recyclable materials while the collection trucks are moving to GJL. Among the recyclables are plastic bottles/cups, tin/metal, and cardboard/paper. Arriving at GJL, the waste is re-sorted according to different types and the difference in selling price. At least 50 stalls of junk shop operate in BAM. More than 20 tons of recyclable materials are sent to Medan every day.

While most of green waste is processed by shredding machine in GJL as described above, other development of 3R activities undertaken in BAM is household-scale composting. At least there are about 1,000 households are still actively engaged. Aside from households, schools are also the target in developing micro-scale composting. In schools, in addition to composting, waste sorting is also developed through the “*waste bank*” programme. Medium-scale composting is also being developed in sub-district of Ulee Kareng to compost organic waste from markets.

### **6. Concluding Remarks**

Several remarks are listed below as a result of the experiences from GJL activities:

- Though GJL is facing a big challenge in implementing a sanitary landfill method, mainly because of the APBD (budget) limitation and low awareness of the community, however, GJL has proven as one example of sustainable sanitary landfill in the region and other districts in Indonesia.
- Collection coverage of the DK3 should be improved, which is now still 78%. However, increasing number of services should not increase the volume of waste entering GJL. The success indicator is the growing community participation in the sorting and processing waste, while the volume of waste entering GJL should be reduced or even showed a decline from year to year.
- Several factors for dumpsite rehabilitation to a sanitary landfill should cover several aspects, i.e. engineering, social, and other supporting factors.
- Socialization of sorting, recycling, and waste utilization (3R) to the community will also improve the sustainability of a sanitary landfill.

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