

WASTE MANAGEMENT PRACTICES ON THE ISLAND OF MINDANAO, PHILIPPINES

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SUMMARY: Mindanao is the southernmost and second largest island within the chain of 70,000 islands making up the Philippines. As part of an investigation into practices regarding the disposal of solid waste, several landfill facilities were evaluated in cities across Mindanao. While numerous facilities were visited throughout the Island, three facilities that represent a cross-section of the Island are discussed within this paper. The cities that are represented include Davao City in the south, Cotobato City to the east, and Butuan City to the north. For each of the municipalities described above, an investigation was conducted regarding the current solid waste disposal practices, the types and quantities of waste, waste disposal options, and alternative disposal practices. All of the facilities evaluated were open dumpsites. As part of the investigation, a feasibility study was conducted at some of the facilities looking at alternative disposal sites, improved collection methods, and placing the waste in sanitary landfills with liner systems and daily cover.

1. INTRODUCTION

The Philippines is a nation of islands located south of mainland Asia. To the west is the South China Sea; to the east, the Pacific Ocean; north is the Bashi Channel, and south, the Sulu and Celebes Seas. The Philippines has no contiguous land borders with any other nation. Its nearest neighbors are Malaysia, Indonesia, and Brunei to the southwest. The southern island of Mindanao is the second largest in the chain of over 7,000 islands. As part of an investigation into practices regarding the disposal of solid waste, several landfill facilities were evaluated in cities across Mindanao.

While numerous facilities were visited throughout the Island, three facilities that represent a cross-section of the Island of Mindanao are discussed within this paper. The cities that are represented include Davao City in the south, Cotobato City to the east, and Butuan City to the north.

Davao is a City/Province with a population of approximately 1.3 million people. Geographically, Davao is the largest City in the Philippines with a total land area of 2,440 square kilometers. Cotobato City is the seat of government for Central Mindanao, as well as the Autonomous Region for Muslim

Mindanao (ARMM). The population of Cotabato City is approximately 200,000 people. Butuan City lies at the crossroad between the provinces of Surigao del Norte, Misamis Oriental, and Davao del Norte. Given its location, Butuan receives significant waste from outside the city limits with an equivalent solid waste production equal to a population of over 300,000 people.

For each of the municipalities described above, an investigation was conducted regarding the current solid waste disposal practices, the types and quantities of waste, waste disposal options, and alternative disposal practices. All of the facilities evaluated were open dumpsites. As part of the investigation at some of the sites, a feasibility study was conducted looking at alternative disposal sites, improved collection methods, and placing the waste in sanitary landfills with liner systems and daily cover.

For the proposed sanitary landfills, recommendations were presented regarding the land requirements, design elements (including liners, leachate collection and treatment systems, cover requirements), and landfill operations. This information can be utilized by the cities to come into compliance with the newly enacted Philippine law (RA 9003), which mandates new landfill standards within the next few years. The results of the investigations for each of the identified cities are presented in the following sections of this paper.

2. DAVAO CITY WASTE MANAGEMENT PRACTICES

2.1 Background

Davao City is the third largest city by population (approximately 1.3 million) and the largest city by geographic area (2,440 square kilometers) in the Philippines. Located about 960 kilometers south of Manila, the city has a mild tropical climate with no pronounced wet or dry season. The average temperature ranges from 20 to 32 degrees Celsius, with rainfall averaging 2,000 mm per year and humidity ranging from 77 to 83 percent. The major industries include agriculture (fruits, vegetable, hemp, rice, lumber, copra, etc.), cement production, and tourism. Of the total land area, approximately 43% is agricultural, 47% is forested, and 10% is urban. The tallest mountain peak in the Philippines, Mount Apo (2,954 m amsl), is located west of the city.

2.2 Waste Management Evaluation, Davao City.

Davao City had the most comprehensive waste management evaluation conducted by the authors of any of the three cities presented in this report. In addition to evaluating the current dumpsite and waste collection practices, a detailed waste characterization study was conducted along with a landfill siting investigation and preliminary landfill feasibility design.

2.2.1 Existing Dumpsite

Davao City has one operational dumpsite (landfill), which serves approximately 70 percent of the population. The original landfill was located approximately nine kilometers northwest of the center of the downtown area along the Phil-Japan Friendship Highway. This landfill was a ravine fill where waste was pushed over a slope estimated at 60 percent. No cover material was applied at the original landfill, where uncontrolled smoldering fires were common.

The original landfill was a modified open dump where waste was unloaded immediately adjacent to the highway by an assortment of City-owned and private trucks. After the trucks dumped their loads, the wastes were picked through by scavengers who removed recyclable materials. After the wastes were scavenged, a D-7 Caterpillar tracked dozer pushed the waste over the edge of the slope.

A picture of the original landfill for Davao City is shown on Figure 1.



Figure 1. Original Davao City Dumpsite

Since the original Davao City Landfill was located along a major highway into the city on land owned by a private party, the need to close and relocate the landfill was realized. Due to time constraints, a new temporary site was identified approximately 27 kilometers from the city. This new landfill was also an open dump, where refuse was pushed off of a ridge top and down a ravine. A photograph of the new Davao City Dumpsite is shown on Figure 2.



Figure 2. New Davao City Dumpsite

2.2.2 Waste Collection

Davao City provides solid waste collection service to approximately 70 percent of the residences and commercial businesses located in the Davao region. Service is limited to the City proper, and the populated areas along the roads connecting Davao to the Villages of Toril, Bunawan, and Calinan, as well as within the Village of Baguio (Jusain 1997). The collection vehicles are operated by the City's Environmental and Natural Resources Office, Solid Waste Management Section (SWMS). Davao's collection fleet consists of 46 trucks. There are both open collection vehicles and compaction vehicles. In addition, the City has three operational compactor trucks.

The City's collection operation consists of three shifts per day, with each shift comprising two or more cycles depending on the distance to the landfill from the route and time of collection. Collection stops are established by the City's SWMS. Collection from the City proper is limited to the period between midnight and 5:00 a.m., the low traffic period. In both the residential and commercial districts, multiple users share the same collection point with individuals being able to subscribe to additional collection for an increased fee paid to the SWMS. A typical collection crew consists of a driver, three collectors, and two loaders. It is a common practice for collection crews to sort through garbage as it is being dumped into vehicles and remove a portion of the recyclable component of the waste stream.

2.2.3 Waste Characterization

The waste characterization sort study was conducted in a manner consistent with United States accepted practices for classification of solid wastes at a landfill taking into consideration local constraints regarding logistics and health and safety. Davao City provided the manpower necessary to conduct the sorts and assumed responsibility for health and safety issues of the work crew.

Physical separation and sampling of wastes were accomplished as follows:

1. Random selected collection trucks were diverted from the landfill and directed to dump their load on the ground in an area that had been cleared of waste;
2. The number of the truck was recorded as was the area within the City where collection occurred;
3. The waste load was divided into quarters by visual estimation;
4. Wastes were separated by hand into waste categories and placed into plastic sacks; and
5. Each sack was weighed and recorded.

The results of the waste characterization study indicate that the waste stream is comprised of a large organic component with a total disposal rate for all materials of approximately 500 tonnes per day. Compared to the United States average composition of solid waste (Tchobanogous 1993), Davao City generates a waste stream 2.3 times higher in food waste than the average waste stream in the United States. A complete discussion on the waste composition study for Davao City was presented at the Seventh International Waste Management and Landfill Symposium (Purdy 1999).

2.2.4 New Landfill Feasibility Study

Several locations were visited and evaluated for potential development as a new sanitary landfill. A qualitative evaluation was conducted based on criteria including topography, soils, depth to groundwater, land use, habitat value, stability, surface water, ownership, access, and other site selection criteria as described in the Eighth International Waste Management and Landfill Symposium (Purdy 2001). Based on the above criteria, a 10-hectare parcel of land was identified and a conceptual design and financial evaluation was conducted. Using the tonnage of waste

determined from the waste characterization study, an initial 2-hectare cell was proposed. This cell included the use of composite liners and a leachate collection and treatment system. The cost analysis for the project including both capital and operating costs for the 10-year life of the facility was estimated at US\$6.76 million.

3. COTABATO CITY WASTE MANAGEMENT PRACTICES

3.1 Background

Cotabato City is one of the fastest growing municipalities in the Philippines with a population of approximately 200,000 people. The city is located on the north side of the delta of the Rio Grande de Mindanao (formerly Cotabato River), along the southwestern side of Mindanao Island. The city has a mild tropical climate with a minor wet and dry season. The major industry of the area is agriculture with over 62% of the labor force employed in agriculture related fields. Aquaculture (fishponds) is also an important industry. The Cotabato Valley is one of the Philippines major agricultural regions with the most important crops being rice, maize, sugarcane, and coffee. Cotabato City is the seat of government for Central Mindanao, as well as the Autonomous Region for Muslim Mindanao (ARMM). It is a fast growing commercial and industrial center and a melting pot of diverse ethnic groups and cultures. The municipality encompasses a total land area of 17,600 hectares.

3.2 Waste Management Evaluation, Cotabato City.

The Refuse Control Division (RCD) of the City General Services Department is responsible for the collection and disposal of solid wastes in the city. As part of the waste management evaluation, the authors visited Cotabato City and inspected the existing waste disposal facility, reviewed the collection practices, and visited potential new landfill locations.

3.2.1 Existing Dumpsite

Cotabato City has one operational dumpsite (landfill), which serves approximately 80 percent of the population. The open dumpsite is located in Barangay Rosary Heights, near the city cemetery. The landfill takes approximately 55 tonnes of refuse per day. No covering of the waste takes place and the wastes are burned in an almost constant, smoldering fire. There is a river flowing nearby the site and groundwater is very shallow. The Cotabato Landfill is approximately 5 hectares in size, and like much of the city area, is just above sea level. Figure 3 shows a picture of the Cotabato Landfill.

3.2.2 Waste Collection

Solid waste is collected from the Poblacion (the City's downtown area) and its adjoining barangays. The collection area also includes two city public markets and hospitals. The collection work force includes 75 personnel that make up the RCD. The solid wastes (placed in drums or receptacles) are collected daily at designated areas. Of the approximately 70 tonnes of waste generated each day, only about 55 tonnes make it to the Cotabato Landfill. The uncollected waste is either burned or littered casually at the place where it is generated. Much of these uncollected wastes find their way into the City's drainage system, hampering the drains during storms and contributing to flooding and general lack of sanitation.



Figure 3. Cotabato City Dumpsite

3.2.3 Waste Characterization

A waste characterization study was not conducted for the Cotabato Landfill. The waste configuration is; however, similar to other locations in Mindanao and can assumed to be similar to the breakdown determined for Davao City. The RCD did determine that of the 55 tonnes of refuse received at the site, 37 tonnes are compostible and 18 tonnes are combustible.

3.2.4 New Landfill Feasibility Study

The municipality of Cotabato City is interested in purchasing or leasing approximately 20 to 30 hectares of land. Of that area, approximately 14 hectares are needed for the new landfill facility. The preliminary design plans for the new landfill call for provisions for controlling water pollution and the movement of landfill gas. A proposed landfill site was visited by the authors and found to be inadequate due to the close proximity to a local river, very high groundwater, very flat topography, a long and narrow unimproved access road, and a bridge needed to cross the river. An alternate location in a nearby jurisdiction was suggested since all locations within the Cotabato City area are at or below sea level with very high groundwater. The costs associated for initial development of the site were determined by the RCD to be approximately US\$1.25 million.

4. BUTUAN CITY WASTE MANAGEMENT PRACTICES

4.1 Background

Butuan City, the provincial capital, is located within the central part of the Agusan del Norte Province along the banks of the Agusan River. Butuan City serves as the strategic center of the Northern Mindanao region. The Butuan's primarily industry is agricultural, being one of the leading rice producers after Bukidnon. Butuan is also a major timber producer in the region with 23 lumber

producers and plywood plants in the city. Butuan's rattan is one of the best in the Philippines. Other agricultural products include corn, vegetables, coconuts, and bananas. Butuan is located approximately 786 kilometers south of Manila with a land area of 758 square kilometers. The population of the city is approximately 266,000 people. Butuan City is reportedly the site of the oldest settlement in the Philippines.

4.2 Waste Management Evaluation, Butuan City.

The Public Services Division (PSD) of Butuan City is responsible for the collection and disposal of solid wastes in the city. As part of the waste management evaluation, the authors visited Butuan City and inspected the existing waste disposal facility, reviewed the collection practices, and visited the proposed new landfill location.

4.2.1 Existing Dumpsite

Butuan City has one operational dumpsite (landfill), which serves approximately 80 percent of the population. The open dumpsite is located in Sosompit Pond, Doogan. The landfill takes approximately 85 tonnes of refuse per day. No covering of the waste takes place and the wastes appear to be creating leachate and foul odors. Groundwater is very shallow in the area and fish farm areas at the northern portion of the city have observed "fishkill" from fluids seeping from the landfill. Figure 4 shows a picture of the Butuan Dumpsite.



Figure 4. Butuan Dumpsite

4.2.2 Waste Collection

Solid waste is collected from the city and its adjoining barangays. The collection work force includes over 100 personnel. The solid wastes (placed in drums or receptacles) are collected daily at designated areas. Of the approximately 106 tonnes of waste generated each day, only about 82 tonnes make it to the Butuan Landfill. In the early 1990's, this difference was even greater with only about 30% collection versus generation. Being at the cross-roads between several provinces, the waste generated within the area is equivalent to a population closer to 300,000 people. The

uncollected waste is either burned or littered casually at the place where it is generated. Much of these uncollected wastes find their way into the City's drainage system, hampering the drains during storms and contributing to flooding and general lack of sanitation.

4.2.3 Waste Characterization

A waste characterization study was not conducted for the Butuan Landfill. The waste configuration is; however, similar to other locations in Mindanao and can assumed to be similar to the breakdown determined for Davao City.

4.2.4 New Landfill Feasibility Study

The proposed new landfill site is located at Barangay Dumalagan, some 15 kilometers from the heart of the city. This location appears to be the most favorable site among all the alternatives considering the geologic and environmental aspects relating to the site. The selected site has an area of approximately 100 hectares of which 40 hectares has been designated for refuse placement. The site satisfies the siting criteria discussed previously in this report and is suitable for landfill development.

5. CONCLUSION

Waste management practices within the Island of Mindanao consist of open dumping of refuse and poor collection practices. Open dumping of refuse leads to the creation of environmental problems including ground and surface water contamination, insect and rodent infestation, odors, and disease. In order to change this growing health concern, the Philippines Government passed a law (RA 9003) which allows no new open dumps and phases out their operation altogether within 5 years. Municipalities within Mindanao and other islands within the Philippines have the desire to operate sanitary landfills, but lack the resources and technical expertise to make changes. With the new law and appropriate funding, the environmental threat from current waste management practices can be significantly reduced.

REFERENCES

- Jusain, Fernando, Environmental Management Specialist I, Davao, Solid Waste Management Section, 1997 personal communication.
- Purdy, S. and Sabugal, F., (1999), Proceedings Sardinia 99, Seventh International Waste Management and Landfill Symposium, Volume III, pages 673-680.
- Purdy, S. and Sabugal, F., (2001), Proceeding Sardinia 2001, Eighth International Waste Management and Landfill Symposium, Volume IV, pages 29-38.
- Tchobanogous, G., (1993), *Integrated Solid Waste Management*, 1993, Table 3-4.

Proceedings of Sardinia 2003, 9th International Waste Management and Landfill Symposium, CISA, Cagliari, Italy, 6-10 October, 2003.