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Study on Solid Waste Management System and Design of Sanitary Landfill for Monywa Township

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ABSTRACT

The description of this paper is "Study on Solid Waste Management System and Design of Sanitary Landfill for Monywa Township". It has mainly contained two portions. First, analysis of solid waste composition and disposal system for seven quarters for downtown area of Monywa city performed. In the analysis of solid waste composition, demographic study and haul route study are carrying out for the collection of sample from each quarter. Household refuse is considered only in this paper. Second, the sanitary landfill for downtown areas of Monywa city is designed. For disposal of municipal solid waste from Monywa, area method is used for landfilling of MSW. And then, the required landfill area and useful life of disposal site are estimated.

KEYWORDS: *Solid waste generation, Disposal syste Sanitary landfill, Area method*

I. INTRODUCTION

Solid waste management is a purposeful systematic control of the generation, storage, collection, transport, processing, recycling and disposal of solid waste. Solid waste also called as 'refuse' includes all kinds of wastes in solid state, excepting excreta, coming from residential, commercial and industrial areas. According to its source, generally the waste is categorized as Municipal Wastes, Industrial Waste, Hazardous Waste, Bio-medical Waste, Agricultural Waste, etc. The amount of solid wastes is increasing due to the generous use and disposal of almost all matter of everyday use. It is required to manage systematically the solid wastes for reducing environmental problems.

Monywa, the city of North West Division, is situated in the upper part of Union of Myanmar and it is the centre of transport and communication for all trades and commerce activities. Solid waste composition studies are essential to proper management of waste for a variety of reasons including a need to estimate material recovery potential, to identify sources of component generation, to facilitate design of processing equipment, to estimate physical, chemical, and thermal properties of the wastes, and to maintain compliance with local, state and national regulations. The composition of generated waste is extremely variable as a consequence of seasonal, life style, demographic, geographic, and local legislation impacts. These variations make defining and measuring the composition of waste more difficult and at the same time more essential. For this reason, it is necessary to develop the solid waste management system and landfill design for Monywa city.

II. COLLECTION OF SOLID WASTES

The term "collection" is to provide a means of regular gathering or collecting all those solid wastes generated by society. It is also to provide the means of hauling all those wastes to the location where the contents of the collection vehicles are emptied or further transfer or for treatment or disposal. Information on collection, one of the most costly functional elements, is presented in four parts dealing with (1) the types of collection services, (2) the types of collection systems, (3) an analysis of collection systems, and (4) the general methodology involved in setting up collection routes.

A. Collection Services

The various types of collection services now used for municipal and commercial-industrial sources. In Monywa city, municipal collection service is used.

B. Types of Collection Systems

Based on their mode of operation, collection system is classified into two categories: hauled container systems and stationary container systems. In Monywa city, the storages of wastes are hauled to the processing, transfer, or disposal site, emptied, and returned to either their original location or some other locations. Therefore, hauled container with tilt-frame container is used in this city.

C. Collection Methods

Waste collection methods necessarily involve some or all of the following: (1) Collection from households or other premises or from different waste generated area; consolidation in temporary storage sites, (2) Transport to a transfer station and (3) Transport to a final disposal site.

The two main categories of collection are,

1. Drop-off centers
2. Buy-back centers

In study time, refuse wastes are collected from households or other premises and from different waste generated area. In recent years, Drop-off center is used in Monywa.

D. layout *of Collection Routes*

The proposed collection routes for seven quarters in Monywa city with their collection frequencies are described in Tables I and II and illustrated in Figures 1 to 7.

Table I LAYOUT COLLECTION ROUTES FOR THE SELECTED AREAS

No.	Quarters	Route	Frequency	Gallon/ Trip	Residences	Population	Avg, Persons/ Recidences	Day/ Wk	Trip/ Wk
1.	Yone-Gyi	R_1 R_2 R_3	3 2 3	1 1 1	6950	41779	6	7	8
2.	Daw-Na-Chan	R_1 R_2	3 3	1 1	6130	30652	5	7	6
3.	Pha-Ya-Gyi	R_1 R_2	3 3	1 1	5201	31211	6	7	6
4.	Sue-Lae-Gone	R_1 R_2	2 2	1 1	2587	15524	6	7	4
5.	Alae	R_1 R_2	2 2	1 1	3290	16452	5	7	4
6.	Aye-Thar-Yar	R_1 R_2	3 3	1 1	4990	29942	6	7	6
7.	Aung-Mingalar	R_1 R_2	2 2	1 1	3959	19797	5	7	4

Table II COLLECTED DAY WITH CORRESPONDING ROUTES FOR THE SELECTED AREAS

No.	Quarter	Route	Monday		Tuesday		Wednesday		Thursday		Friday		Saturday		Sun day	
			M	E	M	E	M	E	M	E	M	E	M	E	M	E
1	Yone-Gyi	R_1	√				√						√			
		R_2			√						√					
		R_3	√				√						√			
2	Daw-Na-Chan	R_1		√				√						√		
		R_2		√				√						√		
3	Pha-Ya-Gyi	R_1	√				√						√			
		R_2	√				√						√			
4	Sue-Lae-Gone	R_1			√						√					
		R_2			√						√					
5	Alae	R_1				√						√				
		R_2				√						√				
6	Aye-Thar-Yar	R_1		√				√						√		
		R_2		√				√						√		
7	Aung-Mingalar	R_1			√						√					
		R_2				√						√				
	Total	15	4	4	4	3	4	4			4	3	4	4		

Figure1. Collection routes for yone-gyi quarter

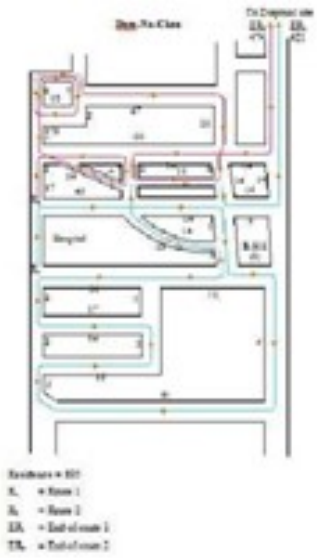

figure2. Collection routes for daw-na-chan quarter

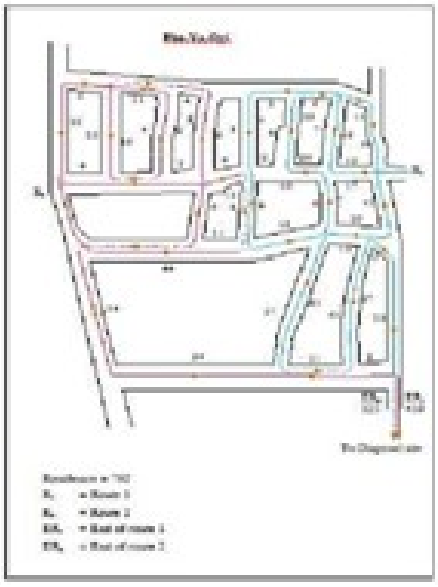

Figure3. Collection Routes For pha-ya-ghi Quarter

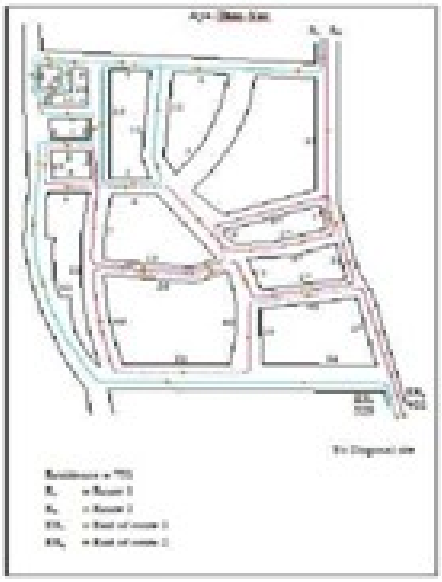

Figure6. Collection Routes For Aye tharyar Quarter

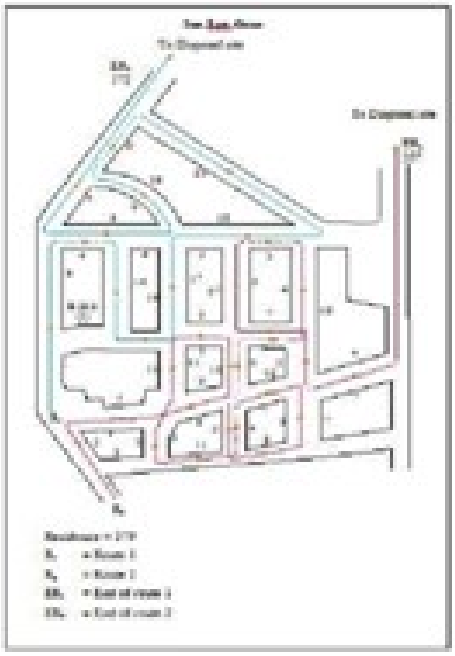

Figure4. Collection Routes sue-lae-gone Quarter

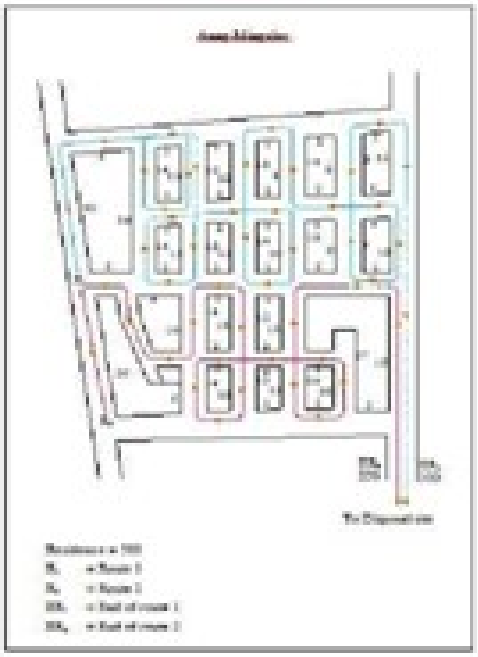

Figure7. Collection Routes foR aung min galar Quarter

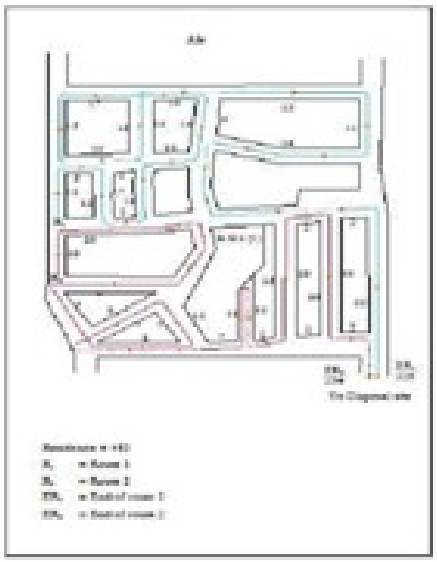

Figure5. Collection Routes For ALae Quarter

III. ANALYSIS OF HOUSEHOLD REFUSE

There are 33107 number of dwelling in Monywa and township population is 185357 persons in study time. The dwell types of in these areas mostly include single unit and multiple low rises. The combination of socio-economic groups is not considered for selecting sample areas. Different places from the different disposal sites are used for collecting the samples that takes the variations in domestic activities. To analyze the household refuse, the container is used to collect the refuse sample and the samples are taken three times. And then, the wastes are separated into various types and each refuse is weighted to make the physical analysis. Composition of household refuse is shown in the Following Tables and average household waste generation is calculated.

Table III. PHYSICAL COMPOSITION OF HOUSEHOLD REFUSE (FOR 1ST TIME)

Components	Weighted Quantities(lb)	Percent (%)
1.Combustibles		
Paper	0.5	5.17
Textiles	0.23	2.38
Vegetable & Grass	2.6	26.89
Wood	1.0	10.34
Plastic	2.26	23.37
Rubber & Leather	0.2	2.07
Kitchen waste	2.5	25.85
2.Non-combustibles		
Ferrous metals	0.2	2.07
Glass	0.18	1.86
Total (lb)	9.67	100

Average household waste generation = 9.67 lb/day

$= \frac{9.67x29340}{2200}$ = 128.96 tons/day

= 0.85 kg/cap/day

Table IV Physical Composition Of Household Refuse (For 2nd Time)

Components	Weighted Quantities(lb)	Percent (%)
1.Combustibles		
Paper	0.7	7.06
Textiles	0	0
Vegetable & Grass	2.3	23.21
Wood	1.1	11.1
Plastic	2.61	26.34
Rubber & Leather	0.1	1.01
Kitchen waste	2.7	27.25
2.Non-combustibles		
Ferrous metals	0.25	2.52
Glass	0.15	1.51
Total (lb)	9.91	100.00

Average household waste generation = 9.91 lb/day

$= \frac{9.91x29340}{2200}$ = 132.16 tons/day

= 0.87 kg/cap/day

Table V Physical Composition Of Household Refuse (For 3rd Time)

Components	Weighted Quantities(lb)	Percent (%)
1.Combustibles		
Paper	0.72	7.63
Textiles	0.25	2.65
Vegetable & Grass	2.31	24.47
Wood	0	0
Plastic	2.75	29.13
Rubber & Leather	0.15	1.59
Kitchen waste	2.85	30.18
2.Non-combustibles		
Ferrous metals	0.21	2.23
Glass	0.2	2.12
Total (lb)	9.44	100.00

Average household waste generation = 9.44 lb/day

$= \frac{9.44x29340}{2200}$ = 125.89 tons/day

= 0.83 kg/cap/day

According to the collected sample results, average household waste generation of 0.85 kg/cap/day for Monywa city is obtained.

IV. DESIGN OF SANITARY LANDFILL SYSTEM

To use the available area at a land fill site effectively a plan of operation for the placement of solid wastes must be prepared. Various operational methods are developed primarily on the basic of field experience. The methods used to fill dry areas are substantially different from those used to fill wet areas. The principal methods used for land filling areas may be classified as;

1. area,
2. trench, and
3. depression.

A. Land Filling Methods and Operations

For landfill design, the area method is used for Monywa city. Area fills are usually located in moderately rolling topography or in large pits if cover material sources are readily available. This method can accommodate high traffic volumes since the working face is not limited by the size of an excavation.

B. Forecasting of Solid Waste Generation

To forecast the solid waste generation, the prediction of population must be calculated. For predicting population, two methods such as Arithmetical Progression (A.P) and Geometrical Progression (G.P) are generally used.

For Monwya city, G.P method is sufficient. Thus, the population of the end of n years or n decades is given by the following equation.

$$P_n = P\,(1 + \frac{i}{100})^n \qquad \text{Equation 1}$$

Where,

P_n = population at the end of n years or n decades

P = present population

n = years or decades

i = population increase rate

According to the census data, the population increase rate of Monywa is taken as 2%. By using equation (1), the population for 2024 years is forecasted. The annual solid waste generationare calculated based on average solid waste generation rate. These results are shown in Table VI.

Table VI PREDICTION OF POPULATION AND FORECASTING OF SOLID WASTE GENERATION

Year	2019	2024
Population	185357	204649
Solid Waste Generation (tons)	57507	63492

C. Estimation of Solid Waste Quantities for Monywa City

The solid wastes volume is computed by using an assumed value of 890 kg/m^3 for the in-place compacted density of the solid wastes. The computed values can be scaled for any other assumed density values. Solid waste generation for Monywa city is 0.85 kg/cap/day. Based on the above data, solid waste quantities for daily and yearly volume are estimated and described in Table VII.

Table VII ESTIMATION Of Solid Waste Quantities

Year	Population	Waste Quantities	
		Daily Volume (m^3)	Yearly Volume (m^3)
2019	185357	177.03	64615.95
2020	189064	180.57	65908.05
2021	192845	184.18	67225.70
2022	196702	187.86	68568.90
2023	200636	191.62	69941.30
2024	204649	195.45	71339.25

D. Location of Site Selection

The most appropriate site location for solid wastes disposal in Monywa city is selected as Sar-kyinn Cemetery landfill site, which is located at the south of Monywa industrial zone. The selected disposal site expends 40 acres.

E. Land Requirements of the Selected Area

Average depth of compacted solid wastes is taken as 10 ft for this study. Estimated daily volume of solid wastes for the year 2024 is 195.45 m^3. Then, yearly area required is calculated as,

$$\text{Area required/yr} = \frac{195.45\left(\frac{m^3}{day}\right)x\ 365(\frac{days}{yr})}{10(ft)x\ 43560\left(\frac{ft^2}{acre}\right)x0.0283(\frac{m^3}{ft^3})}$$

$$= 5.8 \text{ acres/yr}$$

Therefore, the useful life of the disposal site is found to be about 7 years.

F. Filling Plan and Operation of the Selected Disposal Site

The landfilling method is selected as area landfill. According to the topography of the landfill site, the first lift is started at an elevation of 81m (245 ft), as shown in Figure and it is filled with solid wastes to a depth of about 2.8956m (9.5 ft). A 0.015m (6 in) layer of cover material is used to place over the compacted fill at the end of each day. The vents are constructed with a 0.3048m to 0.4572m (12 to 18 in) layer of granular material so that the gases can travel to the surface easily. The design results of cell construction are shown in Table VIII.

Table VIII Design Of Cell Construction

Year	Lift	Waste Volume (m^3)	Waste Area (m^2)
2019	1	64615.95	22315.22
2020	2	65908.05	22761.45
2021	3	67225.70	23216.50
2022	4	68568.90	23680.38
2023	5	69941.30	24154.34
2024	6	71339.25	24637.12

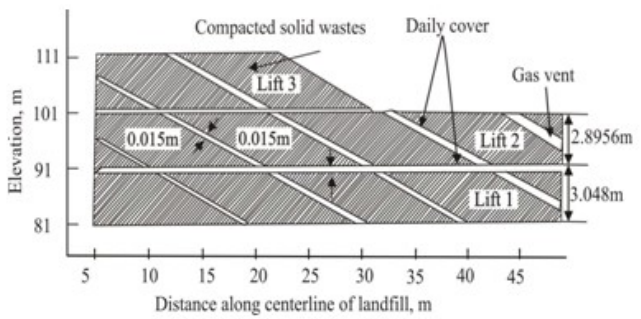

Figure 8 Detail of Cell Construction to be used in Disposal Site

G. Requirements of Cover Material at the Selected Disposal Site

The cover material for each day's accumulation of solid waste is taken from the sides of the fill and from the areas where the subsequent lifts is placed. Some materials available from excavation of the lift is used in operation. Cover material to solid wastes is taken as 1:4.

Table IX ESTIMATION OF COVER MATERIAL

Year	Daily solid wastes volume (m^3)	Daily cover material (m^3)
2019	177.03	44.26
2020	180.57	45.14
2021	184.18	46.05
2022	187.86	46.97
2023	191.62	47.91
2024	195.45	48.86

V. Discussions and Conclusions

Due to increasing population in Monywa city, the daily refuse generation also increases and threatens to the public health and environment. Collection point should be capable of handling of all the waste generated in its concerned area. Layout collection and transportation routes are determined for downtown area in Monywa city. The vehicle taking waste from transfer station to landfill site is fully covered so that vehicle will not cause any environmental hazard. Area of Monywa city is 27.6 km^2 and it has seven dumping site. There are 33107 houses in Monywa city. The samples are collected and analyzed from different places. After collection, all the trucks dump their wastes to the nearest dumping site. The amount of solid wastes is increasing due to the generous use and disposal of almost all matter of everyday use. Therefore, solid waste management system is required for reducing environmental problems. In Monywa city, municipal collection service is used. Based on their mode of operation, collection system is classified into two categories: hauled container systems and stationary container systems. Hauled container with tilt-frame container is used in this city. In recent years, Drop-off center method is used in Monywa. The proposed collection routes for seven quarters in Monywa city with their collection frequencies are determined. For analysis of refuse, socio-economic groups are not considered. Household refuse is considered only. Samples are taken three times. And then, the wastes are separated into various types and each refuse is weighted to make the physical analysis. For landfill design, the area method is used for Monywa city. Area fills are usually located in moderately rolling topography or in large pits if cover material sources are readily available. Solid waste generation of 2024 will be forecasted because of small available areas. According to the census data, the population increase rate of Monywa is taken as 2%. The population for 2024 year is 204649. From refuse analysis results, the average household waste generation of 0.85 kg/capita/day is estimated. Solid waste generation of 2024 is 63492 tons. Thereafter, daily and yearly waste quantities are estimated. The most appropriate site location for solid wastes disposal in Monywa city is selected as Sar-kyinn Cemetery landfill site, which is located at the south of Monywa industrial zone. Yearly area required is 5.8 acres. Therefore, the useful life of the disposal site is found to be about 7 years according to available amount of disposal site. According to the

topography of the landfill site, the first lift is started at an elevation of 81m (245 ft). It is filled with solid wastes to a depth of about 2.8956m (9.5 ft). A 0.015m (6 in) layer of cover material is used to place over the compacted fill at the end of each day. The vents are constructed with a 0.3048m to 0.4572m (12 to 18 in) layer of granular material so that the gases can travel to the surface easily. Cover material to solid wastes is taken as 1:4. Required daily cover material is 48.86 m^3 for 2024 year.

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