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# SOLID WASTE MANAGEMENT OF RAICHUR TOWN

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**Abstract -** *Municipal solid waste management (MSWM) is one of the major environmental problems of Indian cities. Improper management of municipal solid waste (MSW) causes hazards to inhabitants. Various studies reveal that about 90% of MSW is disposed of unscientifically in open dumps and landfills, creating problems to public health and the environment. In the present study, an attempt has been made to provide a comprehensive review of the characteristics, generation, collection and transportation, disposal and treatment technologies of MSW practiced in India. The study pertaining to MSWM for Indian cities has been carried out to evaluate the current status and identify the major problems. Various adopted treatment technologies for MSW are critically reviewed, along with their advantages and limitations. The study is concluded with a few fruitful suggestions, which may be beneficial to encourage the competent authorities/researchers to work towards further improvement of the present system.*

***Key Words***: Muncipal solid Waste, Segregation, Recyclable, Disposal of waste, leachate

## 1. INTRODUCTION

Solid waste is the unwanted or useless solid materials generated from combined residential, industrial and commercial activities in a given area. It may be categorized according to its origin (domestic, industrial, commercial, construction or institutional); according to its contents (organic material, glass, metal, plastic, paper etc); or according to hazard potential (toxic, non-toxin, flammable, radioactive, infectious etc).

Solid Waste Management is one of the most essential services for maintaining the quality of life in the urban areas and for ensuring better standards of health and sanitation. In India, this service falls short of the desired level, as the systems adopted are outdated and inefficient. Institutional weakness, shortage of human and financial resources, improper choice of technology, inadequate coverage and lack of short and long term planning are responsible for the inadequacy of service. Raichur City has having population of 2.34lakhs (as per census 2011) and with an area of 60 SqKms. The City of Raichur though has made a good effort to modernize. For maximizing efficiency and effectiveness of this service, it is necessary to tackle this problem systematically by going into all aspects of the 'Solid Waste Management' (SWM) and device cost effective system which may ensure adequate level of SWM services to all class of citizens, and collection, transportation and disposal of waste in an environmentally acceptable manner in terms of Supreme Court Committee's recommendations as well as Municipal Solid Waste (Management & Handling) Rules 2000.

Agarwalet.al. 2005 investigated recycling of the municipal solid waste (MSW) in the Indian capital city of Delhi. They found that an informal sector comprising waste recyclists and a hierarchy of recyclable dealers plays an important role in the management of solid waste. Sharholyet.al. 2008 reviewed the status of municipal solid waste management in Indian cities. They reported that municipal solid waste management (MSWM) is one of the major environmental problems of Indian cities. Improper management of municipal solid waste (MSW) causes hazards to inhabitants. Upadhyay*et.al.*, 2005 highlights the present scenario of waste management and the options available to convert these wastes into useful products.

In the developed countries, solid waste management (SWM) belongs to prominent thrust areas for pursuing research (Dijkgraaf&Gradus, 2004; Ferrara &Missios, 2005) and economic and technological advancements have initiated responsiveness of stakeholders towards it (Shekdar, 2009). High population growth rates, rapidly varying waste characterization and generation patterns, growing urbanization and industrialization in developing countries (Troschinetz&Mihelcic, 2009) are the important reasons for paying attention towards MSWM as more area is required to accommodate waste (Idris, Inane, & Hassan, 2004). Several studies suggest that reutilizing of solid waste is not only a viable option to MSWM (Kasseva&Mbuligwe, 2000; Sudhir, Muraleedharan, &Srinivasan, 1996) but also desirable—socially, economically, and environmentally (Kaseva& Gupta, 1996; Misra&Pandey, 2005; SchootUiterkamp, Azadi, & Ho, 2011). One of the significant problems in urban India is almost no segregation of MSW and disposal of construction and demolition debris (C&D), plastic wastes, commercial and industrial refuses, and e-waste (Buenrostro&Bocco, 2003; CPCB, 2000a; Position paper on the solid waste managementsector in India, 2009).

### 1.1 Objectives

- To study the existing solid waste management system in study area and to create an updated data base and information system
- To quantify, segregate and to determine the characteristics of solid waste.
- To design a compost plant.
- To design a secured landfill for safe disposal.

➢ To optimize the route for solid waste collection and disposal.

## 2. MATERIALS AND METHODS

### 2.1 Study Area

Raichur has great mythological importance during the period of Ramayana. It is believed that Rama and Seetha had traveled in this area. Gabbur Village of DeodurgaTaluka was said to be the Capital City of King Babruvahana. Weapons and implements made of stone are found in villages called Maski, Karadkal and Kallur. During the 3rd Century, the District was ruled by mauryanDynasty. The excavations reveal that "samratAshoka" ruled in this part of the State. However, some of the excavation reveals that Chalukyas, Rashtrakutas and Hoisalas have ruled the District.

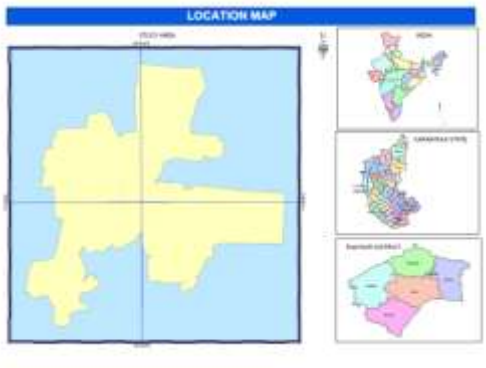


**Fig -2.1**: Raichur District Map

Raichur, the largest Urban Centre in Raichur District, is located at a distance of 336 Kms from Karnataka State Capital, Bangalore. The town is the District headquarters of the Raichur District. The City Municipal Council jurisdiction extends up to an area of 60 Sq.Kms. Housing 2,34,073population within 35 Wards. It is one of the important educational, administrative and trade centre in the State. Raichur is located between two rivers Tungabhadra and Krishna, which flow at a distance of 20 and 30 Kms from the town.

## 3. RESULTS AND DISCUSSION

### 3.1 Estimation of waste generation:

The solid waste segregated and quantified to assess the quantity of organic and inorganic waste. And the same is represented in the following table 1.

**Table -1:** Total Waste Collected From 35 Wards

| Wards | Organic Waste (Kgs/Day) | Inorganic Waste (Kgs/Day) | Total Waste (Kgs/Day) | Organic Waste (%) | Inorganic Waste (%) |
|---|---|---|---|---|---|
| 1 | 1211 | 529 | 1740 | 69.59 | 30.40 |
| 2 | 1804 | 414 | 2218 | 81.33 | 18.66 |
| 3 | 2715 | 979 | 3694 | 73.49 | 26.50 |
| 4 | 2133 | 668 | 2801 | 76.15 | 26.77 |
| 5 | 1953 | 714 | 2667 | 76.28 | 23.71 |
| 6 | 3024 | 668 | 3692 | 81.90 | 18.09 |
| 7 | 1528 | 383 | 1911 | 79.95 | 20.04 |
| 8 | 2109 | 494 | 2603 | 81.02 | 18.97 |
| 9 | 941 | 229 | 1170 | 82.54 | 17.45 |
| 10 | 955 | 180 | 1135 | 84.14 | 15.85 |
| 11 | 911 | 283 | 1194 | 76.29 | 23.70 |
| 12 | 1278 | 530 | 1808 | 70.68 | 29.31 |
| 13 | 2451 | 1241 | 3692 | 66.68 | 33.61 |
| 14 | 1550 | 977 | 2527 | 61.33 | 38.66 |
| 15 | 1388 | 658 | 2046 | 67.83 | 32.16 |
| 16 | 3125 | 1562 | 4652 | 67.17 | 32.82 |
| 17 | 1597 | 1179 | 2776 | 57.52 | 42.47 |
| 18 | 1652 | 1012 | 2664 | 62.01 | 37.98 |
| 19 | 1470 | 1013 | 2483 | 59.20 | 40.79 |
| 20 | 1152 | 445 | 1597 | 72.13 | 27.86 |
| 21 | 2586 | 1237 | 3823 | 67.64 | 32.35 |
| 22 | 1811 | 772 | 2583 | 70.11 | 29.88 |
| 23 | 1365 | 846 | 2211 | 61.73 | 38.26 |
| 24 | 1232 | 975 | 2207 | 55.82 | 44.17 |
| 25 | 1763 | 1071 | 2834 | 62.20 | 37.79 |
| 26 | 1732 | 1161 | 2839 | 61.00 | 39.69 |
| 27 | 2172 | 1250 | 3422 | 79.25 | 20.74 |
| 28 | 1197 | 488 | 1685 | 71.03 | 28.96 |
| 29 | 4785 | 1305 | 6090 | 78.57 | 21.42 |
| 30 | 1091 | 244 | 1335 | 81.72 | 18.27 |
| 31 | 2287 | 650 | 2937 | 77.86 | 22.13 |
| 32 | 1436 | 350 | 1786 | 80.40 | 19.60 |
| 33 | 3510 | 1026 | 4536 | 77.38 | 22.61 |
| 34 | 1906 | 635 | 2541 | 75.00 | 25 |
| 35 | 2323 | 630 | 2935 | 79.14 | 20.85 |
| TOTAL | 66143 | 26798 | 92941 | 71.16 | 28.84 |

The total solid waste generated in the city of raichuris found to be 93 tons/day. The population being in the city 2, 70,281. The per capita waste produced the from the city is 0.35 kg/day.

### 3.2 Moisture Content:

Moisture content is measured immediately after the collection of sample, wet weight of the sample is measured, and is dried in the oven at a temperature of $105^0$C till the weight is constant. The dried sample is then cooled at room temperature and weighed again.

Moisture content, $M = \left(\frac{w-d}{w}\right) x100$

Where, M = moisture content, %
w= initial mass of sample as delivered, kg
d= mass of sample in kg after drying at 105°C

**Table-2:** Average Moisture Content Of Raichur Municipal Solid Waste

| SL. NO | WARD SAMPLE | WET WEIGHT(gms) | DRY WEIGHT(gms) | MOISTURE CONTENT (%) |
|---|---|---|---|---|
| 1 | Sample no.1 | 1897 | 1489 | 21.50 |
| 2 | Sample no.2 | 1785 | 1421 | 20.39 |
| 3 | Sample no.3 | 2189 | 1648 | 24.71 |
| 4 | Sample no.4 | 1564 | 1179 | 24.61 |
| 5 | Sample no.5 | 1765 | 1237 | 29.91 |
| 6 | Sample no.6 | 1961 | 1527 | 22.13 |
| 7 | Sample no.7 | 1766 | 1287 | 27.12 |
| 8 | Sample no.8 | 1639 | 1221 | 25.50 |
| 9 | Sample no.9 | 2055 | 1418 | 31 |
| 10 | Sample no.10 | 1739 | 1208 | 30.53 |
| 11 | Sample no.11 | 2355 | 1601 | 32 |
| 12 | Sample no.12 | 1633 | 1176 | 27.98 |
| 13 | Sample no.13 | 1914 | 1277 | 33.28 |
| 14 | Sample no.14 | 1453 | 974 | 33.24 |
| 15 | Sample no.15 | 1752 | 1170 | 33.21 |
| 16 | Sample no.16 | 1369 | 1041 | 23.95 |
| 17 | Sample no.17 | 2161 | 1615 | 25.26 |
| 18 | Sample no.18 | 1605 | 1181 | 26.41 |
| 19 | Sample no.19 | 2176 | 1578 | 27.45 |
| 20 | Sample no.20 | 2281 | 1562 | 31.52 |
| 21 | Sample no.21 | 1962 | 1420 | 27.62 |
| 22 | Sample no.22 | 1759 | 1325 | 24.67 |
| 23 | Sample no.23 | 1529 | 1125 | 26.42 |
| 24 | Sample no.24 | 2039 | 1444 | 29.18 |
| 25 | Sample no.25 | 2237 | 1763 | 21.18 |
| 26 | Sample no.26 | 2189 | 1623 | 25.85 |
| 27 | Sample no.27 | 1971 | 1497 | 24.04 |
| 28 | Sample no.28 | 2187 | 1655 | 24.32 |
| 29 | Sample no.29 | 2608 | 1985 | 23.88 |
| 30 | Sample no.30 | 2437 | 1797 | 26.26 |
| 31 | Sample no.31 | 1867 | 1467 | 21.42 |
| 32 | Sample no.32 | 2127 | 1657 | 22.09 |
| 33 | Sample no.33 | 2237 | 1687 | 24.58 |
| 34 | Sample no.34 | 2485 | 1645 | 33.80 |
| 35 | Sample no.35 | 2247 | 1706 | 24.07 |
| | | | AVERAGE | 26.60 |

### 3.3Measurment of Density:

The density of the waste is measured by a cubic meter box method. During sample collection in the dumping yard at different places and separate them and fill the waste into the box until it get filled up.

- Specific weight is defined as the weight of a material per unit volume (e.g. kg/$m^3$).
- Usually it refers to uncompacted waste

**Table-3:** Average Density of Total Wastes Collected From 1 to 35 Wards

| Ward NO | FOOD WASTE (kg/$m^3$) | PAPER (kg/$m^3$) | PLASTIC (kg/$m^3$) | GLASS (kg/$m^3$) |
|---|---|---|---|---|
| 1 | 347 | 85 | 64 | - |
| 2 | 332 | 74 | 59 | - |
| 3 | 383 | 79 | 67 | - |
| 4 | 358 | 77 | 62 | - |
| 5 | 371 | 83 | 65 | - |
| 6 | 372 | 86 | 70 | - |
| 7 | 322 | 79 | 66 | 178 |
| 8 | 341 | 90 | 55 | 198 |
| 9 | 372 | 89 | 67 | 208 |
| 10 | 347 | 76 | 91 | 191 |
| 11 | 332 | 69 | 101 | - |
| 12 | 360 | 65 | 98 | 186 |
| 13 | 345 | 63 | 82 | 195 |
| 14 | 380 | 54 | 84 | 216 |
| 15 | 310 | 55 | 87 | 176 |
| 16 | 351 | 67 | 92 | 183 |
| 17 | 310 | 74 | 88 | - |
| 18 | 387 | 55 | 95 | - |
| 19 | 325 | 56 | 93 | 188 |
| 20 | 371 | 57 | 95 | 207 |
| 21 | 291 | 59 | 87 | 184 |

| | | | | |
|---|---|---|---|---|
| 22 | 347 | 65 | 97 | - |
| 23 | 344 | 68 | 97 | 188 |
| 24 | 355 | 76 | 107 | 196 |
| 25 | 375 | 59 | 96 | 196 |
| 26 | 318 | 60 | 88 | 181 |
| 27 | 353 | 57 | 96 | 183 |
| 28 | 372 | 60 | 93 | 192 |
| 29 | 349 | 55 | 76 | 187 |
| 30 | 347 | 59 | 95 | 187 |
| 31 | 348 | 65 | 94 | - |
| 32 | 355 | 72 | 97 | 187 |
| 33 | 367 | 72 | 107 | 195 |
| 34 | 361 | 63 | 99 | 191 |
| 35 | 328 | 65 | 87 | 182 |
| **AVG** | 350 | 69 | 86 | 191 |

### 3.4 Segregation of Waste at Source

The Segregation at source is practiced in City Municipal Council Raichur, there is separate collection system for segregated waste.

Raichur city generates mixed type of waste, which contains all the verity of waste materials which are present in typical MSW of developing countries, i.e, food and vegetable waste, paper, plastic, cloth, rubber, leather, wood, glass, rags, miscellaneous waste, and bricks etc.

At first, plastic, paper and organic wastes are separated in pushcarts by workers only. Then at treatment plastic, paper, glass etc. are separated manually by labour's.

**Table-4: Composition of SWM**

| SL NO | Component | Percentage by mass |
|---|---|---|
| 1 | food & vegetable waste | 67.08 |
| 2 | Paper | 12.55 |
| 3 | Plastic | 8.33 |
| 4 | Metal | 6.9 |
| 5 | Cloth | 3.69 |
| 6 | Glass | 1.4 |
| | Total | 100 |

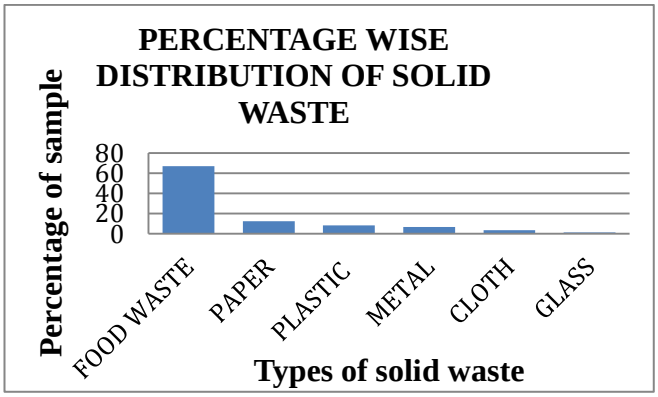


**Fig -3.4.1:** Percentage Wise Distribution of Solid Waste

### 3.5 Bangalore method Of Composting

- This is an anaerobic method conventionally carried out in pits. Formerly the waste was an aerobically stabilized in pits were alternate layers of MSW and night soil were laid.
- The pit is completely filled and a final soil layer is laid to prevent fly breeding, entry of rain water into the pit and for the conservation of the released energy.
- The material is allowed to decompose for four to six months after which stabilized material is taken out and used as compost.

**Calculation of area required for composting:**

Total waste generated per day = 66TPD
Waste generated for 10 days app = 660 TONNES
According to Indian standard density of
Solid waste is = 350 kg/$m^3$
Volume of waste generated (for 10 days) = ($660X10^3/350$)
Waste is compacted for a height of 4m = 1886 $m^3$
Hence area required for one pit = 472 $m^2$
Let us select a breadth of 10m,
Therefor length of pit = 472/10 = 47 m
The size of each pit = $47*10m^2$
Let there be five pits
Therefore area for five pits = $470*5 = 2350 m^2$

Hence after a pit is filled after 10 days by compacting in layers, next pit is started to be filled. After a period of 40-45 days the waste is converted to manure. So the area required for the process of Bangalore method for the total waste collected in 10 days for 660 tons is 2350 $m^2$.

1 ton of organic waste produces 20 to 30 kg of manure per ton.

Therefore, 660 ton of organic waste produces = 660 x 30 = 19600 kg of manure.= 19.6 tons of manure for 10 days.


**Fig 3.5.1** Bangalore method of composting

Manure produce per month = 19 x 3 = 57 tons
Amount obtained per ton from manure= 3000 rs

Revenue generated for ULB=57 X 3000= 1,71,000rs/month.

### 3.6 Landfill Design

The landfill designer must address is whether the unit will be above or below ground. Above ground disposal is particularly attractive for sites with shallow water tables. Above - ground landfills have the advantage that leachate can be drained by gravity, the facility is conspicuous and not easily forgotten or ignored, and construction of liner and drainage system components occurs on more or less level ground, which simplifies construction. Vertical expansions of existing facilities essentially constitute above-ground landfill.

**The Estimation Of Landfill Capacity (Volume/Height/Area) Is Carried Using The Following Steps:**

1. Waste generated per day = 27 tons per day

2. Waste generation rate = 27 x 365 = 9855 tons per year

3. Active life of landfill = 1 years

4. Total waste in 10 years (T) =9855 x 10 = 98550 tons

5. Volume of waste (V) = (98550000/350) = 281571 $m^3$

6. Volume for daily cover = 0.1 V= (0.1 x 28157)= 28157.1 $m^3$

7. Volume for liner and final cover = 0.2V = (0.2 x 28157)=56314.2 $m^3$

8. Total volume (Landfill capacity) = V+0.1V+0.2V = 1.3V = (1.3 X 281571)= 366042 $m^3$

9. Total area available = 91510 $m^2$ = 22.6 acres

10. Area for infrastructure ( office, weighing room, equipments, handling room )= 0.20A = (0 .20 x 91510) =18302 $m^2$

11. Area of land filling = A-0.2A = 0.8A = (0.80 x 91510) =73208 $m^2$

12. Area of land filling in acres = (73208 / 4046) =18 acres

13. Height (+depth) of landfill = 1.30V/0.8A = (366042 / 73208) =5m

(This is a preliminary estimate on the assumption that plan dimensions are much larger than the Height)

**Estimation of leachate production**

The estimate of identified landfill area (A), was multiplied by the annual rainfall (R). The product is expressed as volume (V).

V = (15% of average rainfall) x Area
= (0.15 x R) x A = (0 .15 x0 .638 x 73208) = 7006 $m^3$ for 10 years = 7lits for 10 years

Where V is the volume of leachate discharge in a year ($m^3$ for 10 year)

R is the annual rainfall (m)

A is the surface area of the landfill ($m^2$)

### 3.7 Container Location And Route Proposed To Disposal Site

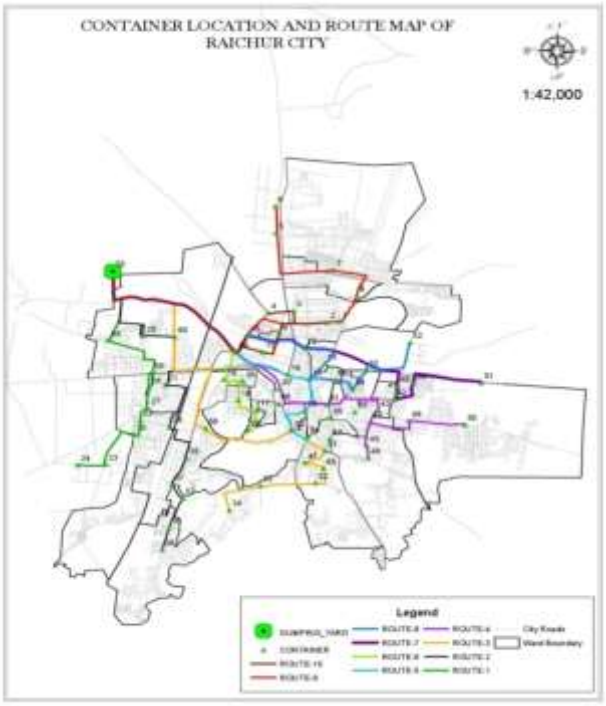


**Fig 3.7.1** Dust Bin Locations and Route Proposal

**Table-5:** Routes for Existing Collection and Transportation of Municipal Solid Waste to dumping yard

| Route no | Distance of each route in km | No of trips | Total Drivers and labours | Total weight in tons |
|---|---|---|---|---|
| R1 | 4.8 | 3+2CL | 4D+8L | 7.5 |
| R2 | 6.7 | 4+3CL | 6D+12L | 10.5 |
| R3 | 8.7 | 4+3CL | 6D+12L | 10.5 |
| R4 | 8.19 | 4+3CL | 6D+12L | 10.5 |
| R5 | 5.2 | 3+2CL | 4D+8L | 7.5 |
| R6 | 4.7 | 2+2CL | 3D+6L | 6 |
| R7 | 7.1 | 4+2CL | 5D+10L | 9 |

| | | | | |
|---|---|---|---|---|
| R8 | 6.9 | 5+3CL | 7D+14L | 12 |
| R9 | 7.5 | 5+3CL | 7D+14L | 12 |
| R10 | 5.7 | 3+2CL | 4D+8L | 7.5 |
| | | | Total | 93 |

**Capacity of vehicle for transportation:**

a) Tractor = 1.5 ton/trip
b) Container lifter (two container/trip) = 1.5ton/trip
c) No. Of labours per Vehicle = 1 driver + 2 labours

Cost waste collection and conveyances = Fuel charges + Driver and Labour charge = 4340 + 68900= 73,240 rs/day= 21, 97,200rs/month

Waste collection charges per month = Total houses x50 rs per house = 46866 x 50=23,43,300rs/month

Sum of profit generated from sells of manure and waste collection charges from house hold==1,71,300 + 23,43,300
=25,14,600rs/month

Net profit generated from SWM =25,14,600 – 21,97,200
=3,17,400rs/month

## 4. CONCLUSIONS

Based on the present study on swm of Raichur Town, the following conclusions can be deawn.

1. General rate of municipal solid waste is 0.35 kg/person/day.
2. Average moisture content of 35 wards is 26.6 %.
3. Food& vegetable waste is 67.08%, paper is 12.55%, cloth is 3.69%, plastic is 8.33%, metal 6.9%, glass is 1.4%.
4. The average density of 35 wards is as follows.
   Food waste = 350 kg/$m^3$
   Paper =69 kg/$m^3$
   Plastic = 86 kg/$m^3$
   Glass = 191 kg/$m^3$
5. The refuse of the area under consideration contains high percentage of compostable matter. Therefore "composting" method can be practiced yielding high amount s of manure for transporting solid wastes to landfill.
6. The area required for Bangalore method is 2350 $m^2$, manure produce per month is 57 tons, amount obtained per ton from manure 3000 rs, and revenue generated for ULB from 57 tons of manure Rs.1,71,000
7. The area required for land fill design is 18 acres , and leachate produced for 10 years is 7 litres
8. Sum of profit generated from sells of manure and waste collection charges from house hold per month is Rs.25,14,100
9. Net profit generated from SWM per month is Rs. 3,16,900.

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