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Recommendations for Waste Management in Kalaburagi

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Abstract: **The article aims at effective waste management measures based on research question 'What collection, transportation and treatment options are required to create an Integrated Solid Waste Management facility for Kalaburagi city (previously known as Gulbarga)?' The city is often criticized for its poor waste management practices. The paper is based on a hypothesis that the Gulbarga Municipal Corporation is looking for waste management recommendations and the data required for making suggestions are collected from local case studies and international examples. Data collected is the solid waste amounts from various waste- generating sources in order to calculate the suggested waste collection containers, transport vehicles and the details of treatment facility. Transport vehicles are categorised into primary and secondary, whereas the treatment facility consists of an incineration (waste to energy) plant, mechanical biological treatment and sanitary landfill. A conceptual design of the facility along with the material flow analyses to and also at the treatment facility helps in identifying the functionality aspects to determine its feasibility.**

Keywords: **Integrated Waste Management, Waste Collection, Waste Transportation, Waste Treatment.**

I. INTRODUCTION

A. Research Aim

The report considers local conditions to recommend a waste management design which includes the infrastructure required for a **direct collection system (without a transfer station).** The city municipality is often blamed for poor management strategies [5]. The objective is collecting data on the solid waste generated from various sources to decide on the ideal requirements to propose an integrated approach to deal with the waste.

B. About the City

Kalaburagi (previously known as Gulbarga) is one of the larger cities in Karnataka (one of the 29 states of India) and is a well-known historical, commercial and education centre. It is the administrative headquarters of Kalaburagi District and is located at a distance of 613 km from state's capital Bengaluru (Bangalore). The Gulbarga Municipal Corporation (GMP) has classified Gulbarga into 55 wards for administrative purposes. It covers an area of about 64 square km and has a population of nearly 6, 50,000 as per the 2017 census [7].

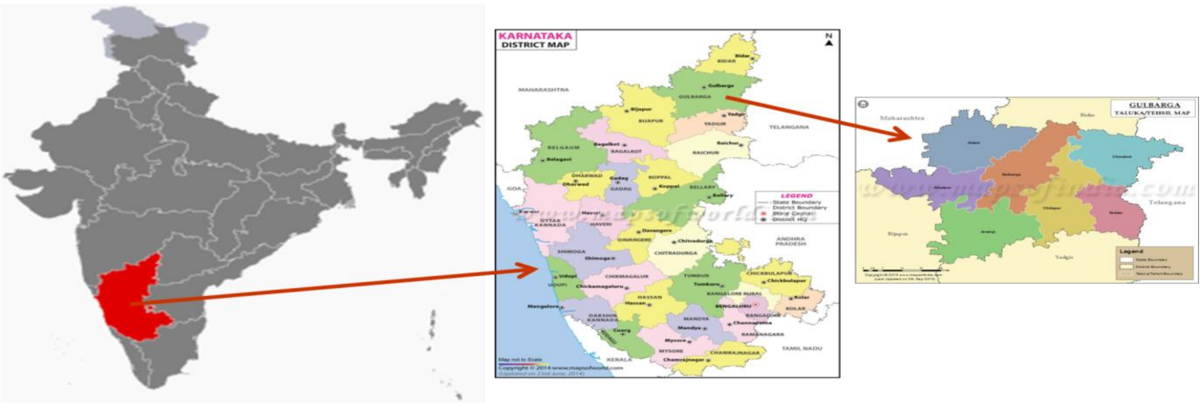

Fig 1. Political map of India, Karnataka State and Kalaburagi City respectively [5]

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C. Hypothesis

This report is made on an assumption that the GMP is looking for waste management practices focusing on improving collection, treatment & disposal of the waste generated in the city. The GMP is the Urban Local Body (ULB) responsible for providing basic civic services like roads, water supply & sewerage, health & sanitation, storm water and solid waste disposal for the city of Gulbarga [3]

II. WASTE AMOUNT GENERATED IN THE CITY

A. Waste Generation Estimate based on Generators

The major sources of generating waste in Gulbarga are households, commercial establishments, hospital and clinics, educational institutions, markets, hotels and street sweeping operations. To arrive at number of waste generators in the city, data like ward wise population, slum and non-slum households and street lengths of all type of roads were obtained from a survey conducted by Tide Technocrats Private Limited (TTPL) in Gulbarga [8]

Table 1. Data of waste generated based on generators [8]

Sl. No.	Waste generators	No. of waste generators	Avg waste per source in Kgs	Total waste in Kgs	Total waste in Tonnes
1	Household	170000	1.2	204000	204
2	Commercial shops	25000	1.6	40000	40
3	Hospitals (MSW)	800	5.1	4080	4.08
4	Small hotels	600	4.1	2460	2.46
5	Large hotels	100	11	1100	1.1
6	Markets (major)	28	1230	34440	34.44
7	Street sweepings				
	Type A - High density areas	400	29	11600	11.6
	Type B - Medium density areas	1200	9.1	10920	10.92
	Type C - Low density areas	500	4.1	2050	2.05
8	Educational institutes	900	6.4	5760	5.76
9	Miscellaneous waste	5%			15.82
	Total				332.23

Table 2. Data on frequency of sweeping depending on the categories of street [8]

Parameter	Length of roads in km	Frequency of sweeping
Type A - High density areas	202.4	Daily
Type B - Medium density areas	369.6	Twice a week
Type C - Low density areas	445.9	Once a week

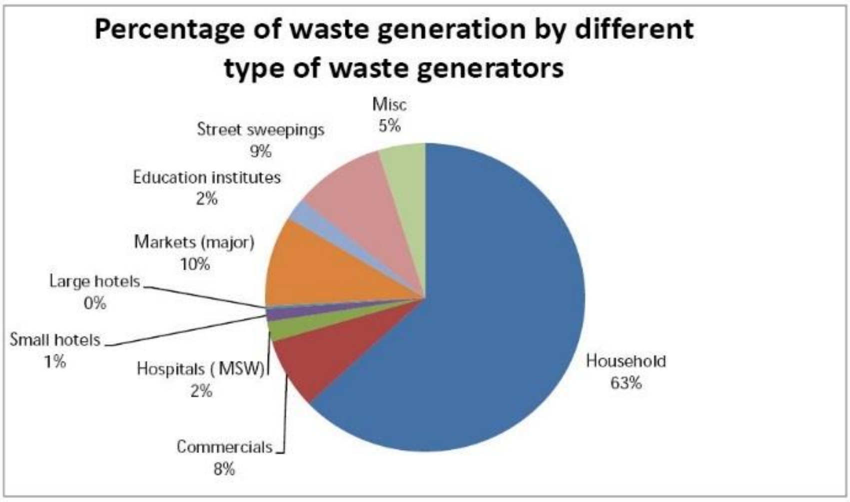

Fig 2. Waste generation chart of Kalaburagi city [8]

B. Normative Estimate of Waste Generation

Gulbarga city being the hub for education, administration, commercial activity and medical services in the Hyderabad Karnataka region experiences about 0.5 lakh of floating population on an average. The central bus terminus and the railway station are the gate ways of the floating population. The movement of the floating population is seen much near the super market area, mini vidhan soudha, station road, central bus terminus and railway station area.

Considering a per capita waste generation of 500 grams by the residents of the city, the normative waste quantity in Gulbarga is estimated to be around 325 tons per day (TPD). The floating population of the city is contributing to the waste quantity by adding up about 5-7 tons of waste every day. Considering the normative standards and the quantity of waste generated by different waste generators, it is estimated that the Gulbarga city generates about 332 TPD of waste every day [7]

III. NECESSARY WASTE COLLECTION CONTAINERS

A. For kerbside collection

Total waste to be collected = 332 Tonnes(T)/day

Suggested container: Material is galvanized steel with powder coating and robust arms which facilitate the use of garbage collection vehicle. Also, automatic lid opening while collecting waste with vehicle.

Volume of each container = 1m3 and Density of waste in container = 0.25T/m3

Volume of waste collected by all containers in 1 day = 332/0.25 = **1328m3 (approx.1400m3)**

Hence, **1400 containers** of each **1m3 volume** are required to collect the waste [2].


Fig 3. Images of suggested waste container and procedure of collecting with vehicle [1],[4]

IV. NUMBER OF TRANSPORT VEHICLES

A. Types of Transportation

The transportation of the waste would be classified into primary and secondary transportation. The primary transportation vehicles will be auto tippers and hand carts involved in door to door collection. These primary transportation vehicles will collect the waste from the generators on a daily basis and dispose the waste into waste collection containers. The secondary transportation would be by compactors and tractor trailers. The compactors will be used to transport the waste from collection containers to the suggested Integrated Solid Waste Management (ISWM) facility. Whereas, tractor trailers will be used to transport drainage waste, construction and demolition debris (Sampath, 2014, p. 47). The following calculations have been made based on year 2018 statistics.

B. Primary Transportation

The primary transportation vehicles will collect the waste on a daily basis from households, commercial establishments including shops, hotels etc; solid waste generated in hospitals and from institutions like school, college, temple, theatre & malls. For the city:

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No. of auto tippers required = 58

No. of hand carts required = 88 [8]

Fig 4. Images of primary transportation means: auto-tippers and hand carts (IndiaMart, 2019) [6]

C. Trucks with compactor and time taken

Volume of each truck = 10m3 and Density of waste in truck = 0.6T/m3 [2]

Volume of waste collected by all truck in 1 day = 332/0.6 = **553.33m3 (approx.560m3)**

Considering 1trip by each truck every day;

We have, no. of trucks required = 560/10 = 56 trucks

Therefore, 1400/56 = **25 containers compacted into 1 truck**

Fig 5. Image of suggested truck with compactor (Gillard, 2019) [6]

Time to collect each container by one truck = 5 mins.

Therefore, time taken to collect 25 containers by each truck = 25x5 = 125mins (2hrs 05mins)

Collection time = **2hrs 05 mins**

Going and returning from ISWM facility = **1hr 25mins**

Total time required for 1 trip by each truck = **3hrs 30 mins**

Assuming 3 trips per truck every day;

Number of trucks required = 56/3 = **18.66 (approx.19 trucks)**

Hence, **19 trucks** of each **10m3 volume** are required assuming **3 trips** are completed by every truck for transport of waste from waste containers to ISWM facility.

D. Tractor trails

It is proposed that the construction and demolition waste generated in the city will be collected using tractor trailers. The waste generators would inform the respective service provider for removal of the debris. The service provider would collect the debris and dispose the same into low lying areas of the city. For the city:

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No. of tractor trailers required = 26 [2]

Fig 6. Image of suggested tractor trailer (IndiaMart, 2019) [6]

V. CAPACTIES AT ISWM FACILITY

A. Annual MSW generated

Waste from 0.7 million inhabitants (i.e. 0.65 million residents and 0.05 floating population) every day = 332 tons. Therefore, MSW generated from 0.7 million inhabitants every year = 332 tons x 365days =**1, 21,180 tons (0.12 million tons).**

B. Waste to Energy (WTE) incineration plant

We have, annual MSW=1, 21,180 tons (0.12 million tons)

Assuming 0.020 million tons (i.e.17% of annual MSW) goes to the incineration plant

We have, energy content of MSW = 6 MJ/kg or 6000 MJ/ton

=> Total energy content = 0.020 million x 6000 = **120 million MJ**

Considering energy efficiency = 25%

E(electricity)= 120million X 0.25 = **30million MJ or 8.10million KWH** (as 1MJ = 0.27 KWH)

Average electricity consumption per person every year = 1,700 KWH

So, 8.10million KWH electricity can be utilized by = 8.10mill / 1,700 = **4,764 persons (or)**

0.73 % of the population

Average cost of incineration = 90 Euros/ton

So for 0.020million ton, the total cost would be = **1.80 million Euros**

C. Sanitary Landfill (Final Disposal)

Assuming 0.0624 million tons (i.e.52% of annual MSW) goes to the landfill

We have, energy content of 1 ton MSW = 200m3 of landfill gas (LFG)

=> Total energy content = 0.0624million x 200 = **12.48million m3 LFG**

Out of which only 50% is methane i.e. **6.24million m3**

And only 33% can be collected i.e. **2million m3** of Methane

We have, energy content of Methane**=** 35.8 MJ/m3

=> Total energy generated = 35.8 x 2 = **71.6 Million MJ**

Considering energy efficiency as 50%, the electricity generated = **35.8 Million MJ**

1 MJ = 0.27 KWH

=> 35.8 Million MJ = 35.8 x 0.27 = **9.66 Million KWH**

Average electricity consumption per person every year = 1,700 KWH

So, 9.66 million KWH electricity can be utilized by = 9.66 mill / 1,700 = **5,682 persons (or) 0.87% of the population**

Average cost of landfilling = 20 Euros/ton [2]

So, for 0.0624 million ton, the total cost would be = **1.24 million Euros**

D. Mechanical Biological Treatment (MBT)

Assuming 0.0132 million tons (i.e.11% of annual MSW) goes to the MBT plant, out of which 30% is Refuse-derived fuel (RDF) and 70% is for biological treatment.

=> Total RDF = **0.00396 million tons**

We have, energy content of RDF = 14 MJ/kg or 14000 MJ/ton

E(RDF) = 0.00396million X 14000 = **55.4million MJ**

We have, E(coal) = 25 MJ/kg

=>Coal substitution = **0.0022 million tons**

Average cost of coal = 50 Euros/ton

=> **Save:** 0.0022 million tons x 50 = **0.11 Million Euros**

VI. AREA OF ISWM FACILITY

A. Area calculations

For Waste Collection:

Annual waste = 1million tons

M (waste) = **1 million tons**

V (waste) = **1 million m3** (as waste density is 1ton/m3)

=>**Area required for collection** = 1million/2 (considering height as 2m) = **0.50 million m2**

For Incineration Plant:

Assuming 0.17 million tons (i.e.17% of annual MSW) goes to the incineration plant

For the DSWMC in Qatar (i.e. benchmark shown below) 18,000m2 area is required for 0.36 million tons annual waste

=> **Area required for incineration=** (18,000x0.17)/0.36 = 8,500 m2 or **0.0085 million m2**

For Sanitary Landfill:

Assuming 0.52 million tons (i.e.52% of annual MSW) goes to the landfill

And Operational period = 20 years

M (waste) = **10.40 million tons**

V (waste) = **10.40 million m3** (as waste density is 1ton/m3)

=>**Area required for landfill**= 10.4million/15 (considering height as 15m) =

0.69 Million m2

For MBT:

Considering 100m2 and the design shown below in plan and elevation:

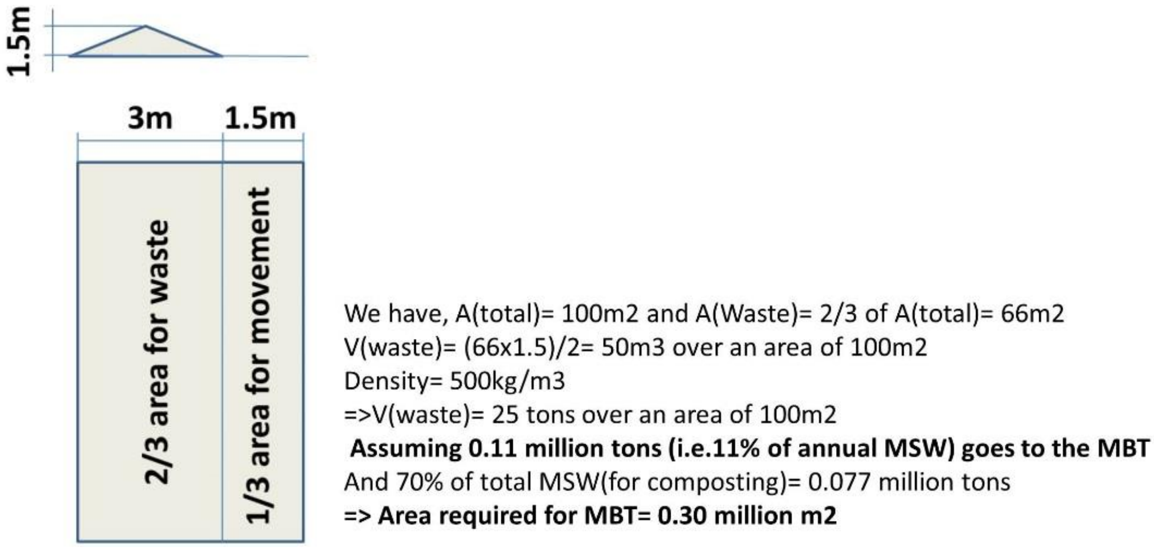

Fig 7. Conceptual Plan and Elevation of MBT facility for calculation

For Recycled Storage:

Assuming 0.20 million tons (i.e.20% of annual MSW) goes to the recycling plant

For the DSWMC in Qatar (i.e. benchmark shown below) 28,800m2 area is required for 0.36 million tons annual waste

=> **Area required for recycled storage**= 16,000 m2 or **0.016 million m2**

Total for ISWM Facility:

Hence, the total area required for waste collection, treatment and final disposal is **2.02 Million m2 (500 acres). Note: The infrastructure and services area is assumed to be 0.50Million m2.**

Table 3. Total area of ISWM facility

Facility	Area Required
Waste Collection	0.50 Million m2
Incineration Plant	0.0085 Million m2
Sanitary Landfill	0.69 Million m2
MBT	0.30 Million m2
Recycled Storage	0.016 Million m2
Infrastructure & Services (approx.)	0.50 Million m2
TOTAL	**2.02 Million m2**

B. Proposed Conceptual Design

Designed to treat a capacity of 1million tons a year (or) 2740 tons of waste a day, the proposed ISWM facility will comprise of waste sorting and recycling facilities, landfill, composting plant and a waste-to-energy (WTE) incineration plant. **The facility will be located over an area of 2.02 Million (or) 500 acres in Udnoor which is about 12kms from the city centre.** Bio medical waste generated by Hospitals and clinics is separately collected by the existing Common Healthcare waste Appropriate Management Plant (CHAMP) facility and will not be a part of this facility. The waste brought to the facility by compactors will be dumped in the collection area and JCB is deployed to form heaps of the wastes and for transporting within the facility (for eg: from collection area to incineration plant to landfill area) (Sampath, 2014, p. 10).

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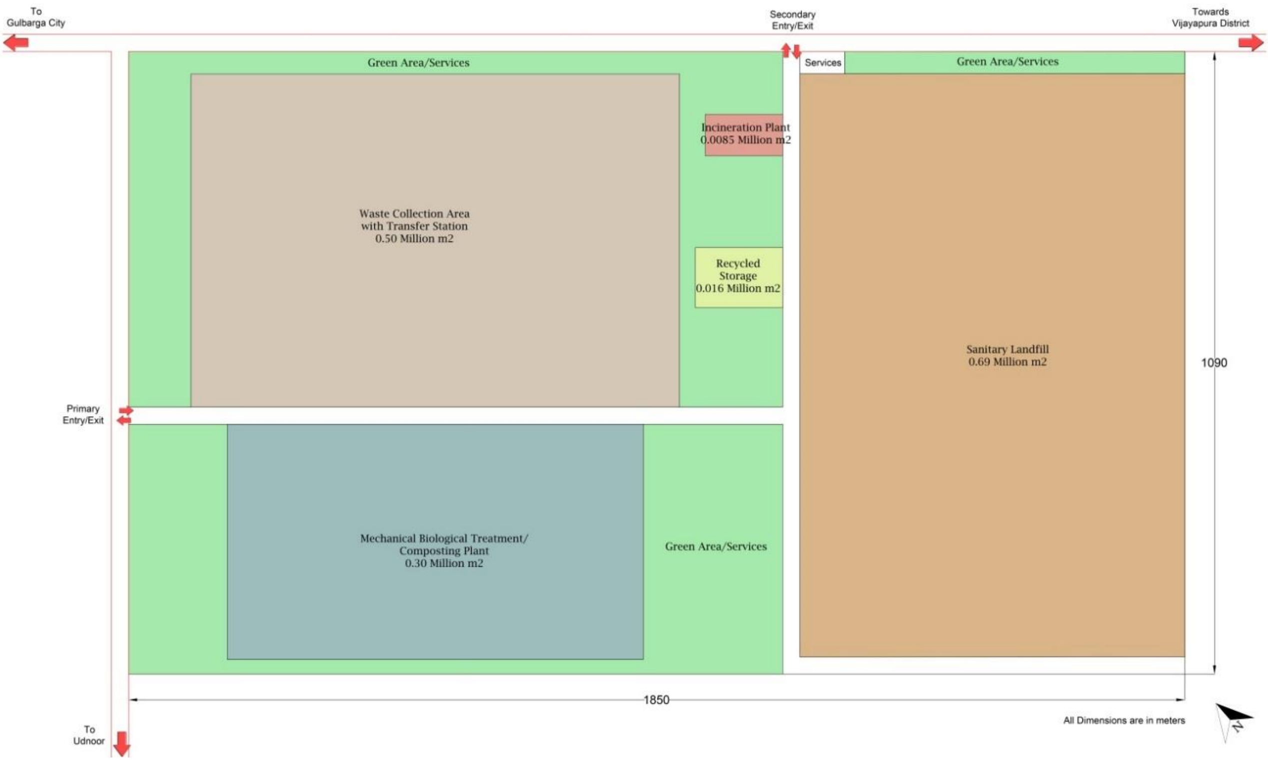

Fig 8. Proposed conceptual design of ISWM facility

C. Benchmark

Keppel Seghers will design and build four Waste Transfer Stations and one Integrated Domestic Solid Waste Management Centre (DSWMC) to handle and treat domestic solid waste for the whole of Qatar. Designed to treat an initial capacity of more than 1,550 tons of waste a day, the DSWMC will comprise waste sorting and recycling facilities, landfill, composting plant and a 1000 tons per day waste-to-energy (WTE) incineration plant.

VII. MATERIAL FLOW ANALYSIS (MFA)

The values shown in the following images are MSW generated/transported in tons/day. It is an analyzes of the waste flow (in numbers or percentage) from all sources till its final treatment.

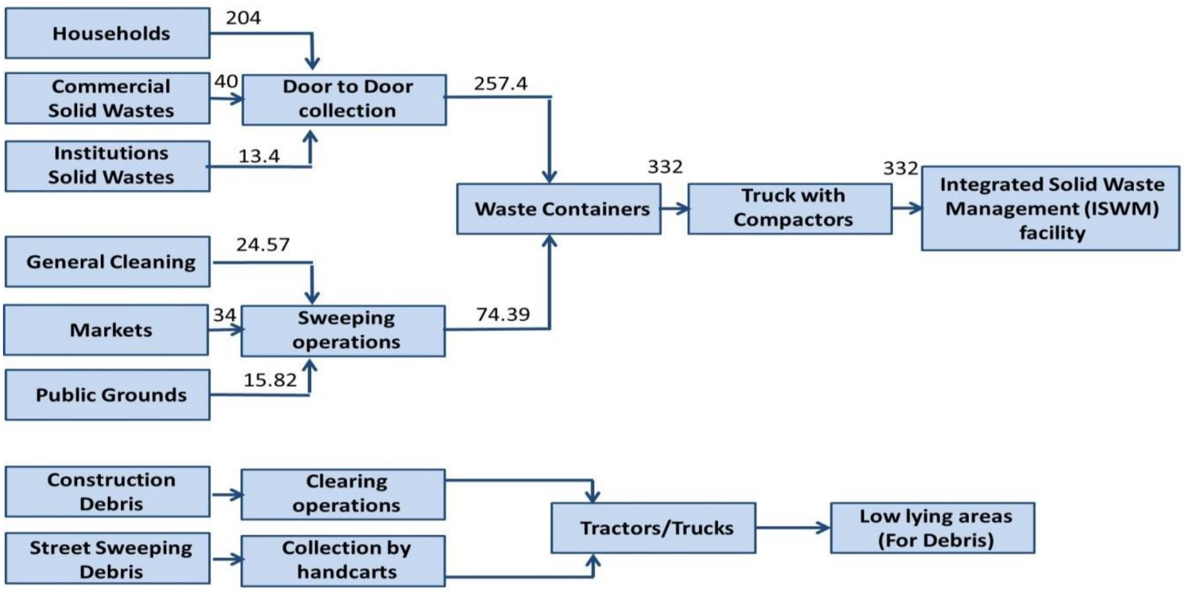

Fig 9. Estimated waste flow for Gulbarga city

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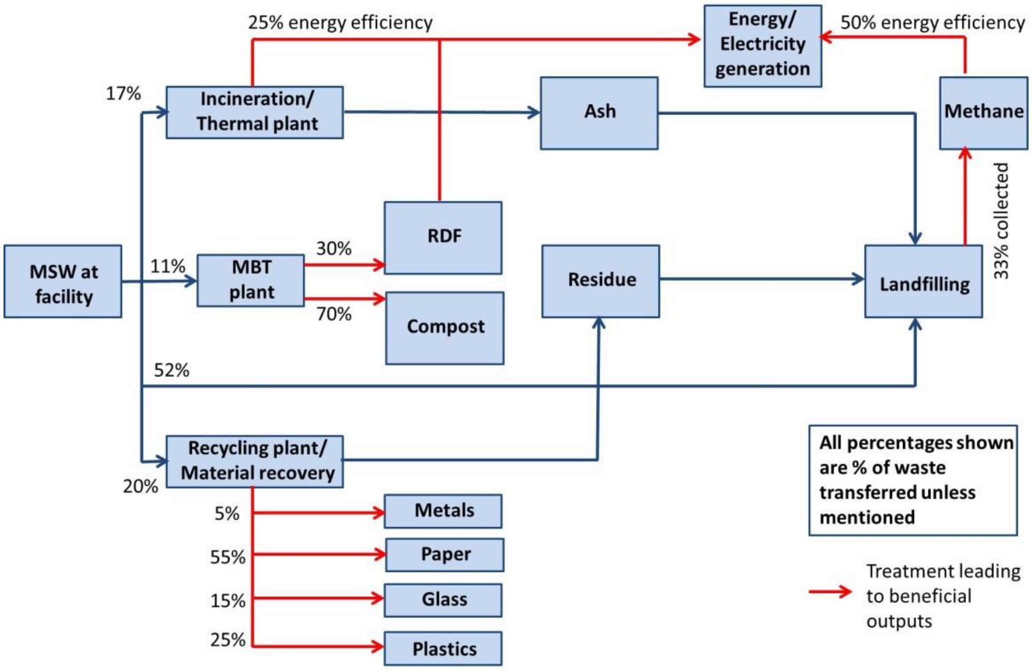

Fig 10. Estimated waste at ISWM

VIII. CONCLUSION

A superficial concept for collection, treatment and disposal of waste has been prepared as a suggestion for the Gulbarga Mahanagara Palike. The plan envisages a combination of municipal managed facility and outsourced methods for collection and transport of MSW. The concept is in accordance with the MSW (Municipal Solid Waste) rules 2000. The MFA and the availability of international benchmark confirms the feasibility of such a design. However, there are certain limitations such as the economic feasibility which hasn't been calculated. Even though the savings in Euros has been calculated, the mediums of funding and project budget require in-depth calculations. Legal considerations such as local laws, rules and regulations consideration would help in determining its actual workability. However, such an integrated approach has several co-benefits not just ecologically and economically but also socially due to the creation of more jobs and employment opportunities; all of which are required for a sustained growth of the city in the decades to follow.

IX. ABREVIATIONS

CHAMP - Common Healthcare waste Appropriate Management Plant

DSWMC – Domestic Solid Waste Management Centre

GMP - Gulbarga Municipal Corporation

ISWM – Integrated Solid Waste Management

MBT – Mechanical Biological Treatment

MFA - Material Flow Analysis

MSW – Municipal Solid Waste

RDF – Residual Derived Fuel

T - Tonnes

TPD – Tons Per Day

TTPL - Tide Technocrats Private Limited

ULB – Urban Local Body

WTE – Waste to Energy

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